Planned				After Implementation	
Unit / Group / Module / Article	**Topics**	**Reference Books**	**No of Lecture Planned**	**Content Delivery Technique**	**Remarks Comments**
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 $eax+b$sin x, $eax+b$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, Volumes I and II,** **Wileyand Sons, 1969** **2) R.R. Goldberg, Methods of Real** **Analysis, Oxford & IBH** **Publishing, 2020**	**6**	**Google Classroom, Hand Notes**	**MH**

Group A **Reduction formulae, derivations and illustrations of reduction formulae of the type** $\int \sin^n x\,dx, \int \cos^n x\,dx, \int \tan^n x\,dx, \int \sec^n x\,dx, \int (\log x)^n dx,$ $\int \sin nx \sin mx\,dx, \int \sin nx \cos m x\,dx.$ **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**	**1) T. Apostol, Volumes I and II,** **Wileyand Sons, 1969** **2) R.R. Goldberg, Methods of Real** **Analysis, Oxford & IBH** **Publishing, 2020**	**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**	**Coordinate Geometry by S.L. Loney** **Advanced Analytical Geometry by Ghosh & Maity** **Analytical Geometry by R. M. Khan**	**12**	**Chalk Blackboard, Class-Notes & Hand-written theory notes with problems.**	**PL**
Group B **Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids,**	**Geometry**	**Coordinate Geometry by S.L. Loney**	**16**	**Chalk Blackboard, Class-Notes &**	**PL**

generating lines, identification of quadric surfaces like cone, cylinder, ellipsoid, hyperboloid, classification of quadrics.		**Advanced Analytical Geometry by Ghosh & Maity** Analytical Geometry by R. M. Khan		**Hand-written theory notes with problems.**	
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. Speigel, Schaum's outline of Vector Analysis Tata McGraw Hill Ed., 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**	**M.R. Speigel, Schaum's outline of Vector Analysis Tata McGraw Hill Ed., 2011.**	**10**	**Chalk Blackboard, Notes**	**BS**
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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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,**	**26**	**Practical : hands on experience**	**DP**

		Prentice Hall of India, 1980			

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, 3rd., 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 $\mathbb{R}$**	**Sets in $\mathbb{R}$**	**1) R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd., Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002** **2) T. Apostol, Mathematical**	**14**	**Chalk and Talk, Tutorial, Google Classroom, Hand Notes, Class tests**	**AB**

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 $\mathbb{R}\backslash\mathbb{Q}$ are dense in $\mathbb{R}$.		**Analysis, Narosa Publishing House**			

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. 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**	**6**	**Chalk and Talk, Notes**	**PL**

Group B **Subsequence. Subsequential limits, lim sup as the L.U.B. and lim inf as the** **G.L.B of a set containing all the subsequential limits. Alternative definition of lim sup and lim inf of a sequence using inequality or as lim sup x_n = subsequence. A bounded sequence {□_n} is convergent if and only if lim □up □_□ = inf sup{□_□, □_{□+1}, . . . , } and lim inf □_□ = sup inf{□_□, □_{□+1}, . . . , } [Equivalence between these definitions is assumed]. 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**	**6**	**Chalk and Talk, Notes**	**PL**
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 *nnnnh* 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, 3rd., 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**
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 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 d^ny/dx^n= f(y) (□ ≥ 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**

SEM III (Major) MATH-H-SEC 3-3-Th Linear Programming & Rectangular Games					
UNIT I **Definition of Linear Programming Problem (L.P.P.). Formation of L.P.P. from daily life involving inequa- tions. Graphical solution of L.P.P. Basic solutions and Basic Feasible Solution (B.F.S) with reference to** **L.P.P. Matrix formulation of L.P.P. 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, 8th Ed., Prentice-Hall India, 2006**	**12**	**Google Classroom, Hand Notes**	**AB**
UNIT I **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, 8th Ed., Prentice-Hall India, 2006**	**15**	**Google Classroom, Hand Notes**	**AB**

