

Lesson Plan – Odd Semester

B.Sc. (Major) in Mathematics

Sem-I

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM I (Major) – MATH-H-CC 1-1-Th – Calculus, Geometry & Vector Analysis					
Group A: Differentiability of a function at a point and in an interval. Meaning of sign of derivative. Differentiating hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to functions of type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$. Indeterminate forms. L'Hospital's rule (statement and example).	Calculus	1) T. Apostol, Vol. I & II, Wiley, 1969 2) R.R. Goldberg, <i>Methods of Real Analysis</i> , Oxford & IBH, 2020	6	Google Classroom, Hand Notes	MH
Group A: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sec^n x dx$, $\int (\log x)^n dx$, $\int \sin^n x \sin^m x dx$, $\int \sin^n x \cos^m x dx$. Parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.	Calculus	Same as above	10	Google Classroom, Hand Notes	MH
Group B Rotation of axes and second degree equations, classification of conics using the discriminant, reduction to canonical form, tangent and normal, polar equations of conics.	Geometry	1) S.L. Loney, <i>Coordinate Geometry</i> 2) Ghosh & Maity, <i>Advanced Analytical Geometry</i>	12	Chalk & Blackboard, Class Notes, Handwritten Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.	Geometry	Same as above	16	Chalk & Blackboard, Class Notes, Handwritten Notes	PL
Group C: Triple product, vector equations, applications to geometry and mechanics concurrent forces in a plane, theory of couples, system of parallel forces.	Vector Analysis	M.R. Spiegel, <i>Schaum's Outline of Vector Analysis</i> , Tata McGraw-Hill, 2011	6	Chalk & Blackboard, Notes	BS
Group C: Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable.	Vector Analysis	Same as above	10	Chalk & Blackboard, Notes	BS

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM I (Major) MATH-H-SEC 1-1-Th C Language with Mathematical Applications					
Overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language, higher level language	C Language with Mathematical Applications	V. Rajaraman: Fundamentals of Computers; PHI Learning Private limited, 2013	2	Chalk and Talk, Notes	DP
Constants, Variables and Data type of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	6	Chalk and Talk, Notes, tutorial, class work	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Operation and Expressions: Arithmetic operators, relational operators, logical operators.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP
Decision Making and Branching: decision making with if statement, if-else statement, Nesting if statement, switch statement, break and continue statement.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	6	Chalk and Talk, Notes, tutorial, class work	DP
Control Statements: While statement, do-while statement, for statement	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP
Arrays: One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	4	Chalk and Talk, Notes, tutorial, class work	DP
User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recurrence of function.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Introduction to Library functions: stdio.h, math.h, string.h, stdlib.h, time.h etc.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	1	Chalk and Talk, Notes	DP
Sample problems	C Language with Mathematical Applications	C. Xavier: C-Language and Numerical Methods, New Age International, 2007., V. Rajaraman: Computer Oriented Numerical Methods, Prentice Hall of India, 1980	26	Practical: hands on experience	DP

Sem-III

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM III (Major) MATH-H- CC 3-3-TH Real Analysis					
Group A: Intuitive idea of real numbers. Mathematical operations and usual order of real numbers revisited with their properties (closure, commutative, associative, identity, inverse, distributive). Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Concept of bounded and unbounded sets in $\mathbb{R}$. L.U.B. (supremum), G.L.B. (infimum) of a set and their properties. L.U.B. axiom or order completeness axiom. Archimedean property of $\mathbb{R}$. Density of rational (and Irrational) numbers in $\mathbb{R}$.	Real Numbers	1) R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3 rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002 2) T. Apostol, Mathematical Analysis, Narosa Publishing House	10	Chalk and Talk, Tutorial, Google Classroom, Hand Notes, Class tests	AB
Group A: Intervals. Neighbourhood of a point. Interior point. Open set. Union, intersection of open sets. Limit point and isolated point of a set. Bolzano-Weierstrass theorem for sets. Existence of limit point of every uncountable set as a consequence of Bolzano-Weierstrass theorem. Derived set. Closed set (defined as Complement of open set). Union and intersection of closed sets as a consequence. No nonempty proper subset of $\mathbb{R}$ is both open and closed. Expressing an open set of $\mathbb{R}$ as countable union of disjoint open intervals (statement only). Dense set in $\mathbb{R}$ as a set having non-empty intersection with every open interval. $\mathbb{Q}$ and $\mathbb{R} \setminus \mathbb{Q}$ are dense in $\mathbb{R}$.	Sets in $\mathbb{R}$	1) R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3 rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002 2) T. Apostol, Mathematical Analysis, Narosa Publishing House	14	Chalk and Talk, Tutorial, Google Classroom, Hand Notes, Class tests	AB

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Real sequence. Bounded sequence. Convergence and non-convergence. Examples. Boundedness of convergent sequence. Uniqueness of limit. Algebra of limits. Relation between the limit point of a set and the limit of a convergent sequence of distinct elements. Monotone sequences and their convergence. Sandwich rule. Nested interval theorem. Limit of some important sequences: $\{\sqrt[n]{n}\}_n$, $\{(\frac{1}{n})^n\}_n$, $\{x^n\}_n$, $\{x^{1/n}\}_n$, $\{x^n\}_n$ with $\frac{x_{n+1}}{x_n} \rightarrow l$ and $ l < 1$, $\{(1 + \frac{1}{n})^n\}_n$, $\{1 + \frac{1}{1!} + \frac{1}{2!} + \dots + \frac{1}{n!}\}_n$, $\{a^{x_n}\}_n$ ($a > 0$). Cauchy's first and second limit theorems.	Real Analysis	R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis T. M. Apostol, Mathematical Analysis	16	Chalk and Talk, Notes	PL
Group B: Subsequence, Subsequential limits, $\limsup$ as the L.U.B. and $\liminf$ as the G.L.B of a set containing all the subsequential limits. Alternative definition of $\limsup$ and $\liminf$ of a sequence using inequality or as $\limsup x_n = \inf_n \sup\{x_n, x_{n+1}, \dots\}$ and $\liminf x_n = \sup_n \inf\{x_n, x_{n+1}, \dots\}$ [Equivalence between these definitions is assumed]. A bounded sequence $\{x_n\}_n$ is convergent if and only if $\limsup x_n = \liminf x_n$. Every sequence has a monotone subsequence. Bolzano-Weierstrass theorem for sequence. Cauchy sequence. Cauchy's general principle of Convergence.	Real Analysis	R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis T. M. Apostol, Mathematical Analysis	12	Chalk and Talk, Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group C: Infinite series, convergence and non-convergence of infinite series, Cauchy criterion, tests for convergence; comparison test, limit comparison test, ratio test, Cauchy's n th root test, Kummer's test (statement and problems), Raabe's test (statement and problems), Gauss test (statement and problems). Alternating series, Leibniz test. Absolute and conditional convergence, Riemann's rearrangement theorem (statement and problems).	Series	1) R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3 rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002 2) T. Apostol, Mathematical Analysis, Narosa Publishing House	8	Chalk and Talk, Tutorial, Google Classroom, Hand Notes, Class tests	AB

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM III (Major) MATH-H-CC 4-3-TH Ordinary Differential Equations – I and Group Theory - I					
Group A: Formation of differential equations, order and degree of a differential equation, First order and first degree differential equations; Homogeneous and exact differential equations, conditions for an equation of the first order to be exact, Integrating factors, Rules for finding integrating factors, Linear equations and Bernoulli equations.	Ordinary Differential Equation	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	10	Chalk and Talk, Notes	BS
Group A: First order higher degree differential equations solvable for x, y and p, Clairaut's forms. Singular solutions, Equations of tac-locus, nodal locus, cuspidal locus.	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	8	Chalk and Talk, Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group A: Higher order linear and nonlinear equations, Concept of Wronskian and its properties, Complementary functions, Particular integrals, linear homogeneous and non-homogeneous equations with constant coefficients, Method of undetermined coefficients, Method of variation of parameters. Simultaneous linear differential equations.	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	8	Chalk and Talk, Notes	BS
Group A: Higher order linear equations with variable coefficients reducible to linear equations with constant coefficients (Euler's equation), Condition for exactness of higher order linear equations, Integrating factors, Equations of the form $\frac{d^n y}{dx^n} = f(y)$ ($n \geq 2$).	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	10	Chalk and Talk, Notes	BS
Group B: Definition of a group, examples of groups including permutation groups, dihedral groups and quaternion groups (through matrices), elementary properties of groups, examples of commutative and non-commutative groups.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL
Group B: Subgroups and examples of subgroups, necessary and sufficient condition for a nonempty subset of a group to be a subgroup, Normalizer, centralizer, center of a group, product of subgroups.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL
Group B: Order of an element of a group, order of a group, cyclic group, properties of cyclic groups, classification of subgroups of cyclic groups	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Permutation, cycle notation for permutations, properties of permutation, even and odd permutations, Alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's little theorem.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM III (Major) MATH-H-SEC 3-3-Th Linear Programming & Rectangular Games					
Definition of Linear Programming Problem (L.P.P.): Formation from daily life involving inequalities, graphical solution, basic solutions, basic feasible solution (B.F.S), matrix formulation, degenerate and non-degenerate B.F.S.	Linear Programming	1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002 2) Hamdy A. Taha, Operations Research, An Introduction, 8 th Ed., Prentice-Hall India, 2006	10	Google Classroom, Hand Notes	AB

