DEPARTMENT OF MATHEMATICS

BIRPARA COLLEGE

LESSON PLANNING

FOUR YEAR UNDERGRADUATE PROGRAMME IN MATHEMATICS

THE NEW CURRICULAM FRAMEWORK,2022

MATHEMATICS(MAJOR)

SEMESTER-I

PAPER CODE-UMATMAJ11001

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

CLASSICAL AND LINEAR ALGEBRA

Topic	Number of Lectures Allotted
Complex numbers: Polar representation, De Moivre's theorem for rational indices and its applications. Trigonometric, logarithm, exponential and hyperbolic functions of complex variable.	10
Theory of equations: Fundamental theorem of Classical Algebra (statement only), relation between roots and coefficients, symmetric functions of roots, transformation of equation, Descartes' rule of signs, Sturms' theorem, cubic equation (Cardan's method), biquadratic equation (Ferrari's method).	15
Inequality: AM ≥ GM ≥ HM, theorem of weighted means and m-th power theorem (statement only), Cauchy-Schwartz inequality (statements only) and its application.	5
Matrices: Inverse of a matrix, characterizations of invertible matrices, elementary operations and matrices, echelon matrix, row/column reduced echelon matrix, rank of matrix, normal forms, equivalency and congruency of matrices.	15
Systems of linear equations: Consistency in equivalence system, Solution of homogeneous system AX=0, Solution of nonhomogeneous system AX=B using row reduced echelon form.	10
Eigen values and eigen vectors of a square matrix, characteristic equation of a matrix, Cayley-Hamilton theorem, and its use in finding the inverse of a matrix.	5

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MATHEMATICS(SEC)

SEMESTER-I

PAPER CODE-UMATSEC11001(A)+ UMATSEC11001 (B)

TOTAL MARKS: 40(TH)+10(CE)+05(ATT)+20(PRAC)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-40

LOGIC, INTEGERS & BOOLEAN ALGEBRA

Topic	Number of Lectures Allotted
Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations.	10
Well-ordering property of positive integers, principles of mathematical induction, division algorithm, divisibility and Euclidean algorithm, congruence relation between integers, Fundamental Theorem of Arithmetic (statement only), solution of linear congruence equations, Chinese remainder theorem.	10
Boolean algebra, Boolean polynomials, minimal and maximal forms of Boolean polynomials, method of Quinn-McCluskey, Karnaugh diagrams. Logic gates, switching circuits and applications of switching circuits.	10
LOGIC, INTEGERS, AND BOOLEAN ALGEBRA (PRACTICAL) (Using hand calculation or any mathematical software)	10

1) Using congruence, find the remainder when a large integer is divided by an integer: (E.g. (a) 7 divides 333333 (b) 15 divides 17404 (c) 16 divides 777777 (d) 42 divides 31000020 (e) 4|15+25+35+45+⋯+1005 (f) 13|1!+2!+⋯. +70! (g) 17| $(23n+1+3.52n+1), n \geq 1$ etc.) 2) Find the last digit/last two digits of a large integer (using congruence): (E.g. (a) 191919 (b) 7373 (c) 33100 (d) 1313 (e) 7100 etc.) 3) Code validation problems: ISBN code, UPC code, EAN codes, Credit card number, GST number (GSTIN). 4) Sketch XOR, NAND, NOR, and XNOR Gates, and find their truth table. Simplify the logical circuits using these gates and draw the simplest form. 5) Sketch the logic circuits corresponding to simple real-life situations. (E.g.: Doorbell, Burglar Alarm, Freezer warning Buzzer, Mixed Task (mixing colors), inverter, Coffee/Soup vending machine, Automatic watering system, Automatic car door open warning system, temperature detector circuits, etc.)	

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MATHEMATICS(MAJOR)

SEMESTER-II

PAPER CODE-UMATMAJ12002

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

CALCULUS AND GEOMETRY

Topic	Number of Lectures Allotted
Unit 1: Reduction formulae, derivations and illustrations, integration techniques including trigonometric and logarithmic functions, arc length of curves including parametric curves, area enclosed by a curve and area between two curves.	15
Unit 2: Higher order derivatives, Leibnitz rule and applications, problems of the type e^(ax+b) sin x, e^(ax+b) cos x, (ax + b)^n sin x, (ax + b)^n cos x, L'Hospital's rule and its applications, parameterizations, pedal equation, envelopes, evolute, asymptotes, radius of curvature, concavity, convexity, cusps and inflection points.	15
Unit 3: 2D Geometry - Reflection properties of conics, rotation of axes, second degree equations, classification of conics using the discriminant, polar equations of conics.	15
Unit 4: 3D Geometry - Spheres, cylindrical surfaces, cones, ellipsoids, paraboloids, hyperboloids, plane sections of conicoids, generating lines, classification of quadrics.	15