UNIT II **Slack and surplus variables. Standard form of L.P.P. theory of simplex method. Feasibility and optimality conditions.**	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**5**	**Google Classroom, Hand Notes**	**AB**
UNIT II **The 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, 8th Ed., Prentice-Hall India, 2006**	**8**	**Google Classroom, Hand Notes**	**AB**
UNIT III **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. Complementary slackness, Duality and simplex method and their applications.**	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**5**	**Google Classroom, Hand Notes**	**AB**

UNIT IV **Transportation and Assignment problems. Mathematical justification for optimality criterion. Hungarian method. Traveling Salesman problem.**	**Linear Programming & Game Theory**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**7**	**Google Classroom, Hand Notes**	**AB**
UNIT IV **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 of solving 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, 8th Ed., Prentice-Hall India, 2006**	**8**	**Google Classroom, Hand Notes**	**AB**
SEM V (H) CBCS CC 11 Probability & Statistics					
UNIT I **Random experiment, σ-field, Sample space, probability as a set function, probability axioms, probabil- ity space. Finite sample spaces. Conditional probability, Bayes theorem, independence. Real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical**	**Probability**	**1. GROUNDWORK OF MATHEMATICAL PROBABILITY AND STATISTICS by Amritava Gupta**	**20**	**Chalk Blackboard Notes**	**BS**

expectation, moments, moment generating function, characteristic function. Discrete distri- butions : uniform, binomial, Poisson, geometric, negative binomial, Continuous distributions : uniform, normal, exponential.		**2. Theory And Problems Of Probability And Statistics (Schaum S Outline Series) by Spiegel**			
UNIT II **Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, moments, covariance, correlation coefficient, independent random variables, joint moment generating function (jmgf) and calculation of covariance from jmgf, characteristic function. Conditional expectations, linear regression for two variables, regression curves. Bivariate normal distribution.**	**Probability**	**1. GROUNDWORK OF MATHEMATICAL PROBABILITY AND STATISTICS by Amritava Gupta** **2. Theory And Problems Of Probability And Statistics (Schaum S Outline Series) by Spiegel**	**15**	**Chalk Blackboard Notes**	**BS**
UNIT III **Markov and Chebyshev's inequality, Convergence in Probability, statement and interpretation of weak law of large numbers and strong law of large numbers. Central limit theorem for independent and identically distributed random variables with finite variance.**	**Probability**	**1. GROUNDWORK OF MATHEMATICAL PROBABILITY AND STATISTICS by Amritava Gupta**	**5**	**Chalk Blackboard Notes**	**BS**

		2. Theory And Problems Of Probability And Statistics (Schaum S Outline Series) by Spiegel			
UNIT IV **Sampling and Sampling Distributions : Populations and Samples, Random Sample, distribution of the sample, Simple random sampling with and without replacement. Sample characteristics.** **Sampling Distributions : Statictic, Sample moments. Sample variance, Sampling from the normal distributions, Chi-square, t and F -distributions, sampling distribution of $\bar{X}$, s^2, $\frac{\bar{X}-\mu}{s/\sqrt{n}}$ $(\bar{X}-\mu)$** **Estimation of parameters : Point estimation. Interval Estimation- Confidence Intervals for mean and variance of Normal Population. Mean-squared error. Properties of good estimators - unbiasedness, consistency, sufficiency, Minimum-Variance Unbiased Estimator (MVUE).** **Method of Maximum likelihood : likelihood function, ML estimators for discrete and continuous models.**	**Statistics**		**15**		**MH**
UNIT V **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. The *p*-value (observed level of significance), Calculating *p*-values.**	**Statistics**		**15**		**MH**