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Hyperplane, Convex set, Cone, extreme points, convex hull and convex polyhedron. Supporting and Separating hyperplane. The collection of a feasible solutions of an L.P.P. constitutes a convex set. The extreme points of the convex set of feasible solutions correspond to its B.F.S. and conversely. The objective function has its optimal value at an extreme point of the convex polyhedron generated by the set of feasible solutions (the convex polyhedron may also be unbounded). In the absence of degeneracy, if the L.P.P. admits of an optimal solution then at least one B.F.S. must be optimal. Reduction of a F.S. to a B.F.S.	Linear Programming	1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002 2) Hamdy A. Taha, Operations Research, An Introduction, 8 th Ed., Prentice-Hall India, 2006	20	Google Classroom, Hand Notes	AB
Slack and surplus variables. Standard form of L.P.P. theory of simplex method. Feasibility and optimality conditions. Algorithm. Two phase method. Degeneracy in L.P.P. and its resolution.	Linear Programming	1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002 2) Hamdy A. Taha, Operations Research, An Introduction, 8 th Ed., Prentice-Hall India, 2006	5	Google Classroom, Hand Notes	AB
Duality theory: The dual of dual is the primal. Relation between the objective values of dual and the primal problems. Relation between their optimal values.	Linear Programming	1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002 2) Hamdy A. Taha, Operations Research, An Introduction, 8 th Ed., Prentice-Hall India, 2006	5	Google Classroom, Hand Notes	AB

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Post-optimal Analysis: Discrete changes in the cost vector, Discrete changes in the requirement vector, Discrete changes in the coefficient matrix, Addition of a variable, Addition of a constraint. Transportation and Assignment problems. Mathematical justification for optimality criterion. Hungarian method. Traveling Salesman problem.	Linear Programming	1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002 2) Hamdy A. Taha, Operations Research, An Introduction, 8 th Ed., Prentice-Hall India, 2006	10	Google Classroom, Hand Notes	AB
Concept of game problem. Rectangular games. Pure strategy and Mixed strategy. Saddle point and its existence. Optimal strategy and value of the game. Necessary and sufficient condition for a given strategy to be optimal in a game. Concept of Dominance. Fundamental Theorem of rectangular games. Algebraic method. Graphical method and Dominance method to solve Rectangular games. Inter-relation between theory of games and L.P.P.	Linear Programming & Game Theory	1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002 2) Hamdy A. Taha, Operations Research, An Introduction, 8 th Ed., Prentice-Hall India, 2006	10	Google Classroom, Hand Notes	AB

Sem-V

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM V (Major) MATH-H-CC 9-5-TH Probability and Statistics					
Group – A: Probability Random experiment, equally likely outcomes, Sample space, Events, -field, Probability as a set function, Probability axioms, Probability space; Conditional probability, The multiplication rule, The law of total probability and Bayes' theorem; Independence of events and trials; Joint probability, Bernoulli trial and binomial law, Poisson approximation of binomial law;	Probability	A. Gupta, Ground work of mathematical Probability and statistics W. Feller, An introduction to Probability Theory and its Application	07	Chalk and Talk, Google Classroom, Hand Notes	BS
Real random variables (discrete and continuous), distribution function of a random variable, Properties of distribution function, Probability mass / density functions and properties; Discrete distributions: Binomial, Poisson; Continuous distributions: Uniform, Normal, Exponential; Transformation of a random variable; Mathematical expectation, Mean, Variance, Moments, Quantiles, Skewness, Kurtosis, Median, Mode; Moment generating function, Characteristic function;	Probability	A. Gupta, Ground work of mathematical Probability and statistics W. Feller, An introduction to Probability Theory and its Application	08	Chalk and Talk, Google Classroom, Hand Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Multivariate random variables, Joint distribution of discrete and continuous random variables and their properties, Joint probability mass / density functions, Marginal and Conditional distributions, Independent random variables; Conditional expectations, Expectation of function of two random variables, Moments, Covariance, Correlation coefficient, linear regression for two variables, regression curves; Bivariate normal distribution; Distribution of the sums of independent discrete / continuous random variables, Product of two random variables; Chi-square, t and F-distributions;	Probability	A. Gupta, Ground work of mathematical Probability and statistics W. Feller, An introduction to Probability Theory and its Application	08	Chalk and Talk, Google Classroom, Hand Notes	BS
Chebyshev's inequality, Convergence in Probability, Statement of weak law of large numbers and strong law of large numbers; Statement of Central limit theorem; Statement of De Moivre Laplace limit theorem, Normal approximation of the binomial distribution; Statement of Uniqueness theorem of Characteristic functions.	Probability	A. Gupta, Ground work of mathematical Probability and statistics W. Feller, An introduction to Probability Theory and its Application	08	Chalk and Talk, Google Classroom, Hand Notes	BS
Review of Probability	Probability	Same as above	04	Chalk and Talk, Google Classroom	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group – B: Statistics Populations and Samples, Random Sample Sampling and Sampling Distributions, Distribution of the sample, Simple random sampling with and without replacement, Sample Statistic, Sample characteristics - Sample moments, Sample variance, Sampling from the normal distributions; Estimation of parameters: Point estimation, Interval Estimation, Mean-squared error, Properties of good estimators - unbiasedness, consistency, sufficiency, Minimum-Variance Unbiased Estimator (MVUE), Unbiased estimators for expectation and variance;	Statistics	A. Gupta, Ground work of mathematical Probability and statistics S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics	08	Chalk and Talk, Google Classroom, Hand Notes	MH
Method of Maximum likelihood: The maximum likelihood principle, Likelihood function and Loglikelihood function, Maximum likelihood estimators for discrete and continuous models, Properties of maximum likelihood estimators; Bivariate frequency Distribution: Bivariate data, Correlation and covariance, Linear Regression, principle of least squares and fitting of polynomials and exponential curves. Confidence intervals: General principle; Confidence intervals for the mean of Normal population-for known variance and unknown variance; Confidence interval for variance of Normal population;	Statistics	A. Gupta, Ground work of mathematical Probability and statistics S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics	08	Chalk and Talk, Google Classroom, Hand Notes	MH

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Statistical hypothesis: Simple and composite hypotheses, null hypotheses, alternative hypotheses, one sided and two-sided hypotheses, The critical region and test statistic, type I error and type II error, level of significance, Power function of a test, most powerful test, Neyman-Pearson lemma (Statement only), Likelihood-ratio tests; Tests on the Mean of a Normal Distribution, Variance Known; Tests on the Mean of a Normal Distribution, Variance unknown; Tests on a Population Proportion, Chi-square test for goodness of fit.	Statistics	A. Gupta, Ground work of mathematical Probability and statistics S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics	06	Chalk and Talk, Google Classroom, Hand Notes	MH
Review of Statistics	Statistics	Same as above	03	Chalk and Talk, Google Classroom, Hand Notes	MH