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MATHEMATICS(SEC)

SEMESTER-II

PAPER CODE-UMATSEC12002 (A)+ UMATSEC12002 (B)

TOTAL MARKS: 40(TH)+10(CE)+05(ATT)+20(PRAC)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-40

GRAPH THEORY

TOPIC	NUMBER OF LECTURES ALLOTTED
Unit 1 : Definition, examples, basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs, isomorphism of graphs, paths, and cycles.	9
Unit 2 : Eulerian circuits, Hamiltonian cycles, Eulerian and Hamiltonian graphs, representation of a graph by a matrix, adjacency matrix, incidence matrix, and weighted graphs.	9
Unit 3 : Traveling salesman's problem, shortest path, Dijkstra's algorithm, Warshall algorithm, Tree and their properties, spanning tree, Kruskal's Algorithm, Forest, Connectivity, matching in bipartite graphs, matching in general graphs.	12
GRAPH THEORY (PRACTICAL) (Using hand calculation or any mathematical software) 1. Travelling salesman problems: E.g.: Given a list of tourist spots in Darjeeling district and mention the distances between each pair of spots. If we start from Siliguri, what is the possible shortest path that visits each one	10

exactly once and returns to the original place at Siliguri?". 2. Without lifting pencil puzzles (Euler Paths & Circuits): E.g.: How can you sketch a given shape on paper without taking off the pen as well as without tracing the same line twice? 3. Draw bipartite graphs for different networks like ecological networks, epidemiological networks, biomedical networks, biomolecular networks, etc. 4. Find the solution to matching problems (matching job seekers with job vacancies or assigning students to project supervisors, Stable Marriage problem), social network problems (connections between users and interests), etc. using bipartite graphs. 5. Sketch the graph of real-life situations like landing cables, LAN networks, a network of pipes for drinking water or natural gas, an electric grid, tour operations, etc., and find the solution using Kruskal's algorithm. 6. Sketching graphs related to the problems of digital mapping services in google maps (like GPS, to calculate the shortest or quickest route), social networking applications, robotic paths (like robot car to take to reach a specific location while avoiding obstacles), logistics, and transportation (most efficient routes for vehicles and to optimize delivery schedule), Emergency Services (ambulance, fire truck, or police car) and then find the shortest path using Dijkstra's algorithm	

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MATHEMATICS(MAJ)

SEMESTER-III

PAPER CODE- UMATMAJ23003

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

REAL ANALYSIS

TOPIC	NUMBER OF LECTURES ALLOTTED
Unit 1: Review of Algebraic and order properties of $\mathbb{R}$, ε-neighborhood of a point in $\mathbb{R}$. Idea of countable and uncountable subsets of $\mathbb{R}$. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima with their properties and supporting examples. Completeness property of $\mathbb{R}$ and its equivalent properties. Archimedean property, density property of $\mathbb{R}$, intervals. Limit point and isolated point of a set, open set, closed set, derived set and their properties. Bolzano-Weierstrass theorem on limit point, Nested interval theorem. compact sets in $\mathbb{R}$, Heine-Borel Theorem.	15
Unit 2: Sequences: Sequence, bounded sequence, convergent sequence, limit and limit points of a sequence, uniqueness of limit of convergent sequences, lim inf & lim sup. Limit theorems, Monotone sequences, monotone convergence theorem, Sandwich theorem, Subsequences, divergence criteria. Monotone subsequence theorem (statement only), Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence	15

criterion.	
Unit 3: Limits of functions (ε-δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limit. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.	15
Unit 4: Series: Infinite series, convergence and divergence of infinite series, Cauchy criterion. Tests for convergence: comparison test, limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, integral test. Absolutely convergent series (Ratio test, Root test), conditionally convergent series (Leibniz's test) and alternating series. Re-arrangement of terms	15

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MATHEMATICS(MAJ)