Simple hypothesis versus simple alternative : Neyman-Pearson lemma (Statement only). **Bivariate frequency Distribution : Bivariate data, Scatter diagram, Correlation, Linear Regression, principle of least squares and fitting of polynomials and exponential curves.**					
Graphical Demonstration **Graphical representation of data - how to load data, plot a graph viz. histograms (equal class intervals and unequal class intervals), frequency polygon, pie chart, ogives with graphical summaries of data.** **Measures of central tendency and measures of dispersion ,moments, skewness and kurtosis.** **Karl Pearson correlation coefficient.** **Correlation coefficient for a bivariate frequency distribution.** **Lines of regression, angle between lines and estimated values of variables.** **Fitting of polynomials, exponential curves by method of least squares.** **Confidence interval for the parameters of a normal distribution (one sample and two sample problems).**	**Teaching Aid**	**Online**	**5**	**R Software, Chalk Board**	**BS**

SEM V (H) CBCS CC 12
Group theory-II & Linear algebra-II

UNIT I **Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups.**	**Group theory**		**12**		**PL**
UNIT I **External direct product and its properties, the group of units modulo *n* as an external direct product, internal direct product, converse of Lagrange's theorem for finite abelian group, Cauchy's theorem for finite abelian group, Fundamental theorem of finite abelian groups.**	**Group theory**		**23**		**PL**
UNIT II **Inner product spaces and norms, Gram-Schmidt orthonormalization process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator and its basic properties.**	**Linear algebra**	**1) John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002** **2) M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011**	**12**	**Chalk and Talk, Tutorial, Google Classroom, Hand Notes, Class tests**	**AB**
UNIT II **Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators. Eigenspaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms (Jordan & rational).**	**Linear algebra**	**1) John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002** **2) M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011**	**15**	**Chalk and Talk, Tutorial, Google Classroom, Hand Notes, Class tests**	**AB**

SEM V (H) CBCS DSE A 1.1

Advanced Algebra

UNIT I **Group actions, stabilizers, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.**	**Group Theory**		**11**		**PL**
UNIT I **Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n, p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.**	**Group Theory**		**14**		**PL**
UNIT 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.**	**Ring Theory**	**Abstract Algebra by Sen, Ghosh , Mukhopadhyay & Maity** **Contemporary Abstract Algebra by Joseph. A. Gallian** **Advanced Abstract Algebra by Ismail Hoque**	**15**	**Chalk Blackboard, Class-Notes & Hand-written theory notes with problems.**	**PL**
UNIT II **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, Eisenstein criterion and unique factorization in Z[x].**	**Ring Theory**	**Abstract Algebra by Sen, Ghosh , Mukhopadhyay & Maity**	**25**	**Chalk Blackboard, Class-Notes & Hand-written theory notes**	**PL**

		Contemporary Abstract Algebra by Joseph. A. Gallian **Advanced Abstract Algebra by Ismail Hoque**		**with problems.**	
UNIT II **Ring embedding and quotient field, regular rings and their examples, properties of regular ring, ideals in regular rings.**	**Ring Theory**	**Abstract Algebra by Sen, Ghosh , Mukhopadhyay & Maity** **Contemporary Abstract Algebra by Joseph. A. Gallian** **Advanced Abstract Algebra by Ismail Hoque**	**10**	**Chalk Blackboard, Class-Notes & Hand-written theory notes with problems.**	**PL**
SEM V (H) CBCS DSE A 1.2 **Bio Mathematics**					
UNIT I **Mathematical biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, bacterial growth in a chemostat, harvesting a single natural population, Prey predator systems and Lotka-Volterra equations, populations in competitions, epidemic models (SI, SIR, SIRS, SIC)**	**Bio Mathematics**	**1. Introductory Mathematical Biology- Nandadulal Bairagi** **2. Elements of Mathematical Ecology - Mark Kot**	**25**	**Chalk and Talk, Notes, Computer Simulations**	**MH**