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM V (Major) MATH-H-CC 10-5-TH Ring Theory - II and Linear Algebra - I					
Group – A: Ring Theory – II Principal ideal domain, principal ideal ring, prime element, irreducible element, greatest common divisor (gcd), least common multiple (lcm), expression of gcd, examples of a ring R and a pair of elements a, $b \in R$ such that gcd(a, b) does not exist, Euclidean domain, relation between Euclidean domain and principal ideal domain.	Abstract Algebra	S. K. Mapa, Higher Algebra (Abstract and Linear) D. S. Malik, J. M. Mordeson and M. K. Sen; Fundamentals of Abstract Algebra;	10	Chalk and Talk, Google Classroom, Hand Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Polynomial rings, division algorithm and consequences, factorization domain, unique factorization domain, irreducible and prime elements in a unique factorization domain, relation between principal ideal domain, unique factorization domain, factorization domain and integral domain, polynomial ring over unique factorization domain, Eisenstein criterion and unique factorization in $\mathbb{Z}[x]$.	Abstract Algebra	Same as above	15	Chalk and Talk, Google Classroom, Hand Notes	PL
Ring embedding and quotient field, regular rings and their examples, properties of regular ring, ideals in regular rings.	Abstract Algebra	Same as above	03	Chalk and Talk, Google Classroom, Hand Notes	PL
Review of Ring Theory-II	Abstract Algebra	Same as above	04	Chalk and Talk, Google Classroom, Hand Notes	PL
Group-B: Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Subspaces of $\mathbb{R}^n$. Dimension of subspaces of $\mathbb{R}^n$. Geometric significance of subspace up to $\mathbb{R}^3$. Four fundamental subspaces associated with a matrix. The dimension of the solution space of $Ax = 0$ and the rank of A. Full rank factorization, rank inequalities, Sylvester's inequality.	Linear Algebra	S. K. Mapa, Higher Algebra (Abstract and Linear) S. Lang, Linear Algebra S. H. Friedberg, A. J. Insel and L. E. Spence and; Linear Algebra	14	Chalk and Talk, Google Classroom, Hand Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, change of coordinate matrix. Algebra of linear transformations. Isomorphisms. Isomorphism theorems, invertibility and isomorphisms. Eigen values, eigen vectors and characteristic equation of a matrix (over C). Cayley-Hamilton theorem and its use in finding the inverse of a matrix.	Linear Algebra	Same as above	12	Chalk and Talk, Google Classroom, Hand Notes	AB
Review of Linear Algebra-I	Linear Algebra	Same as above	02	Chalk and Talk, Google Classroom, Hand Notes	AB

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM V (Major) MATH-H-CC 11-5-TH Riemann Integration and Series of Functions					
Group - A: Partition of a closed and bounded interval and refinement of a partition. Upper Darboux sum $U(P, f)$ and lower Darboux sum $L(P, f)$ and associated results. Upper integral and lower integral. Darboux's theorem. Darboux's definition of integration over a closed and bounded interval. Riemann's definition of integrability. Equivalence with Darboux's definition of integrability (statement only). Necessary and sufficient condition for Riemann integrability.	Riemann Integration	R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis T. Apostol, Mathematical Analysis,	08	Chalk and Talk, Google Classroom, Hand Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Concept of negligible set (or zero set) defined as a set covered by countable number of open intervals sum of whose lengths is arbitrary small. Examples of negligible sets: any subset of a negligible set, finite set, countable union of negligible sets. A bounded function on closed and bounded interval is Riemann integrable if and only if the set of points of discontinuity is negligible (Statement only). Example of Riemann integrable functions.	Riemann Integral	Same as above	10	Chalk and Talk, Notes	PL
Integrability of sum, scalar multiple, product, quotient, modulus of Riemann integrable functions. Properties of Riemann integrable functions arising from the above results. Function defined by definite integral $\int_a^x f(t)dt$ and its properties. Antiderivative (primitive or indefinite integral). Fundamental theorem of Integral Calculus. First Mean Value theorem of integral calculus. Weierstrass's & Bonnet's form of second mean value theorems (statement only).	Riemann Integral	Same as above	14	Chalk and Talk, Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Improper integral Range of integration, finite or infinite. Necessary and sufficient condition for convergence of improper integral in both cases. Cauchy's principal value of improper integral. Tests of convergence: Comparison and μ -test. Absolute and non-absolute convergence and inter-relations. Statement of Abel's and Dirichlet's test for convergence of the integral of product of two functions. Convergence and working knowledge of Beta and Gamma function and their interrelation (statement only) $\Gamma(n)\Gamma(1-n) = \frac{\pi}{\sin n\pi}$, $0 < n < 1$, to be assumed in computation of the integrals $\int_0^{\pi/2} \sin^n x dx$, $\int_0^{\pi/2} \cos^n x dx$, $\int_0^{\pi/2} \tan^n x dx$, when they exist (using Beta and Gamma function).	Improper Integral	Same as above	08	Chalk and Talk, Notes	AB
Group B: Sequence of functions defined on a set, Pointwise and uniform convergence. Cauchy criterion of uniform convergence. Weierstrass's M-test. Boundedness, continuity, integrability and differentiability of the limit function of a sequence of functions in case of uniform convergence. Series of functions defined on a set, Pointwise and uniform convergence. Cauchy criterion of uniform convergence. Weierstrass's M-test. Passage to the limit term by term. Boundedness, continuity, integrability, differentiability of a series of functions in case of uniform convergence. Dini's theorem.	Series of Functions	R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis T. Apostol, Mathematical Analysis,	08	Chalk and Talk, Notes	AB

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Power series: Fundamental theorem of power series. Cauchy-Hadamard theorem. Determination of radius of convergence. Uniform and absolute convergence of power series. Properties of sum function. Differentiation and integration of power series. Abel's limit theorems. Uniqueness of power series having sum function. Fourier series: Trigonometric series. Statement of sufficient condition for a trigonometric series to be a Fourier series. Fourier coefficients for periodic functions defined on $[-\pi, \pi]$. Statement of Dirichlet's condition of convergence. Statement of Fourier's theorem on sum of Fourier series.	Series of Functions	Same as above	09	Chalk and Talk, Notes	AB
Review of Series of Functions	Series of Functions	Same as above	03	Chalk and Talk, Notes	AB

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM V (Major) MATH-H-CC 12-5-TH Mechanics-II					
Statics-II: Friction: Laws of static friction, Limiting friction, Angle of friction and Cone of friction. Positions of equilibrium of a particle constrained to rest on a (i) rough plane curve and (ii) rough surface.	Statics	S. L. Loney, An Elementary Treatise on Statics, Cambridge University Press, 1917 (2nd edition). A. S. Ramsey, Dynamics (Part I & Part II), CBS Publishers, 2002 (2nd edition).	04	Chalk and Talk, Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Virtual work: Degrees of Freedom, Constraints, Virtual Displacement, Virtual Work, Workless Constraints, Forces which do not appear in the equation of virtual work, Forces which appear in the equation of virtual work, Principle of virtual work for any system of coplanar forces acting on a rigid body and deduction of conditions of equilibrium from the Principle of virtual work	Statics	S. L. Loney, An Elementary Treatise on Statics, Cambridge University Press, 1917 (2nd edition). A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	05	Chalk and Talk, Notes	BS
Stable and unstable equilibrium: Field of forces, Conservative field, Potential energy of a system, Concepts of Stable, Unstable and Neutral equilibrium, Energy test of stability for a system having one degree of freedom, Stability when gravity is the only external force, Condition of stability of equilibrium of two heavy bodies resting one upon another, the bodies being rough enough to prevent sliding.	Statics	S. L. Loney, An Elementary Treatise on Statics, Cambridge University Press, 1917 (2nd edition). A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	05	Chalk and Talk, Notes	BS
Arbitrary force system in three dimensions: 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, Equilibrium equations, Reduction to wrench intensity and pitch of a wrench, Poinso't's central axis, Equation of the central axis of a given system of forces, Invariants of a given system of forces.	Statics	S. L. Loney, An Elementary Treatise on Statics, Cambridge University Press, 1917 (2nd edition). A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	05	Chalk and Talk, Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Review of Statics-II	Statics	S. L. Loney, An Elementary Treatise on Statics, Cambridge University Press, 1917 (2nd edition). A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	03		BS
Dynamics of a Particle-II: Stability of nearly circular orbits, Disturbed orbits, Motion of a particle on rough curve, Expressions for components of velocity and acceleration referred to a set of rotating axes, Motion of a particle of varying mass including problems of mass addition (Rain-drop Problem) and mass reduction (Rocket Problem).	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	08	Chalk and Talk, Notes	MH
Dynamics of a system of particles: General theorems (Emphasis should be given on theoretical discussion only in this part): Configuration of a mechanical system and its degrees of freedom, External forces, Internal forces and two assumptions connected with these forces, Mass of a system, Centre of mass of a system and its motion, Linear momentum of a system and principle of conservation of linear momentum, Angular momentum of a system about a point and an axis, Angular momentum principle about the centre of mass, Conservation of angular momentum about a point and an axis, Kinetic energy(K.E.) of a system, The energy principle and Conservation of energy.	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	04	Chalk and Talk, Notes	MH

