CMJ UNIVERSITY, SHILLONG
REGULATION FOR MSC MATHERMATICS

Duration – Two Years
Eligibility - B.Sc. with relevant subject or its equivalent

Scheme of Distribution of Marks

Sr. No.	First Year	Internal Assessment Marks	Term End Examination	Total Marks	Passing Marks
1	Analysis	30	70	100	40
2	Differential Equations	30	70	100	40
3	General Topology	30	70	100	40
4	Differential Geometry	30	70	100	40
5	Mathematical Statistics	30	70	100	40
Sr. No.	**Second Year**	**Internal Assessment Marks**	**Term End Examination**	**Total Marks**	**Passing Marks**
1	Real Analysis	30	70	100	40
2	Complex Analysis	30	70	100	40
3	Numerical Methods	30	70	100	40
4	Discrete Mathematics	30	70	100	40
5	Algebra	30	70	100	40

M.SC MATHS (Second year)

ANALYSIS

MSM 101

Unit-I

Derivation

Definition of Derivative – Derivatives and Continuity – Algebra of Derivatives – Chain Rule – One sided derivatives and Infinite derivatives – Function with non-Zero derivative – Zero derivatives and local extrema – Roll's Theorem. The Mean Value Theorem for derivatives – Intermediate Value Theorem for derivatives – Taylor's formula with remainder.

Functions of Bounded Variations

Introduction – Properties of Monotonic functions – Functions of bounded variations – Total Variation – Addition Property of total Variations – Total Variation on [a, x] as a function of x – Function of bounded variation expressed as the difference of increasing functions – continuous function of bounded variation.

Unit-II

The Riemann Stieltje's Integral

Introduction – Notation – The definition of Riemann Stieltjes' Integral – Linear properties – Integration by parts – Change of variable in a Riemann Stieltjes' integral – Reduction to a Riemann Integral – Step Function as Integrators – Reduction to a Reimann Integral to finite sum – Eulers' Summation Formula – Monotonically increasing Integrators – Upper and Lower Integrals – Additive and Linearity properties of Upper and Lower Integrals – Riemann's Condition – Comparison Theorems – Integrators of bounded variation – Necessary and sufficient conditions for existence of Riemann Stieltges Integrals – Mean Value Theorem for Riemann Stieltje's Integrals – The Integral as a function of interval – 2^{nd} Fundamental Theorem of Integral Calculus – Change of variable in a Riemann Integral – Second Mean Value Theorem for Riemann Integrals

Unit-III

Sequences of Functions

Point wise Convergence of sequences of functions – Examples of sequences real valued functions – Definition of uniform Convergence – uniform Convergence and continuity – The Cauchy condition for uniform Convergence – Uniform Convergence of Infinite Series of function – Uniform Convergence and Riemann Stieltje's Integration – The Taylor's Series generated by a function – Bernstein's Theorem – The Bionomial Series – Abel's Limit Theorem – Tauber's Theorem.

Unit-IV

Measure Theory

Inner Measure – Out Measure – Measurable Set – Measurable Function – properties of Measurable function – Little woods' three principles – The Lebesgue Integral of a bounded function over a set of finite measure – The Integral of a non-negative function – The general Lebesgue Integral.

Unit-V

Differentiation and Integration

Differentiation of monotonic function – Functions of bounded variation – Differentiation of an Integral – Absolute continuity – Infinite products – Products and Series of partial fractions for Trigonometric functions – Gamma function.

DIFFERENTIAL EQUATIONS

MSM 102

Unit-I

Linear Equations with Constant Coefficients

Non-homogeneous equations of order two – Homogeneous and non-homogeneous equations of order n – Initial value problem – Annihilater method to solve a non-homogeneous equation.

Unit-II

Linear Equations with Variable Coefficients

Initial value problems for homogeneous equations – solutions of homogeneous equations – Wornskian and Linear independence – Reduction of the order of homogeneous equation.

Unit-III

Elliptic Differential Equations

Elliptic Differential equations – Occurrence of Laplace and Poisson equations – Boundary Value Problems – Separation of variable method – Laplace equation in cylindrical – Spherical coordinates – Dirichlet and Neuman problems for circle – Sphere.

Unit-IV

Parabolic Differential Equations

Parabolic Differential Equations – Occurrence of the diffusion equation – Boundary conditions – Separation of variable method – Diffusion equation is cylindrical – Spherical coordinates.

Unit-V

Hyperbolic Differential Equations

Hyperbolic Differential Equations – Occurrence of Wave equation – One-dimensional Wave equation – Reduction to Canmical form – 'D' Alembertz solution – Separation of variable method – Periodic solutions – Cylindrical spherical coordinates.

GENERAL TOPOLOGY

MSM 103

Unit–I

Topological Spaces

Topological Spaces – Basis for a Topology – The Order Topology, the product topology on XxY, the subspace topology, closed sets and limit points.