UNIT II **Activator-inhibitor system, insect outbreak model: Spruce Budworm. Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria. Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario. Spatial models: One species model with diffusion. Two species model with diffusion, conditions for diffusive instability, spreading colonies of microorganisms, Blood flow in circulatory system, travelling wave solutions, spread of genes in a population.**	**Bio Mathematics**	**1. Introductory Mathematical Biology- Nandadulal Bairagi** **2. Elements of Mathematical Ecology - Mark Kot**	**30**	**Chalk and Talk, Notes, Computer Simulations**	**MH**
UNIT III **Discrete models : Overview of difference equations, steady state solution and linear stability analysis. Introduction to discrete models, linear models, growth models, decay models, drug delivery problem, dis- crete prey-predator models, density dependent growth models with harvesting, host-parasitoid systems (Nicholson- Bailey model), numerical solution of the models and its graphical representation. case studies. Optimal exploitation models, models in genetics, stage structure models, age structure models.**	**Bio Mathematics**	**1. Introductory Mathematical Biology- Nandadulal Bairagi** **2. Elements of Mathematical Ecology - Mark Kot**	**15**	**Chalk and Talk, Notes, Computer Simulations**	**MH**

Graphical Demonstration **Growth model (exponential case only).** **Decay model (exponential case only).** **Lake pollution model (with constant/seasonal flow and pollution concentration).** **Case of single cold pill and a course of cold pills.** **Limited growth of population (with and without harvesting).** **Predatory-prey model (basic Volterra model, with density dependence, effect of DDT, two prey one predator).** **Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).** **Battle model (basic battle model, jungle warfare, long range weapons).**	**Teaching Aid (using any software)**	**1. Introductory Mathematical Biology- Nandadulal Bairagi** **2. Elements of Mathematical Ecology - Mark Kot**	**5**	**Computer Simulations, Google Colab**	**MH**
SEM V(H) CBCS DSE – B 1.2 **Linear Programming & Game Theory**					
UNIT I **Definition of Linear Programming Problem (L.P.P.). Formation of L.P.P. from daily life involving inequations. Graphical solution of L.P.P. Basic solutions and Basic Feasible Solution (B.F.S) with reference to L.P.P. Matrix formulation of L.P.P. 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, 8th Ed., Prentice-Hall India, 2006**	**12**	**Google Classroom, Hand Notes**	**AB**

UNIT I **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, 8th Ed., Prentice-Hall India, 2006**	**15**	**Google Classroom, Hand Notes**	**AB**
UNIT II **Slack and surplus variables. Standard form of L.P.P. theory of simplex method. Feasibility and optimality conditions.**	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**5**	**Google Classroom, Hand Notes**	**AB**
UNIT II **The 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, 8th Ed., Prentice-Hall India, 2006**	**8**	**Google Classroom, Hand Notes**	**AB**

UNIT III **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. Complementary slackness, Duality and simplex method and their applications.**	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**8**	**Google Classroom, Hand Notes**	**AB**
UNIT IV **Transportation and Assignment problems. Mathematical justification for optimality criterion. Hungarian method. Traveling Salesman problem.**	**Linear Programming & Game Theory**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**10**	**Google Classroom, Hand Notes**	**AB**
UNIT IV **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 of solving 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, 8th Ed., Prentice-Hall India, 2006**	**17**	**Google Classroom, Hand Notes**	**AB**