SEMESTER-III

PAPER CODE- UMATMAJ23004

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

DIFFERENTIAL EQUATION

TOPIC	NUMBER OF LECTURES ALLOTTED
Unit 1: Differential equations: General, particular, explicit, implicit and singular solutions of a differential equation. First order and first-degree equations: Existence theorem (statement only), Exact equation, integrating factors and different calculating rules (statement of relevant results), linear equation and Bernoulli equations, special integrating factors and transformations. First order but not of first-degree equations: Clairaut's equation. General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications. Higher order linear equations with constant coefficients: complementary function and particular integral, method of undetermined coefficients, method of variation of parameters, Euler's homogeneous equation. Second order linear equations with variable coefficients: method of variation of parameters, reduction to normal form, change of dependent and independent variables.	30
Unit 2: Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.	12
Unit 3: Lipschitz condition and Picard's Theorem (Statement only). Autonomous system, Equilibrium points, Interpretation of the phase plane.	10
Unit 4: Power series solution of a differential equation about an ordinary point, solution about a regular singular point. Simple eigen value problems.	8

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MATHEMATICS(MAJ)

SEMESTER-III

PAPER CODE- UMATMAJ23005

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

GROUP THEORY

TOPIC	NUMBER OF LECTURES ALLOTTED
Unit 1: Equivalence relations, partially ordered relation, functions, permutations, even and odd permutations, invertible functions. Groupoid, semigroup, monoid, groups, finite and infinite groups, commutative groups. Basic properties of groups. Finite semigroup with cancellation properties, semigroup containing unique solution of ax=b and xa=b. Well known groups: $\mathbb{Z}n$, Un, $Mn(R)$, $GL(n,\mathbb{R})$, $SL(n,\mathbb{R})$, Klein's 4 group, multiplicative group of n-th roots of unity, symmetric group Sn ($e.g.$ $S3$,$S4$,$S5$,...), alternating group An, Dihedral group, Quaternion group etc.	20
Unit 2: Subgroups and its basic properties. Union, intersection and product of subgroups, necessary and sufficient condition for a subset of a group to be a subgroup. Centralizer, normalizer and center of a group.	10
Unit 3: Order of a group, order of an element. Cyclic groups, cosets, normal subgroups & factor/quotient groups and their basic properties. Lagrange's theorem and consequences including Fermat's Little theorem, Cauchy's theorem for finite abelian	18

groups, necessary and sufficient conditions for a subgroup of a group to be a normal subgroup.	
Unit 4: Group homomorphisms & isomorphisms and their basic properties, Cayley's theorem, First, Second and Third isomorphism theorems and their simple problems.	12

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MATHEMATICS(SEC)

SEMESTER-III

PAPER CODE- UMATSEC23003 (A)+ UMATSEC23003 (B)

TOTAL MARKS: 40(TH)+10(CE)+05(ATT)+PRC(20)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-40

C-PROGRAMMING LANGUAGE

TOPIC	NUMBER OF LECTURES ALLOTTED
Unit 1 An overview of history of computers and architecture of computer. Concept of compiler, assembler, machine language, high level language, object-oriented language, programming language and importance of C programming.	5
Unit 2 Characters, Constants and variables data types. Expression, statements, declaration. Operators: Arithmetic operators, increment and decrement operators, relational operators, logical operators, assignment operators, conditional operators.	5
Unit 3 Conditional control statements: If, if-else, nested if-else statements. Switch, break and continue statements. Loop control statements: For, while and do-while statements.	10
Unit 4 Arrays, One, two and multidimensional arrays, declaration and type of arrays. Reading and displaying elements of arrays. User-defined Functions: Function Prototype, Definition of functions, Type of functions, local and global variables in a function, type of return values, function declaration, nesting of functions, main ( ) function, recurrence of function. Library functions, e.g. stdio.h, math.h, string.h, stdlib.h, etc. No arguments and no return values, arguments but no return values, arguments with return values, no arguments but returns a value.	10

C-PROGRAMMING LANGUAGE (PRACTICAL) 1. Write a program to print (a) first 100 natural numbers, (b) even numbers and (c) odd numbers in 1-100. 2. Write a program to print all numbers between 30 to 50, and all even numbers between 70 and 95. 3. Write a program to calculate the sum or product of (a) first 100 natural numbers, (b) first 25 even natural numbers and (c) odd numbers between 30 and 90. 4. Read 10 numbers from keyboard and find their sum, product and average. 5. Write a program to find (a) the last digit (b) sum and product of all digits of a given number. 6. Read 3 numbers from keyboard and find the maximum and minimum of them. 7. Write a program to find factorial of a given number. 8. Find the maximum and minimum element of a given array. 9. Sort the elements of an array in ascending and descending order. 10. Write a program to print all numbers of a given array in reverse order. 11. Write a program to print all (a) prime numbers (b) even numbers from a given array. 12. Write a program to print a matrix. 13. Write a program to find the addition and the product of two matrices. 14. Find the transpose of a given matrix. 15. Find the product of two matrices. 16. Write a program to check whether a number is even or odd. 17. Write a program to check whether a number is a prime number or not. 18. Write a program to check whether a number is Armstrong number or not. 19. Write a program to check whether a number is Perfect numbers. 20. Compute the area of (a) rectangle (b) triangle having lengths of 3 sides (c) circle. 21. Find the distance between two points (p,r) and (q,s). 22. Find the intersection point of two intersecting straight lines $ax+by=c$ and $px+qy=r$. 23. Find the solution of a quadratic equation. 24. Write a program to solve a system of two linear equations in two unknowns.	10

25. Write a function to calculate addition, product of two numbers. 26. Write a function to calculate the factorial of a number. etc.	