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Dynamics of rigid body: Vector angular velocity and its existence, particle velocities in a rigid body.	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	02	Chalk and Talk, Notes	MH
Moments and Products of Inertia, Moment of inertia of a body about any line through the origin of a coordinate frame, Radius of gyration, Equimomental systems, Principal axis and Momental ellipsoid, theorems of parallel and perpendicular axes (statements only).	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	04	Chalk and Talk, Notes	MH
General motion: Deduction of the equations: $m \frac{d\vec{V}}{dt} = \vec{F}$, $\frac{dL_G}{dt} = \vec{K}_G$ from linear and angular momentum principle, Deductions of equations of motions from D'Alembert's Principle, Independence of the motion of centre of inertia and the motion relative to the centre of inertia, Angular momentum of a rigid body and the kinetic energy of a rigid body rotating about a fixed axis, Motion of a rigid body about a fixed axis, Compound pendulum, Interchangeability of the point of suspension and centre of oscillation.	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	08	Chalk and Talk, Notes	MH

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Motion of a rigid body in two dimensions: Equations of motion of a rigid body in two dimensions in the form $m \frac{d\vec{V}_x}{dx} = \vec{F}_x$, $m \frac{d\vec{V}_y}{dx} = \vec{F}_y$, $I \frac{d\omega}{dx} = K_G$ Expressions for K.E. and angular momentum about the origin, Condition of pure rolling and sliding.	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	05	Chalk and Talk, Notes	MH
Motion under impulsive forces: Equation of motion for impulsive forces for two dimensions, Statements of the conservation of linear and angular momentum. Problems of impulse applied to a free rod and a rod constrained to rotate about a fixed axis. [4 classes]	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	04	Chalk and Talk, Notes	MH
Review of Dynamics of a Particle-II:	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	03	Chalk and Talk, Notes	MH

Sem-VII

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM VII (Major) MTHM-DSCC 16-TH Group Theory - III & Linear Algebra - II					
Group A: Finite Abelian group, Fundamental theorem of finite Abelian groups, classification of all non-isomorphic Abelian groups of a given finite order, finitely generated free Abelian groups, structure of finitely generated free Abelian groups, torsion of a group.	Abstract Algebra	1) M. Artin, <i>Abstract Algebra</i> , 2nd Ed., Pearson, 2011. 2) I. N. Herstein, <i>Topics in Algebra</i> , Wiley Eastern Limited, India, 1975. 3) Joseph A. Gallian, <i>Contemporary Abstract Algebra</i> , 4th Ed., Narosa Publishing House, New Delhi, 1999.	08	Chalk and Talk, Notes	PL
Group A: Group actions, permutation representation of group action, orbit, stabilizer, applications of group actions – Generalized Cayley’s theorem (extended Cayley’s theorem), Index theorem, Burnside theorem.	Abstract Algebra	Same as above	06	Chalk and Talk, Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group A: Groups acting on themselves by conjugation, conjugacy classes, class equation and consequences, conjugacy in S_n , Cauchy's theorem on finite groups, p -group, Centre of p -groups, Sylow's theorems, some applications of Sylow's theorems, simple groups, non-simplicity of groups of order p^n ($n > 1$), pq , p^2q , p^2q^2 (p, q distinct primes), determination of all simple groups of order less than or equal to 60, non-simplicity of A_n ($n \geq 5$), uniqueness of simple group of order 60.	Abstract Algebra	Same as above	10	Chalk and Talk, Notes	PL
Review of Group Theory-III	Abstract Algebra	Same as above	04	Chalk and Talk, Notes	PL
Group B: Finite dimensional inner product spaces and norms, Gram-Schmidt orthonormalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator and its basic properties.	Linear Algebra	1) Friedberg, Insel and Spence, <i>Linear Algebra</i> ; Prentice Hall of India. 2) Hoffman and Kunze, <i>Linear Algebra</i> , Prentice Hall of India, New Delhi. 3) Gilbert Strang, <i>Introduction to Linear Algebra</i> , 5th Ed., Wellesley-Cambridge Press and SIAM, 2016.	08	Chalk and Talk, Notes	BS
Group B: Bilinear and quadratic forms, Diagonalisation of symmetric matrices, second derivative test for critical point of a function of several variables, Hessian matrix, Sylvester's law of inertia (statement only), Index, signature.	Linear Algebra	Same as above	08	Chalk and Talk, Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Fundamental theorem of Linear Algebra (Part – I and Part – II), existence and uniqueness of solutions to $Ax = b$, a matrix transforms its row space to its column space.	Linear Algebra	Same as above	06	Chalk and Talk, Notes	BS
Group B: Duality and transposition, linear forms or linear functionals, dual space V^d , bi-dual space V^{dd} , dual basis, natural isomorphism between V and V^{dd} , Annihilators W^0 of a nonempty subset W of a vector space V , $\dim W^0 = \dim V - \dim W$ where W is a subspace of V , transpose T^t of a linear transformation T , $T^{tt} = T$, $(T^t)^{-1} = (T^{-1})^t$ if T is an isomorphism, $(\text{Im } T)^0 = \ker T^t$, $\dim(\text{Im } T) = \dim(\text{Im } T^t)$, $(\ker T)^0 = \text{Im } T^t$. Eigenspaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms (Jordan & rational) [problems only].	Linear Algebra	Same as above	10	Chalk and Talk, Notes	BS

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM VII (Major) MTHM-DSCC 17-TH Complex Analysis - II & Measure Theory - I					

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group A: Curves in the complex plane, complex line integrations and its properties, fundamental theorem of calculus, Cauchy-Goursat theorem (statement only), Cauchy's integral formula, Cauchy's integral formula for derivatives (statement only), Morera's theorem, Liouville's theorem, fundamental theorem of algebra.	Complex Analysis	1) L. V. Ahlfors, <i>Complex Analysis</i> , 3rd Ed., McGraw-Hill, New York, 1979. 2) J. B. Conway, <i>Functions of One Complex Variable</i> ; Narosa Publishing, New Delhi, 1973. 3) James Ward Brown and Ruel V. Churchill, <i>Complex Variables and Applications</i> , 8th Ed., McGraw-Hill International Edition, 2009.	10	Chalk and Talk, Notes	PL
Group A: Maximum Modulus theorem (statement only) and its applications, Minimum Modulus Theorem (statement only).	Complex Analysis	Same as above	04	Chalk and Talk, Notes	PL
Group A: Taylor's theorem, Laurent's theorem (statement only), zeros of an analytic function, interior uniqueness theorem / Identity theorem.	Complex Analysis	Same as above	06	Chalk and Talk, Notes	PL
Group A: Various kinds of singularities of complex valued functions in the extended complex plane, removable singularity, pole, essential singularity, Casorati-Weierstrass theorem concerning the nature of a function having an essential singularity, singularities of entire functions at infinity.	Complex Analysis	Same as above	06	Chalk and Talk, Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group A: Residue calculus: Residue theorem and its applications, Residue theorem for the extended complex plane.	Complex Analysis	Same as above	06	Chalk and Talk, Notes	PL
Group B: Extended real number system $\mathbb{R}^* \equiv \mathbb{R} \cup \{\infty, -\infty\}$, arithmetic operations on $\mathbb{R}^*$, linear order on $\mathbb{R}^*$.	Measure Theory	1) H. L. Royden, <i>Real Analysis</i> , 4th Ed., Macmillan Pub. Co. Inc., New York, 1993. 2) P. R. Halmos, <i>Measure Theory</i> , D. Van Nostrand Co. Inc., London, 1962. 3) Inder Kumar Rana, <i>An Introduction to Measure & Integration</i> , Narosa Publishing House, 1997.	03	Chalk and Talk, Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Motivation for the theory of Lebesgue integration: limitations of Riemann integration, necessity of extending the concept of length of an interval to an arbitrary set; Lebesgue outer measure (m^*), properties of m^* : monotonicity, $m^*(I)$ is the length of I for any interval I , translation invariance property of m^* , countable subadditivity of m^* , m^* is not additive even for two disjoint sets. σ -algebra, Borel σ -algebra, Borel sets, example of Borel sets, additivity of m^* if one of the sets is open, additivity of m^* if one of the sets is closed, approximation of Borel sets from below by closed sets, additivity of m^* if one of the sets is a Borel set, existence of a subset of $\mathbb{R}$ that is not a Borel set, m^* is countably additive on Borel sets.	Measure Theory	Same as above	12	Chalk and Talk, Notes	BS
Group B: Definition of Lebesgue measurable set: a set $A \subseteq \mathbb{R}$ is called Lebesgue measurable if there exists a Borel set $B \subseteq A$ such that $m^*(A \setminus B) = 0$, m^* is countably additive on Lebesgue measurable sets, the set of all Lebesgue measurable sets form a σ -algebra, any set $A \subset \mathbb{R}$ with $m^*(A) = 0$ is Lebesgue measurable; characterisation of Lebesgue measurable sets by open sets, closed sets, F_σ -sets, G_δ -sets; a set $A \subseteq \mathbb{R}$ is Lebesgue measurable if and only if for any set $E \subseteq \mathbb{R}$ we have $m^*(E) = m^*(E \cap A) + m^*(E \setminus A)$ [Caratheodory's criterion], non-measurable sets, Cantor set and its properties.	Measure Theory	Same as above	13	Chalk and Talk, Notes	BS