Minor/MDC/General

Unit / Group / Module / Article	Topics	Reference Books	No of Lecture Planned	Content Delivery Technique	Remarks Comments
SEM I (Minor + MDC) 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, Volumes I and II,Wileyand Sons, 1969** **2) R.R. Goldberg, Methods of RealAnalysis, Oxford & IBH Publishing, 2020**	**6**	**Google Classroom, Hand Notes**	**MH**
Group A **Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sec^n x\,dx$, $\int (\log x)^n dx$,** **$\int \sin nx \sin mx\,dx$, $\int \sin nx \cos m x\,dx$. 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**	**1) T. Apostol, Volumes I and II,** **Wileyand Sons, 1969** **2) R.R. Goldberg, Methods of Real** **Analysis, Oxford & IBH Publishing, 2020**	**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**	**Coordinate Geometry by S.L. Loney** **Advanced Analytical Geometry by Ghosh & Maity** **Analytical Geometry by R. M. Khan**	**12**	**Chalk Blackboard, Class-Notes & Hand-written theory notes with problems.**	**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**	**Coordinate Geometry by S.L. Loney** **Advanced Analytical Geometry by Ghosh & Maity** **Analytical Geometry by R. M. Khan**	**16**	**Chalk Blackboard, Class-Notes & Hand-written theory notes with problems.**	**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. Speigel, Schaum's outline of Vector AnalysisTata McGraw Hill Ed., 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**	**M.R. Speigel, Schaum's outline of Vector AnalysisTata McGraw Hill Ed., 2011.**	**10**	**Chalk Blackboard, Notes**	**BS**

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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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. Balagurnsamy : 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 (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, Volumes I and II,** **Wileyand Sons, 1969** **2) R.R. Goldberg, Methods of Real** **Analysis, Oxford & IBH** **Publishing, 2020**	**6**	**Google Classroom, Hand Notes**	**MH**
Group A **Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sec^n x\,dx$, $\int (\log x)^n dx$,** **$\int \sin nx \sin mx\,dx$, $\int \sin nx \cos mx\,dx$. 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**	**1) T. Apostol, Volumes I and II,** **Wileyand Sons, 1969** **2) R.R. Goldberg, Methods of Real** **Analysis, Oxford & IBH** **Publishing, 2020**	**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**	**Coordinate Geometry by S.L. Loney** **Advanced Analytical Geometry by Ghosh & Maity** **Analytical Geometry by R. M. Khan**	**12**	**Chalk Blackboard, Class-Notes & Hand-written theory notes with problems.**	**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**	**Coordinate Geometry by S.L. Loney** **Advanced Analytical Geometry by Ghosh & Maity** Analytical Geometry by R. M. Khan	**16**	**Chalk Blackboard, Class-Notes & Hand-written theory notes with problems.**	**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. Speigel, Schaum's outline of Vector Analysis Tata McGraw Hill Ed., 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**	**M.R. Speigel, Schaum's outline of Vector Analysis Tata McGraw Hill Ed., 2011.**	**10**	**Chalk Blackboard, Notes**	**BS**
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 d^ny/dx^n= f(y) (□ ≥ 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**
SEM III (MDC) MATH-MD-SEC 3-3-Th **Linear Programming & Rectangular Games**					

UNIT I **Definition of Linear Programming Problem (L.P.P.). Formation of L.P.P. from daily life involving inequa- tions. Graphical solution of L.P.P. Basic solutions and Basic Feasible Solution (B.F.S) with reference to L.P.P. Matrix formulation of L.P.P. 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, 8th Ed., Prentice-Hall India, 2006**	**12**	**Chalk and Talk, Hand Notes**	**AB**
UNIT I **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, 8th Ed., Prentice-Hall India, 2006**	**15**	**Chalk and Talk,, Hand Notes**	**AB**
UNIT II **Slack and surplus variables. Standard form of L.P.P. theory of simplex method. Feasibility and optimality conditions.**	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**5**	**Chalk and Talk,, Hand Notes**	**AB**

UNIT II **The 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, 8th Ed., Prentice-Hall India, 2006**	**8**	**Chalk and Talk,, Hand Notes**	**AB**
UNIT III **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. Complementary slackness, Duality and simplex method and their applications.**	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**5**	**Chalk and Talk,, Hand Notes**	**AB**
UNIT IV **Transportation and Assignment problems. Mathematical justification for optimality criterion. Hungarian method. Traveling Salesman problem.**	**Linear Programming & Game Theory**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**7**	**Chalk and Talk,, Hand Notes**	**AB**