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MATHEMATICS(MAJ)

SEMESTER-IV

PAPER CODE- UMATMAJ24006

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

THEORY OF REAL AND COMPLEX FUNCTIONS

TOPIC	NUMBER OF LECTURES ALLOTTED
Unit 1: Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, absolute extremum theorem. Rolle's theorem. Lagrange and Cauchy mean value theorem, intermediate value property of derivatives- Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.	18
Unit 2: Taylor's theorem with Lagrange's form and Cauchy's form of remainder, application of Taylor's theorem to convex functions. Taylor's series and Maclaurin's series expansions of exponential, trigonometric functions, log(1+x), 1/(ax+b) and (x + 1)n etc.	10
Unit 3: Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions. Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.	12
Unit 4: Geometric representation of complex numbers, stereographic projection. Complex	20

functions, continuity and differentiability of complex functions, analytic functions, Cauchy-Riemann equation, harmonic functions, Milne's method (statement only). Conformal mapping, Bilinear transformation (simple problems).	

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MATHEMATICS(MAJ)

SEMESTER-IV

PAPER CODE- UMATMAJ24007

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

MECHANICS

TOPIC	NUMBER OF LECTURES ALLOTTED
Dynamics Unit 1: 30 classes Motion of a particle along a straight line. Simple harmonic motion, Two-dimensional equation of motion in Cartesian and Polar coordinate systems. Tangent and normal components of velocity and acceleration. Central force and central orbit. Motion in a plane under central forces. Motion under the inverse square law, Kepler's laws, modelling ballistics and planetary motion. System of particles, center of mass. Motion of a center of mass, motion about center of mass. Principle of conservation of linear momentum and angular momentum. Rigid body, centre of gravity, moment and product of inertia, radius of gyration. Theorems of parallel and perpendicular axis. Calculation of momentum inertia, Routh's law.	30
Statics Unit 2: 30 classes Co-planar forces: Astatic equilibrium, positions of equilibrium of a particle lying on a smooth plane curve under the action of given forces. Virtual work: Principle of virtual work, converse of the principle of virtual work. Forces in three dimensions: Poinsot's central axis. Moment of a force about a line, axis of a couple, resultant of any number of couples acting on a rigid body, reduction of a system of forces acting on a rigid body. Resultant force is an invariant of the system but the resultant couple is not an invariant. A given system of forces can have only one central axis. Wrench, Pitch, Intensity and Screw. Condition that a given system of forces may have a single resultant. Invariants of a given system of forces. Equation of the central axis of a given system of forces. Stable and Unstable equilibrium: Field of forces, conservative field, potential energy of a system.	30

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MATHEMATICS(MAJ)

SEMESTER-IV

PAPER CODE- UMATMAJ24008

TOTAL MARKS: 60(TH)+10(CE)+05(ATT)=75

TOTAL NUMBERS OF LECTURES ALLOTTED-60

RING THEORY AND LATTICE THEORY

TOPIC	NUMBER OF LECTURES ALLOTTED
Unit 1: Ring and its properties. Well-known rings: Matrix ring, $\mathbb{Z}n$, $\mathbb{Z}[i]$, $\mathbb{Q}[i]$, ring of quaternions, polynomial ring $R[x]$, ring of continuous functions etc. Divisors of zero, units, cancellation property $\Longleftrightarrow$ no zero divisors, Characteristics of a ring, integral domains, ID $\Longleftrightarrow$ cancellation property. Fields, every field is an ID, finite integral domain is a field, etc. Subring & subfield and their necessary and sufficient conditions.	18
Unit 2: Ideals, ideal generated by a subset of a ring, principal ideal, operations on ideals: sum (A+B), intersection, union & product (AB) etc. Prime ideals, maximal ideals, Quotient rings and its properties.	16
Unit 3: Ring homomorphisms & isomorphisms and their properties, Isomorphism theorems I, II & III and their simple applications.	10
Unit 4: Lattice: Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms. Definition, examples and properties of modular and distributive lattices.	16