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM VII (Major) MTHM-DSCC 18-TH Generalised Functions, Integral Transforms & Integral Equations					
Group A: Introduction and notations, test functions, linear functional, space of generalised functions, completeness of generalised functions, support of a generalised function, regular generalised functions, singular generalised function.	Generalised Functions	1) R. F. Hoskins, <i>Generalized Functions</i> , Horwood, Chichester and New York, 1979. 2) D. S. Jones, <i>Generalized Functions</i> , Cambridge University Press, 1982. 3) R. P. Kanwal, <i>Generalized Functions: Theory and Technique</i> , Birkhauser, New York, 1998.	06	Chalk and Talk, Notes	MH
Group A: The Dirac Delta function, support of a Delta function, and Delta sequences. Change of variables in generalised function, multiplication of generalised function, Sochozki formula, derivative of a generalised function, anti-derivative of a generalised function and examples.	Generalised Functions	Same as above	06	Chalk and Talk, Notes	MH

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Fourier Transform: Definition and algebraic properties of Fourier transform, convolution, translation, modulation, analytical properties of Fourier transforms, transform of derivatives and derivatives of transform, Parseval formula, inversion theorem, application to solving ordinary differential equations.	Integral Transforms	1) I. N. Sneddon, <i>Fourier Transform</i> , McGraw-Hill, 1951. 2) E. J. Watson, <i>Laplace Transforms and Application</i> , Van Nostrand Reinhold Co. Ltd., 1981. 3) Peter K. F. Kuhfittig, <i>Introduction to the Laplace Transform</i> , Plenum Press, New York, 1980.	14	Chalk and Talk, Notes	MH
Group B: Laplace Transforms: Definition and algebraic properties of Laplace transform, transform of derivatives and derivatives of transform, convolution, the inversion theorem and its application to find inverse of Laplace Transform, application to solving ordinary differential equations.	Integral Transforms	Same as above	14	Chalk and Talk, Notes	MH
Group C: Reduction of boundary value problem of an ordinary differential equation to an integral equation. Fredholm equation: solution by the method of successive approximation, Neumann series, existence and uniqueness of the solution of Fredholm equation, equations with degenerate kernel, eigen values and eigen solutions.	Integral Equations	1) F. G. Tricomi, <i>Integral Equations</i> , Dover, 1985. 2) D. Porter and D. S. G. Stirling, <i>Integral Equations</i> , Cambridge University Press, 2004. 3) A. Wazwaz, <i>A First Course in Integral Equations</i> , World Scientific, 1997.	10	Chalk and Talk, Notes	MH

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group C: Volterra equation: solution by the method of iterated kernel, existence and uniqueness of solution, solution of Abel equation, solution of Volterra equation of convolution type by Laplace transform.	Integral Equations	Same as above	10	Chalk and Talk, Notes	MH

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM VII (Major) MTHM-DSCC 19-TH Topology - I					
Basic Concepts: Definition and examples of topological spaces. Metric space as a topological space. Open set (defined as a member of the topology), closed set (defined as the complement of an open set), closure of a set, dense subset. Neighbourhood, interior, exterior, boundary, accumulation point, derived set. Bases and subbases. Subspace topology. Finite product of topological spaces. Alternative methods for defining a topology in terms of Kuratowski closure operator and neighbourhood system.	Topology	1) James R. Munkres, <i>Topology</i> , 2nd Ed., Pearson Education, 2004. 2) George F. Simmons, <i>Introduction to Topology and Modern Analysis</i> , McGraw-Hill, New York, 1963. 3) K. D. Joshi, <i>Introduction to Topology</i> , Wiley Eastern Ltd., 1983.	14	Chalk and Talk, Notes	AB
Countability Axioms: First and second countability, separability and Lindelöf property. Every metric space is first countable. Equivalence of second countability, separability and Lindelöf property in metric spaces.	Topology	Same as above	08	Chalk and Talk, Notes	AB

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Continuous Functions: Definition and examples. Simple properties and characterizations of continuous functions. Past-ing lemma for continuous functions. Heine's continuity criterion for first countable topologi-cal spaces. Open map, closed map and homeo-morphism, topological invariants.	Topology	Same as above	10	Chalk and Talk, Notes	AB
Separation Axioms: T_i -property ($i = 0, 1, 2, 3, 3\frac{1}{2}, 4, 5$), regularity, complete regularity, normality and complete normality, basic properties of separation ax-ioms, characterizations of T_1, T_2 , regularity and normality, Urysohn's lemma (statement only), Tietze's extension theorem (statement only). T_5 -property of a metric space.	Topology	Same as above	14	Chalk and Talk, Notes	AB
Compactness: Characterizations and basic properties, Alexan-der subbase theorem (statement only) and its application, compactness and finite intersection property, compactness and separation axioms. Every compact Hausdorff space without iso-lated point is uncountable. Compactness and continuous functions. Product of two compact spaces is compact. Countably compact, sequen-tially compact, Frechet compact, pseudo com-pact and their equivalence in metric spaces.	Topology	Same as above	14	Chalk and Talk, Notes	AB

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM VII (Major) MTHM-DSCC 20-TH Functional Analysis - I					

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Cardinal Number: Concept of cardinal number of an infinite set, cardinality of $\mathbb{N}$ ($= \aleph_0$), $\mathbb{Z}$, $\mathbb{Q}$, $\mathbb{R}$ ($= c$), $\mathbb{C}$, order relation of cardinal numbers, Schröder-Bernstein theorem.	Functional Analysis	1) Walter Rudin, <i>Functional Analysis</i> , Tata McGraw-Hill, 1974. 2) B. V. Limaye, <i>Functional Analysis</i> , New Age International Ltd. 3) John B. Conway, <i>A Course in Functional Analysis</i> , Springer, 1990.	06	Chalk and Talk, Notes	DP
Concept of infinite basis of a linear space (or vector space), every linear space has a basis (statement only), cardinality of any two bases of a linear space are same (statement only), dimension defined as the cardinal number of a basis of a linear space.	Functional Analysis	Same as above	04	Chalk and Talk, Notes	DP
Normed linear space (n.l.sp.), every n.l.sp. is a metric space and hence a topological space, norm function is continuous, examples of n.l.sp.: finite dimensional spaces $\mathbb{R}^n, \mathbb{C}^n$ etc., $P[a, b]$, ℓ^∞ , c , c_0 , c_{00} , ℓ^p ($p \geq 1$), the space $C[a, b]$ of all continuous functions on $[a, b]$ with supremum norm, the space $R[a, b]$ of all Riemann integrable functions on $[a, b]$ with Riemann integral norm, Banach space, quotient space, convexity of open and closed balls, a n.l.sp. is complete if and only if every absolutely convergent series is convergent.	Functional Analysis	Same as above	16	Chalk and Talk, Notes	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Bounded linear transformation between two n.l.spaces, its equivalence with continuity, norm of a bounded linear transformation, various formulae for calculating norm of a bounded linear transformation, space of bounded linear transformations, equivalence of two norms in a linear space, isometric isomorphism and topological isomorphism (i.e. isomorphism and homeomorphism) between two n.l.spaces. Every finite dimensional n.l.sp. is a Banach space, equivalence of any two norms in a finite dimensional linear space, every n -dimensional n.l.sp. is topologically isomorphic with the n -dimensional Euclidean space, every linear transformation is bounded on a finite dimensional n.l.sp. Riesz lemma, a closed bounded set A in a n.l.sp. X is compact if and only if X is finite dimensional.	Functional Analysis	Same as above	18	Chalk and Talk, Notes	DP
Bounded linear functional and its example, a functional f on a n.l.sp. X is bounded if and only if $\ker f$ is closed in X , formula for calculating $\ f\ $ of a bounded linear functional f on a normed linear space, construction of unbounded linear functional on every infinite dimensional linear space, Hahn-Banach theorem (extension form only) and its consequences, dual and 2nd dual of a n.l.sp., dual space of any n.l.sp. is a Banach space, every n.l.sp. can be embedded isometrically and isomorphically into its 2nd dual space, definition of reflexivity of a n.l.sp. Dual spaces of $\mathbb{R}^n$, ℓ^p ($p \geq 1$), c , c_0 , c_{00} .	Functional Analysis	Same as above	16	Chalk and Talk, Notes	DP