Unit–II

Continuous Functions

Continuous Functions, the product topology, the metric topology.

Unit–III

Connectedness

Connected Spaces, Connected Subspaces of the real line, Components and Local Connectedness.

Unit-IV

Compactness

Compact spaces -compact subspace of the real line -limit point compactness-local compactness.

Unit-V

Countability and Separation Axioms

The Countability Axioms - The separation axioms - Normal spaces -The Urysohn Lemma - The Urysohn metrization theorem -The Tietze extension theorem.

DIFFERENTIAL GEOMETRY

MSM 104

Unit – I

Theory of Space Curves

Theory of space curves - Representation of space curves - Unique parametric representation of a space curve - Arc- length - Tangent and osculating plane - Principal normal and binomial - Curvature and torsion - Behavior of a curve near one of its points - The curvature and torsion of a curve as the intersection of two surfaces.

Unit – II

Theory of Space Curves (Contd.)

Contact between curves and surfaces - Osculating circle - Osculating sphere - Locus of center of spherical curvature -Tangent surfaces - Involutes and Evolutes - Intrinsic equations of space curves - Fundamental Existence Theorem - Helices.

Unit – III

Local Intrinsic properties of Surface

Definition of a Surface - Nature of points on a surface -Representation of a surface - Curves on surface - Tangent plane and surface normal - The general surface of revolution - Helicoids - Metric on a surface - Direction Coefficients on a surface.

Unit – IV

Local Intrinsic properties of surface and Geodesic on a surface

Families of curves - Orthogonal trajectories - Double family of curves - Isometric correspondence - Intrinsic properties -Geodesics and their differential equations - Canonical geodesic equation - Geodesics on surface of revolution.

Unit – V

Geodesic on a Surface

Normal property of Geodesics - Differential equations of geodesics using normal property - Existence theorems - Geodesic parallels - Geodesic curvature - Gauss Bonnett Theorems - Gaussian curvature - Surface of Constant curvature.

MATHEMATICAL STATISTICS

MSM 105

Unit – I

Probability

Introduction – Sample space - Probability axioms – Combinatorics: Probability on Finite sample spaces -Conditional Probability and Baye's Theorem -Independence of events.

Unit – II

Random Variables and their Probability Distribution

Introduction - Random variables - Probability distribution of a random variable - Discrete and continuous random variables - Function of a random variable.

Unit – III

Moments and Generating Functions

Introduction - Moments of a Distribution Function -Generating functions - Some moment inequalities.

Unit – IV

Multiple Random Variables

Introduction - Multiple random variables - Independent random variables - Functions of several random variables - Covariance, Correlation and Moments - Conditional expectation – Order Statistics and their distributions.

Unit – V

Limit Theorem

Introduction - Modes of Convergence - Weak Law of large numbers – Strong Law of large numbers - Limiting Moment Generating Functions – Central Limit Theorem.

MASTER OF SCIENCE [MATHEMATHICS]Second Year

REAL ANALYSIS

MSM - 201

UNIT – I

Riemann-Steiltjes Integral, Definition of Riemann-Steiltjes Integral and Existence Theorems, Properties of Integrals, Integration and Differentiation, Integration of Vector Valued Functions, Rectifiable Curves

UNIT – II

Sequences And Series Of Functions, Uniform Convergence And Continuity, Uniform Convergence And Integration, Uniform Convergence And Differentiation, Equicontinuous Family Of Functions, The Weierstrass Theorem, Algebra Of Functions

UNIT – III

Functions Of Several Variables: Vector Spaces, Linear Transformations And Linear Operators, Matrix Representation Of A Linear Transformation, Contraction Principle, Inverse Function Theorem, Implicit Function Theorem, Determinants, Jacobians, Derivatives Of Higher Order, Differentiation Of Integrals

UNIT – IV

Lebesgue Measure And Lebesgue Integral: Outer Measure, Measurable Sets, Lebesgue Measure, Measurable Functions And Littlewood's Theorem, The Lebesgue Integral Of Bounded, Functions Over A Set Of Finite Measure, The Integral Of A Non-Negative Function, The General Lebesgue Integral And Convergence In Measure

UNIT – V

Differentiation And Integration: Differentiation Of Monotone Functions, Functions Of Bounded Variations, Differentiation Of An Integral, Absolute Continuity, The L^p Spaces, Convex Functions, The Minkowski And Holder Inequalities, Convergence And Completeness, Bounded Linear Functionals On The L^p Spaces

COMPLEX ANALYSIS

MSM - 202

UNIT – I

Introduction to Complex Plane, Arithmetic of the Complex Numbers, Geometry of Complex plane, Extended Complex plane and the Stereographic Projection, Topology of the Complex plane, One point compactification and the Riemann Sphere, Analysis in the Complex Domain, Sequence and Series.