UNIT IV **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 of solving 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, 8th Ed., Prentice-Hall India, 2006**	**8**	**Chalk and Talk,, Hand Notes**	**AB**
SEM V(G) CBCS MTM-G-SEC-A-TH **Object Oriented Programming in C++**					
Unit-1 **Programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++ program, differences between C and C++, basic C++ operators, Comments, working with variables, enumeration, arrays and pointer.**	**C++**	**1. Object Oriented Programming with C++, E.Balagurusamy** **2. Let us C, Yashavant P Kanetkar.**	**10**	**Chalk, Hand Notes, Computer**	**DP**
Unit-2 **Objects, classes, constructor and destructors, friend function, inline function, encapsulation, data abstraction, inheritance, polymorphism, dynamic binding, operator overloading, method overloading, overloading arithmetic operator and comparison operators.**	**C++**	**1. Object Oriented Programming with C++, E.Balagurusamy** **2. Let us C, Yashavant P Kanetkar.**	**10**	**Chalk, Hand Notes, Computer**	**DP**

Unit-3 **Template class in C++, copy constructor, subscript and function call operator, concept of namespace and** **exception handling**	**C++**	**1. Object Oriented Programming with C++, E.Balagurusamy** **2. Let us C, Yashavant P Kanetkar.**	**10**	**Chalk, Hand Notes, Computer**	**DP**
SEM V(G) CBCS MTM-G-DSE-A-TH **Particle Dynamics**					
Velocity and Acceleration of a particle. Expressions for velocity and acceleration in rectangular Cartesian and polar co-ordinates for a particle moving in a plane. Tangential and normal components of velocity and acceleration of a particle moving along a plane curve.	**Particle Dynamics**	**Advanced Analytical Dynamics by Utpal Chatterjee**	**10**	**Chalk Blackboard Notes**	**BS**
Concept of Force : Statement and explanation of Newton's laws of motion. Work, power and energy. Principles of conservation of energy and momentum. Motion under impulsive forces. Equations of motion of a particle (i) moving in a straight line, (ii) moving in a plane.	**Particle Dynamics**	**Advanced Analytical Dynamics by Utpal Chatterjee**	**10**	**Chalk Blackboard Notes**	**BS**
Study of motion of a particle in a straight line under (i) constant forces, (ii) variable forces (S.H.M., Inverse square law, Damped oscillation, Forced	**Particle Dynamics**	**Advanced Analytical Dynamics by Utpal Chatterjee**	**15**	**Chalk Blackboard Notes**	**BS**

and Damped oscillation, Motion in an elastic string). Equation of Energy. Conservative forces.					
Motion in two dimensions : Projectiles in vacuum and in a medium with resistance varying linearly as velocity. Motion under forces varying as distance from a fixed point.	**Particle Dynamics**	**Advanced Analytical Dynamics by Utpal Chatterjee**	**15**	**Chalk Blackboard Notes**	**BS**
Central orbit. Kepler's laws of motion. Motion under inverse square law.	**Particle Dynamics**	**Advanced Analytical Dynamics by Utpal Chatterjee**	**10**	**Chalk Blackboard Notes**	**BS**
SEM 1, SEM 3 IDC MATH-H-IDC-1-Th, MATH-H-IDC-3-Th Mathematics in Everyday life					
Group A **Concept and definition of sets, subsets and set operations Union, Intersection, Complementation, Subtraction; Statements of basic laws of set algebra.** **Venn diagrams. Statement of the formula** $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ **and its application in daily life.**	**Basics of Set Theory**	**Elementary Number Theory with Applications Second Edition, Thomas Koshy, Academic Press, 2007**	**4**	**Chalk and Talk, Tutorial, Google Classroom, Hand Notes**	**AB**
Group B **Statement and simple problems on First Principal of Mathematical Induction.** **Statement of Division Algorithm; G.C.D. of two positive integers, Expression of G.C.D. of two**	**Understanding Integers**	**M.K. Sen and B.C. Chakraborty; Introduction to Discrete Mathematics, Books and Allied (P) Ltd, 2019**	**18**	**Chalk and Talk, Tutorial, Google Classroom, Hand Notes**	**AB**