Lesson Plan – Odd Semester

MDC and Minor and IDC Courses in Mathematics

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM I (Minor/MDC) (MATH-H-MC 1-1-Th / MATH-MD-CC 1-1-Th) Calculus, Geometry & Vector Analysis					
Group A: Differentiability of a function at a point and in an interval. Meaning of sign of derivative. Differentiating hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to functions of type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$. Indeterminate forms. L'Hospital's rule (statement and example).	Calculus	1) T. Apostol, Vol. I & II, Wiley, 1969 2) R.R. Goldberg, <i>Methods of Real Analysis</i> , Oxford & IBH, 2020	6	Google Classroom, Hand Notes	MH
Group A: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sec^n x dx$, $\int (\log x)^n dx$, $\int \sin^n x \sin^m x dx$, $\int \sin^n x \cos^m x dx$. Parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.	Calculus	Same as above	10	Google Classroom, Hand Notes	MH
Group B Rotation of axes and second degree equations, classification of conics using the discriminant, reduction to canonical form, tangent and normal, polar equations of conics.	Geometry	1) S.L. Loney, <i>Coordinate Geometry</i> 2) Ghosh & Maity, <i>Advanced Analytical Geometry</i>	12	Chalk & Blackboard, Class Notes, Handwritten Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.	Geometry	Same as above	16	Chalk & Blackboard, Class Notes, Handwritten Notes	PL
Group C: Triple product, vector equations, applications to geometry and mechanics concurrent forces in a plane, theory of couples, system of parallel forces.	Vector Analysis	M.R. Spiegel, <i>Schaum's Outline of Vector Analysis</i> , Tata McGraw-Hill, 2011	6	Chalk & Blackboard, Notes	BS
Group C: Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable.	Vector Analysis	Same as above	10	Chalk & Blackboard, Notes	BS

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM I (MDC) MATH-MD-SEC 1-1-Th C Language with Mathematical Applications					
Overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language, higher level language	C Language with Mathematical Applications	V. Rajaraman: Fundamentals of Computers; PHI Learning Private limited, 2013	2	Chalk and Talk, Notes	DP
Constants, Variables and Data type of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	6	Chalk and Talk, Notes, tutorial, class work	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Operation and Expressions: Arithmetic operators, relational operators, logical operators.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP
Decision Making and Branching: decision making with if statement, if-else statement, Nesting if statement, switch statement, break and continue statement.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	6	Chalk and Talk, Notes, tutorial, class work	DP
Control Statements: While statement, do-while statement, for statement	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP
Arrays: One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	4	Chalk and Talk, Notes, tutorial, class work	DP
User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recurrence of function.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Introduction to Library functions: stdio.h, math.h, string.h, stdlib.h, time.h etc.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	1	Chalk and Talk, Notes	DP
Sample problems	C Language with Mathematical Applications	C. Xavier: C-Language and Numerical Methods, New Age International, 2007., V. Rajaraman: Computer Oriented Numerical Methods, Prentice Hall of India, 1980	26	Practical: hands on experience	DP

Sem-III

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM III (Minor) MATH-H-MC 1-3-Th Calculus, Geometry & Vector Analysis					
Group A: Differentiability of a function at a point and in an interval. Meaning of sign of derivative. Differentiating hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to functions of type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$. Indeterminate forms. L'Hospital's rule (statement and example).	Calculus	1) T. Apostol, Vol. I & II, Wiley, 1969 2) R.R. Goldberg, <i>Methods of Real Analysis</i> , Oxford & IBH, 2020	6	Google Classroom, Hand Notes	MH
Group A: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sec^n x dx$, $\int (\log x)^n dx$, $\int \sin^n x \sin^m x dx$, $\int \sin^n x \cos^m x dx$. Parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.	Calculus	Same as above	10	Google Classroom, Hand Notes	MH
Group B Rotation of axes and second degree equations, classification of conics using the discriminant, reduction to canonical form, tangent and normal, polar equations of conics.	Geometry	1) S.L. Loney, <i>Coordinate Geometry</i> 2) Ghosh & Maity, <i>Advanced Analytical Geometry</i>	12	Chalk & Blackboard, Class Notes, Handwritten Notes	PL
Group B: Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.	Geometry	Same as above	16	Chalk & Blackboard, Class Notes, Handwritten Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group C: Triple product, vector equations, applications to geometry and mechanics concurrent forces in a plane, theory of couples, system of parallel forces.	Vector Analysis	M.R. Spiegel, <i>Schaum's Outline of Vector Analysis</i> , Tata McGraw-Hill, 2011	6	Chalk & Blackboard, Notes	BS
Group C: Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable.	Vector Analysis	Same as above	10	Chalk & Blackboard, Notes	BS

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No of Lecture Planned	Content Delivery Technique	Remarks Comments
SEM III (MDC) MATH-MD-CC 3-3-Th Ordinary Differential Equations & Group Theory					
Group A: Formation of differential equations, order and degree of a differential equation, First order and first degree differential equations; Homogeneous and exact differential equations, conditions for an equation of the first order to be exact, Integrating factors, Rules for finding integrating factors, Linear equations and Bernoulli equations.	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	10	Chalk and Talk, Notes	BS
Group A: First order higher degree differential equations solvable for x, y, and p, Clairaut's forms. Singular solutions, Equations of tac-locus, nodal locus, cuspidal locus.	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	8	Chalk and Talk, Notes	BS

Group A: Higher order linear and nonlinear equations, Concept of Wronskian and its properties, Complementary functions, Particular integrals, linear homogeneous and non-homogeneous equations with constant coefficients, Method of undetermined coefficients, Method of variation of parameters. Simultaneous linear differential equations.	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	8	Chalk and Talk, Notes	BS
Group A: Higher order linear equations with variable coefficients reducible to linear equations with constant coefficients (Euler's equation), Condition for exactness of higher order linear equations, Integrating factors, Equations of the form $\frac{dy}{dx} = f(y)$ ($n \geq 2$).	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	10	Chalk and Talk, Notes	BS
Group B: Definition of a group, examples of groups including permutation groups, dihedral groups and quaternion groups (through matrices), elementary properties of groups, examples of commutative and non-commutative groups.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL
Group B: Subgroups and examples of subgroups, necessary and sufficient condition for a nonempty subset of a group to be a subgroup, Normalizer, centralizer, center of a group, product of subgroups.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL
Group B: Order of an element of a group, order of a group, cyclic group, properties of cyclic groups, classification of subgroups of cyclic groups	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL

Group B: Permutation, cycle notation for permutations, properties of permutation, even and odd permutations, Alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's little theorem.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL
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Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM III (MDC) MATH-MD-SEC 3-3-Th C Language with Mathematical Applications					
Overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language, higher level language	C Language with Mathematical Applications	V. Rajaraman: Fundamentals of Computers; PHI Learning Private limited, 2013	2	Chalk and Talk, Notes	DP
Constants, Variables and Data type of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	6	Chalk and Talk, Notes, tutorial, class work	DP
Operation and Expressions: Arithmetic operators, relational operators, logical operators.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP
Decision Making and Branching: decision making with if statement, if-else statement, Nesting if statement, switch statement, break and continue statement.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	6	Chalk and Talk, Notes, tutorial, class work	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Control Statements: While statement, do-while statement, for statement	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP
Arrays: One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	4	Chalk and Talk, Notes, tutorial, class work	DP
User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recurrence of function.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	5	Chalk and Talk, Notes, tutorial, class work	DP
Introduction to Library functions: stdio.h, math.h, string.h, stdlib.h, time.h etc.	C Language with Mathematical Applications	Y. Kanetkar: Let Us C; BPB Publication, 1999., E. Balagurusamy: Programming in ANSI C, Tata McGraw Hill, 2004.	1	Chalk and Talk, Notes	DP
Sample problems	C Language with Mathematical Applications	C. Xavier: C-Language and Numerical Methods, New Age International, 2007., V. Rajaraman: Computer Oriented Numerical Methods, Prentice Hall of India, 1980	26	Practical: hands on experience	DP

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM III (MDC-mn) MATH-MD-MC 1-3-Th Calculus, Geometry & Vector Analysis					
Group A: Differentiability of a function at a point and in an interval. Meaning of sign of derivative. Differentiating hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to functions of type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$. Indeterminate forms. L'Hospital's rule (statement and example).	Calculus	1) T. Apostol, Vol. I & II, Wiley, 1969 2) R.R. Goldberg, <i>Methods of Real Analysis</i> , Oxford & IBH, 2020	6	Google Classroom, Hand Notes	MH
Group A: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \sec^n x dx$, $\int (\log x)^n dx$, $\int \sin^n x \sin^m x dx$, $\int \sin^n x \cos^m x dx$. Parametric equations, parametrizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution.	Calculus	Same as above	10	Google Classroom, Hand Notes	MH
Group B Rotation of axes and second degree equations, classification of conics using the discriminant, reduction to canonical form, tangent and normal, polar equations of conics.	Geometry	1) S.L. Loney, <i>Coordinate Geometry</i> 2) Ghosh & Maity, <i>Advanced Analytical Geometry</i>	12	Chalk & Blackboard, Class Notes, Handwritten Notes	PL
Group B: Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.	Geometry	Same as above	16	Chalk & Blackboard, Class Notes, Handwritten Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group C: Triple product, vector equations, applications to geometry and mechanics concurrent forces in a plane, theory of couples, system of parallel forces.	Vector Analysis	M.R. Spiegel, <i>Schaum's Outline of Vector Analysis</i> , Tata McGraw-Hill, 2011	6	Chalk & Blackboard, Notes	BS
Group C: Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions of one variable.	Vector Analysis	Same as above	10	Chalk & Blackboard, Notes	BS

Sem V

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
MATH-MD-CC 6-5-TH – Statistics and Numerical Analysis					
Group A: Statistics Probability Theory: Theorems on Total Probability, Conditional probability and Multiplication theorem, Bayes' Theorem (Application only), Independence of events, Related Problems. Compound experiment, Independent trials, Bernoulli's trials, Binomial law. Probability Distribution: Random Variables, Probability Distribution function, Properties of probability distribution function, Discrete and continuous distribution, Probability mass and probability density function, Some important probability distributions and their properties - Binomial, Poisson, Uniform and Normal, Related problems.	Statistics (Probability, Distributions, Expectation, Methods, Inference)	Feller (1968), Hogg et al. (2007), Goon et al. (2013/2016)	10	Lectures, Examples	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Two-dimensional random variables and bi-variate distribution (discrete and continuous), Marginal distribution, Bivariate Uniform and Normal distributions, Related problems. Mathematical Expectation: Definition of mathematical expectation, Mean, Variance, Standard Deviation, Moments, Theorems on mathematical expectation (statement only), Standardized random variate, Mean, Variance and standard deviation of Binomial, Poisson and Normal distributions. Mathematical Expectation in bivariate distribution, Moments, Covariance, Correlation coefficient, $E(X + Y) = E(X) + E(Y)$, $E(XY) = E(X)E(Y)$ for independent variates.	Statistics (Probability, Distributions, Expectation, Methods, Inference)	Feller (1968), Hogg et al. (2007), Goon et al. (2013/2016)	10	Lectures, Examples	DP
Elements of Statistical Methods: Measure of Central tendency: Arithmetic Mean, Geometric Mean, Harmonic Mean, Median and Mode (their advantages and disadvantages), Relation between Mean, Median and Mode. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Variance / Standard Deviation. Moments, Raw moments and Central moments and relation between them, Effect of change of origin and change of scale on moments. Correlation and Regression: Bivariate data, Scatter Diagram, Correlation coefficient - its determination and properties, Regression lines of y on x and x on y - their deductions and properties.	Statistics (Probability, Distributions, Expectation, Methods, Inference)	Feller (1968), Hogg et al. (2007), Goon et al. (2013/2016)	10	Lectures, Examples	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Sampling Theory: Meaning and objects of sampling, Parameter and Statistic, Sampling distribution of a statistic, Methods of drawing random sample, Mean and Variance of sample mean, Basic idea of some distributions used in Sampling Theory - (i) Standard Normal distribution, (ii) Chi-square distribution, (iii) Student's t-distribution, (iv) Snedecor's F-distribution, Related problems. Statistical Inference: Estimation of Parameters, Unbiased estimator, Consistent estimator, Sample mean is an unbiased estimate of population mean, Sample variance is a biased estimator of population variance, Point estimation, Interval estimation, Method for finding Confidence Intervals, Confidence intervals for mean of Normal (μ, σ) population when σ is known and when σ is unknown, Statistical Hypothesis - Null Hypothesis and Alternative Hypothesis, Critical Region, Type I and II error, Level of significance, Related simple problems.	Statistics (Probability, Distributions, Expectation, Methods, Inference)	Feller (1968), Hogg et al. (2007), Goon et al. (2013/2016)	10	Lectures, Examples	DP

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Numerical Analysis Approximate numbers: Significant figures, Rounding off of numbers. Errors Absolute, Relative and Percentage. Operators - Δ , ∇ and E (Definitions and some relations among them). Interpolation: Problem of interpolation, Equi-spaced arguments, Difference Table, Deduction of Newton's Forward Interpolation Formula, remainder term (expression only), Newton's Backward interpolation Formula (Statement only) with remainder term. Unequally-spaced arguments, Lagrange's Interpolation Formula (Statement only), Related problems.	Numerical Analysis (Errors, Operators, Interpolation)	Bradie (2007), Jain et al. (2005), Gerald & Wheatley (2008)	10	Lectures, Numerical Problems	DP
Numerical Integration: Trapezoidal rule and Simpson's $\frac{1}{3}$ rule with geometrical interpretation, Related problems. Numerical solution of nonlinear equations: To find a real root of an algebraic or transcendental equation. Location of root (tabular method), Bisection method, Newton-Raphson method with geometrical interpretation. Related problems. Numerical solution of system of linear equations: Gauss elimination method using partial pivoting for solution of system of three linear equations in three unknowns.	Numerical Analysis (Integration, Solutions)	Bradie (2007), Jain et al. (2005), Gerald & Wheatley (2008)	10	Lectures, Numerical Problems	DP

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
MATH-MD-CC 7-5-TH – Mathematical Methods					
Group A: Sequence and Series of functions: Concept of Point-wise and Uniform convergence of sequence of functions and series of functions defined on intervals with special reference of Power Series, Statement of Weierstrass' M-Test for Uniform convergence of sequence of functions and of series of functions, Simple applications, Statements of important properties like boundedness, continuity, differentiability of the limit function of uniformly convergent sequence of functions and of the sum function of uniformly convergent series of functions, Convergence of Power Series, Radius of convergence, Statement of Abel's Theorem on Power Series and region of convergence of Power Series, Simple problems.	Sequence and Series of Functions, Power Series	Widder (1947), Taylor & Mann (1983), Courant & John (1989)	20	Chalk & Blackboard, Notes	AB
Group B: Application of differential calculus: Tangents and Normals, Pedal equations, Curvature, radius of curvature of plane curves, Rectilinear asymptotes (Cartesian only); Envelopes (Cartesian only), Concavity, Convexity, Point of inflection (Cartesian only), Definition and examples of singular points (viz. Node, Cusp, Isolated point) (Cartesian only). Maxima and minima of functions: Maxima and Minima of functions involving one and two variables, Lagrange's Method of undetermined multipliers of functions involving two variables (Problems only).	Differential Calculus Applications, Maxima and Minima	Thomas & Finney (2005), Strauss et al. (2007), Olmstead (1961)	28	Chalk & Blackboard, Notes , Problem Solving	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group C: Fourier series on $[-\pi, \pi]$: Periodic function, Determination of Fourier coefficients, Statement of Dirichlet's conditions (improperness excluded) for convergence and statement of the theorem on convergence and sum of Fourier series, Sine and Cosine series. Laplace Transform and its application to ordinary differential equation: Laplace Transform and Inverse Laplace Transform, Statement of Existence theorem, Statements of elementary properties of Laplace Transform and its Inverse, Application of the solution of ordinary differential equation of second order with constant coefficients.	Fourier Series, Laplace Transform	Spiegel (2020), Anton et al. (2002), Apostol (1967)	12	Chalk & Blackboard, Notes , Problem Solving	AB