UNIT – II

Elementary Properties of Analytic Functions, Introduction to the concept of an analytic function, Power Series, Linear fractional Transformations, Exponential and Trigonometric Functions

UNIT – III

Conformal Mappings, Definition and properties of Conformal Mappings, Elementary Conformal Mappings, Physical applications of conformal mappings, Single valued Branches for multi-valued functions

UNIT – IV

Complex Integral Calculus, Basic definition and properties of Complex Integration, Cauchy's Theorem, General form of Cauchy's Theorem, Cauchy's Integral Formula and its applications.

UNIT – V

Complex Integral Calculus (Contd), Singularities, Calculus of residues, Computation of integrals, Harmonic Functions

NUMERICAL METHODS

MSM - 203

UNIT – I

Newton's Method (or) Newton-Raphson method, Newton-Raphson Method, Complex Roots, Fixed- Point Iteration, X = G(X) Method, Bairstow's Method for Quadratic Factors, Numerical Differentiation: Numerical Integration:

UNIT – II

Solution of System Of Equations, Gauss Elimination Method (Direct Methods), Method Of Factorisation, Lu Decomposition Of A Tridiagonal Matrix, Iterative Methods (Indirect Methods), Relaxation Methods System Of Non-Linear Equations

UNIT – III

Solution of Ordinary Differential Equations, The Taylor-Series Method, Euler And Modified Euler Methods, Runge-Kutta Methods, Multi-Step Methods: System Of Equations And Higher Order Equations.

UNIT – IV

Boundary Value Problems, Boundary Value Problems, Solution through A Set Of Equations finite, Difference Methods, Derivative Boundary Conditions Derivatives At The End Points, Characteristic Value Problem, Iterative Methods For Eigen Value

UNIT – V

Numeric Solutions of Partial Differential Equations, (Elliptic, Parabolic And Hyperbolic PDE), Types Of Partial – Differential Equations The Heat Equation And Wave Equation Poisson, Equation And Crank- Nicolson Method, Parabolic Equation In Two Or Three Dimensions Iterative Methods And Hyperbolic Equations,

DISCRETE MATHEMATICS

MSM - 204

UNIT – I

Set theory- Notations, representation of a set, different types of set, theorem on subsets and symmetric difference, Venn diagram, set operation –union, intersection, disjoint, difference, complement, symmetric difference, laws of sets: union, intersection, complement of sets, symmetric difference, De Morgan's laws, ordered pair Cartesian product of sets

UNIT – II

Relations: domains ,range, inverse relation, inverse relation, binary relations, type of relations, equivalence class, partition of a set, composition of relation, Functions, domain and range, transformation, mathematical induction-Propositional logic-truth table, connectives, negation, conjunction, disjunction, conditional, bi conditional, converse and contra positive, types of proposition, tautology, contradiction, contingency, list of properties, proof of properties

UNIT – III

Predicate, quantification, forming propositions from predicates, universal quantifier and connective and, existential, existential quantifier and connective, how to read quantified formulas, order of application of quantifier, well-formed formula for first order predicate logic, rules for constructing WFFS, from WFF to proposition, transcribing English to predicate logic WFFS-Counting-basic counting principles, sum and product rules, inclusion and exclusion principle

UNIT – IV

Permutations: notations of permutations, Factorial Notation, Permutations Of *N* Dissimilar, Things Taken *R* At A Time, Restricted Permutations, Permutation Of Objects Some Of Which Are Exactly Alike: Permutations Of Repeated Things, Circular Permutations, Number Of Circular Permutations Of *N* Dissimilar Things-Combination: Number Of Combination Of *N* Dissimilar Things Taken *R* At A Time, Theorem On Restricted Combination

UNIT – V

Logic circuit: flow table, OR, AND, NOT, NOR & NAND operation, logic circuits algebraically, Boolean Algebra-laws of Boolean algebra, duality principle-Graph Theory-graph, edges and vertices, degree of a vertex in a graph, paths and cycles in a graph, graphical representation, Hamiltonian: paths and circuit, graphs and circuit, isomorphism, connectivity-Algebraic system: Abelian group, order of a group, semi-group, important theorems on groups, subgroups, isomorphism

ALGEBRA

MSM - 205

UNIT – I

Group Theory: Another Counting Principle, Equivalence Relation, Conjugacy Relation, Cauchy's Theorem, Sylow's Theorem, Direct Products, External and Internal Direct Products.

UNIT – II

Ring Theory: Euclidean Rings, Unique Factorization Theorem, a Particular Euclidean Ring, Polynomial Rings, Poly Nominal over the Rational Field

UNIT – III

Field Theory: Extension of Fields, Roots Of Polynomials, More About Roots, Simple Extension

UNIT – IV

Elements of Galois Theory: Automorphism, Galois Group, Solvability By Radicals: Solvability Groups, Finite Fields

UNIT – V

Linear Transformations: Canonical Forms, Triangular Form, Nilpotent Transformations, Trace and Transpose: Trace Of a Matrix, Transpose of a Matrix, Hermitian, Unitary Transformations, Normal Transformations