integers x, y in the form px+qy (p, q are integers) (Euclidean Algorithm without proof). **Representation of a positive integer in Binary and Decimal mode.** **Linear Diophantine equation in two variables: Statement of condition on the existence of integral solution, General / particular solution, Simple real life applications.** **Prime integers. Some elementary properties of prime integers (only statement), Fundamental theorem of Arithmetic (only statement), Algorithm for Primality test.** **Congruence of Integers: Meaning of $a \equiv b$ (mod m). Statements of elementary properties of congruence; If of $a \equiv b$ (mod m), then for any integer c, of $(a + c) \equiv (b + c)$ (mod m) , of $(a - c) \equiv (b - c)$ (mod m) and of $a \equiv b$ (mod m), $a^n \equiv b^n \ (mod\ m)$ for natural numbers n.** **Applications of congruence of integers: Divisibility tests by 2, 3, 4, …, 7, 9, 11, 13 (Statements of relevant results and problems only). Check Digits in International Standard Book Number (ISBN), Universal Product Code (UPC), VISA and MASTER card (Statements of relevant results and Problems only).Formation of Round Robin Tournament Table using congruence of integers (Technique and Problems only).**					
Group C **Proposition, propositional variables and propositional Logic.** **Logic Connectives: NOT (Negation), OR(Disjunction), AND (Conjunction), Exclusive**	**Mathematical Logic**	**Elliott Mendelson; Introduction to Mathematical Logic, Chapman and Hall, London, 1997**	**6**	**Chalk and Talk, Tutorial, Google Classroom, Hand Notes**	**AB**

OR (XOR), IMPLICATION (If p then q) and BI-IMPLICATION (If and only if) and their Truth Tables; Truth value of a proposition, Truth tables of expressions involving more than one logical connective. **Tautology, logical consequence, logical equivalence, contradiction.**					
Group D **Idea of Linear Programming Problems: Objective function, decision variables, constraints.** **Formulation of daily life problems as an LPP (e.g. Carpenter problem, preparation of mixtures of chemicals, diet problems etc.)** **Solution of an LPP by graphical method (only bounded region).** **Definition of Game. Examples of daily life Two person zero sum game, Strategy, Payoff, Saddle point, Solution of a game problem without saddle point (only elementary problems).**	**Basics of Operation Research**	**J.G. Chakraborty and P.R, Ghosh; Linear Programming and Game Theory, Moulik Library, 2009**	**8**	**Chalk and Talk, Tutorial, Google Classroom, Hand Notes**	**AB**
Motivation of Linear Programming problem. Statement of L.P.P. Formulation of L.P.P. Slack and Surplus variables. L.P.P. is matrix form. Convex set, Hyperplane, Extreme points, convex Polyhedron, Basic solutions and Basic Feasible Solutions (B.F.S.). 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, 8th Ed., Prentice-Hall India, 2006**	**7**	**Google Classroom, Hand Notes**	**MH**
The set of all feasible solutions of an L.P.P. is a convex set. The objective function of an L.P.P. assumes its optimal value at an extreme print of the	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa**	**8**	**Google Classroom, Hand Notes**	**MH**

convex set of feasible solutions, A.B.F.S. to an L.P.P. corresponds to an extreme point of the convex set of feasible solutions.		**Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**			
Fundamental Theorem of L.P.P. (Statement only) Reduction of a feasible solution to a B.F.S. Standard form of an L.P.P. Solution by graphical method (for two variables), by simplex method and method of penalty. Concept of Duality. Duality Theory. The dual of the dual is the primal. Relation between the objective values of dual and the primal problems. Dual problems with at most one unrestricted variable, one constraint of equality. Transportation and Assignment problem and their optimal solutions.	**Linear Programming**	**1) G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002** **2) Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006**	**10**	**Google Classroom, Hand Notes**	**MH**