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM V (MDC-mn) MATH-MD-MC 3-5-TH Ordinary Differential Equations and Group Theory					
Group A: Formation of differential equations, order and degree of a differential equation, First order and first degree differential equations; Homogeneous and exact differential equations, conditions for an equation of the first order to be exact, Integrating factors, Rules for finding integrating factors, Linear equations and Bernoulli equations.	Ordinary Differential Equation	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	10	Chalk and Talk, Notes	BS

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group A: First order higher degree differential equations solvable for x, y and p, Clairaut's forms. Singular solutions, Equations of tac-locus, nodal locus, cuspidal locus.	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	8	Chalk and Talk, Notes	BS
Group A: Higher order linear and nonlinear equations, Concept of Wronskian and its properties, Complementary functions, Particular integrals, linear homogeneous and non-homogeneous equations with constant coefficients, Method of undetermined coefficients, Method of variation of parameters. Simultaneous linear differential equations.	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	8	Chalk and Talk, Notes	BS
Group A: Higher order linear equations with variable coefficients reducible to linear equations with constant coefficients (Euler's equation), Condition for exactness of higher order linear equations, Integrating factors, Equations of the form $\frac{d^n y}{dx^n} = f(y)$ ($n \geq 2$).	Ordinary Differential Equations	S. L. Ross, Differential Equations G. F. Simmons, Differential Equations with Applications and Historical Notes	10	Chalk and Talk, Notes	BS
Group B: Definition of a group, examples of groups including permutation groups, dihedral groups and quaternion groups (through matrices), elementary properties of groups, examples of commutative and non-commutative groups.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group B: Subgroups and examples of subgroups, necessary and sufficient condition for a nonempty subset of a group to be a subgroup, Normalizer, centralizer, center of a group, product of subgroups.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL
Group B: Order of an element of a group, order of a group, cyclic group, properties of cyclic groups, classification of subgroups of cyclic groups	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL
Group B: Permutation, cycle notation for permutations, properties of permutation, even and odd permutations, Alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's little theorem.	Abstract Algebra	J. A. Gallian, Contemporary Abstract Algebra I. N. Herstein, Topics in Algebra	6	Chalk and Talk, Notes	PL

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM V (MDC-mn) MATH-MD-MC 4-5-Th Mechanics					
Statics-I: Idea about Physical Independence Principle of Forces, Principle of transmissibility of a force, Principle of action and reaction and Principle of parallelogram law of forces, Composition and resolution of forces, Concurrent Forces in a plane, Composition and resolution of forces, Equilibrium of three forces acting at a point, Lami's theorem, Moment of a force about a point and an axis, Varignon's theorem, Resultant forces and resultant couple, Coplanar forces: Its reduction and conditions of equilibrium	Statics-I	S. L. Loney, An Elementary Treatise on Statics, Cambridge University Press, 1917 (2nd edition). A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	07	Chalk and Talk, Google Classroom, Hand Notes	MH
Review of Statics-I	Statics	Same as above	01	Chalk and Talk, Google Classroom, Hand Notes	MH
Particle Dynamics-I: Law of gravitation, Concept of inertial frame, Newton's laws of motion, Concept of equation of motion of a particle, Rectilinear motion in a given force field, Simple harmonic motion, damped and forced oscillations, Concept of resonance, motion of elastic strings, Rectilinear motion under uniform gravity, Rectilinear motion in a resisting medium where resistance is proportional to velocity.	Particle Dynamics	S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Cambridge University Press, 1913 A. S. Ramsey, Dynamics (Part I& Part II), CBS Publishers, 2002 (2nd edition).	16	Chalk and Talk , Google Classroom, Hand Notes	MH
Work, power, energy, Conservative forces, Potential energy, Existence of potential energy function, Conservative field and Principle of conservation of energy.	Particle Dynamics	Same as above	06	Chalk and Talk, Google Classroom, Hand Notes	MH

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Impulse of a force, Impulsive force, Principle of conservation of linear momentum, Collision of elastic bodies: Coefficient of restitution, Newton's law of collision, Direct and oblique impact of a smooth sphere with a fixed plane, Direct and oblique impact of two smooth spheres.	Particle Dynamics	Same as above	06	Chalk and Talk, Google Classroom, Hand Notes	MH
Motion of a particle in a plane (2D Cartesian): Angular velocity and angular acceleration, expressions for components of velocity and acceleration, Tangential and normal components of velocity and acceleration, Motion of a projectile in a resisting medium under gravity. Motion of a particle in a plane (2D Polar): Expressions for components of velocity and acceleration.	Particle Dynamics	Same as above	08	Chalk and Talk, Google Classroom, Hand Notes	MH
Central forces and central orbits, Motion under inverse square law, Times of describing the arcs of central orbits for a particle moving under inverse square law, Kepler's laws on planetary motion, Motion of artificial satellites, Tangential and normal components of velocity and acceleration, Constrained motion of a particle on smooth curve.	Particle Dynamics	Same as above	08	Chalk and Talk, Google Classroom, Hand Notes	MH
Review of Particle Dynamics-I	Particle Dynamics	Same as above	6	Chalk and Talk, Google Classroom, Hand Notes	MH

IDC Courses (Sem-I and Sem-III)

Department of Mathematics

Planned				After Implementation	
Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
SEM I / II / III (IDC) – MATH-H-IDC-1/2/3-TH – Mathematics in Daily Life					
Group A: Concept and definition of sets, sub-sets, set operations (union, intersection, complementation, subtraction), basic laws of set algebra. Venn diagrams, formula $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ and its daily life applications.	Set Theory	Courant & Robbins (1995)	4	Chalk & Blackboard	AB
Group B: First Principle of Mathematical Induction: Statement and simple problems. Division Algorithm: G.C.D. of two positive integers, expression of G.C.D. as $px + qy$ (Euclidean Algorithm without proof). Representation of positive integers in binary and decimal modes. Linear Diophantine Equation in Two Variables: Existence of integral solutions, general/particular solutions, real-life applications. Prime Integers: Elementary properties, Fundamental Theorem of Arithmetic (statement only), primality test algorithm. Congruence of Integers: Meaning of $a \equiv b \pmod{m}$, elementary properties, divisibility tests (2, 3, 4, 5, 7, 9, 11, 13), check digits (ISBN, UPC, VISA, MasterCard), round-robin tournament table using congruence.	Number Theory	Burton (1989), Rosen (1984)	18	Blackboard, Examples	AB

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Unit / Group / Module / Article	Topics	Reference Books	No. of Lectures	Delivery Technique	Remarks
Group C: Proposition, propositional variables, logical connectives (NOT, OR, AND, XOR, IMPLICATION, BI-IMPLICATION), truth tables, truth value, tautology, logical consequence, logical equivalence, contradiction.	Logic	Mendelson (1997), Chakraborty (2016)	6	Blackboard, Truth Table Charts	AB
Group D: Linear Programming Problems: Objective function, decision variables, constraints, formulation (e.g., carpenter problem, chemical mixtures, diet problems), graphical solution (bounded region). Game Theory: Two-person zero-sum games, strategy, payoff, saddle point, elementary problems.	LPP	Thie & Keough (2008), Bronson & Naadimuthu (1997), Chakraborty & Ghosh (2009)	8	Diagrams, Graphs, Games	AB
Group E: Time Value of Money: Simple and compound interest (fundamental formulae), interest payable monthly, quarterly, annually. Ordinary Simple Annuities: Accumulated and discounted value, loan repayment, simple problems (no formula derivation). Dividend calculation, income tax calculation (old and new regimes).	Financial Math	Zima & Brown (1996), Chandra (2008)	9	Examples, Practice Sheets	MH