# SEMESTER SYLLABUS

## M.Sc. MATHEMATICS

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## SCHEME OF EXAMINATION & DISTRIBUTION OF MARKS

### SEMESTER - I

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title of the Paper (s)</th>
<th>Internal Assessment</th>
<th>Term End Exam</th>
<th>Practical</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Advanced Abstract Algebra (I)</td>
<td>20</td>
<td>80</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>2.</td>
<td>Real Analysis (I)</td>
<td>20</td>
<td>80</td>
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</tr>
<tr>
<td>3.</td>
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</tr>
<tr>
<td>4.</td>
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<td>80</td>
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<tr>
<td>5.</td>
<td>Advanced Discrete Mathematics (I)</td>
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<td>80</td>
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<tbody>
<tr>
<td>1.</td>
<td>Advanced Abstract Algebra (II)</td>
<td>20</td>
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<td>2.</td>
<td>Real Analysis (II)</td>
<td>20</td>
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<tr>
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<td>Topology (II)</td>
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<tbody>
<tr>
<td>1.</td>
<td>Integration Theory and Functional Analysis -I</td>
<td>20</td>
<td>80</td>
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<td>100</td>
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<tr>
<td>2.</td>
<td>Partial Differential Equations, Mechanics and Gravitation - I</td>
<td>20</td>
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### OPTIONAL PAPER (ANY THREE)

<table>
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<tr>
<th></th>
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<tbody>
<tr>
<td>3.</td>
<td>Program. in C with ANSI Features I</td>
<td>20</td>
<td>50</td>
<td>30</td>
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<td>4.</td>
<td>Fuzzy Sets and their Applications-I</td>
<td>20</td>
<td>80</td>
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<td>5.</td>
<td>Operations Research-I</td>
<td>20</td>
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<td>6.</td>
<td>Fluid Mechanics-I</td>
<td>20</td>
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<td>7.</td>
<td>Information Theory-I</td>
<td>20</td>
<td>80</td>
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<tr>
<td>8.</td>
<td>Fundamentals of Computer Science –I</td>
<td>20</td>
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</table>
**SEMESTER-I**

**PAPER-I**

**ADVANCED ABSTRACT ALGEBRA**

**Group**- Permutation group, Normal subgroup, Three Isomorphism Theorems, Correspondence Theorem, Maximum Normal subgroup, Automorphism and Inner Automorphism, Centre of groups.

**Normal Series**- Normal and Subnormal series, Composition Series, Jordan-Holder theorem, Solvable groups, Nilpotent groups.

**Rings & Modules**- Definitions, Maximal and prime ideals, Nilpotent and Nill Ideals, Zorn’s Lemma (statements only), its application to obtain maximal ideals.

**REFERENCES:**
SEMESTER- I  
PAPER-II  
REAL ANALYSIS-I

The Riemann–Stieltjes Integral- Definition and existence of Riemann–Stieltjes integral, Properties of the Integral, Integration and differentiation, the Fundamental Theorem or Calculus, integration of vector-valued function Rectifiable curves.

Functions of Several Variables- Linear transformation, derivatives in an open subset of $\mathbb{R}^n$, Contraction principle, Inverse function theorem, Implicit function theorem, Derivatives of higher orders, Differentiation of integrals.

Sequences and series of Functions- Point wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, Uniform convergence and continuity uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation theorem.

Power Series- Uniqueness theorem for power series, Abel’s and Tauber's theorem.

REFERENCES:

Definition and examples of topological spaces, closed sets, Closure, Dense subsets, Neighborhoods, Interiors, exteriors and boundary points.
Accumulation point and derived set, Bases and sub-base, subspaces and relative topology, Alternate methods of defining a topology in terms of Kuratowski Closure Operator and Neighborhoods systems.
Continuous functions and Homeomorphism.
Separation axioms, $T_0$, $T_1$, $T_2$, $T_3$, $T_{31/2}$, $T_4$ spaces, their characterization and basic properties.
First and second countable countable spaces, Lindelof’s theorems, Separable Spaces, Second Countability and Separability, Uryshohn’s lemma and Tietz Extension Theorem.

REFERENCES:
1. G.F. Simmons: Introduction to Topology and Modern Analysis, Mcgraw-Hill
2. J.N. Sharma: Topology, Krishna Prakashan Mandir, Meerut
SEMESTER-I
PAPER- IV
COMPLEX ANALYSIS – I

Complex Integration, Cauchy-Goursat Theorem, Cauchy’s integral Formula, Higher order derivatives.
Morera’s theorem, Cauchy inequality and Liouville theorem, the fundamental theorem of Algebra, Taylor’s theorem, Maximum modulus principle.
Laurent’s series isolated singularities.
Meromorphic functions, Schwartz lemma, the Argument principle, Rouche’s theorem.
Inverse function theorem.
Residues, Cauchy’s residue theorem, Evaluation of integrals, Branches of many values functions with special references to argz, logz, and z^8.

Bilinear transformations, their properties and classification, Definitions and examples of conformal mappings.

REFERENCES:
4. J.N. Sharma: Functions of a complex variable, Krishna Prakashan Mandir, Meerut
SEMESTER-I
PAPER-V
ADVANCED DISCRETE MATHEMATICS- I

Formal logic- Statement and Notation, Connectives—Negation, Conjunction, Disjunction, Truth Table, Conditional and Biconditional statement, well-formed formula, Tautology, Equivalent formula, Duality and functionally complete set of connectives, two state devices and statement logic, Normal form, Principle conjunctive and Principle Disjunctive Normal forms, The theory of interface for the statement calculus, Rules of Interface, Automatic Theorem proving, the predicate calculus, Quantifiers, Rules of Interface, Free and Bound variables, Interface theory of predicate calculus, valid formulas over finite universe, valid formulas involving quantifiers, formulas involving more than one quantifiers.

Algebraic Structure - Algebraic system, Semigroups and Monoids (including those pertaining to concatenation operation), Homomorphism of semigroup and SubMonoids. Direct products, Basic Homomorphism theorem.

Lattices - Lattices as partially ordered sets and their properties. Lattices as Algebraic systems, Sub lattices, direct products and homomorphism, Complete, Complemented and Distributive Lattice

Boolean Algebra- Boolean Algebras as lattices, Various Boolean Identities, The switching Algebra, example, Subalgebras, Direct products and Homomorphism, Join-irreducible elements, Atoms and min-terms, Boolean forms and their Equivalence, Minterm Boolean forms, Sum of products, canonical forms, Minimization of Boolean functions Application of Boolean Algebra to Switching theory (Using AND, OR, NOT gates) The Karnaugh Map Method.

REFERENCES:
3. N. Deo: Graph Theory with applications to Engineering and Computer Sciences. Prentice Hall of India.
SEMESTER-II
PAPER-I
ADVANCED ABSTRACT ALGEBRA-II

Modules and Vector Space - Definition and examples of sub-modules, Quotient modules, Direct sum, Modules generated by a set R, Homomorphism of modules, Isomorphism Theorem, exact sequence of modules, short exact sequence Cyclic Modules, Semi Simple Modules, Simple Modules, Schure's Lemma, Free Modules, Representation of Linear mapping, Rank of Linear mapping, Rank Nullity Theorem.

Field Theory - Extension field, Algebraic and transcendental extensions, Separable and inseparable extensions, Normal extension, Perfect fields, Finite fields, Primitive element, algebraically closed fields, Automorphisms of extensions, Galois extensions, fundamental theorem of Galois Theory.

Noetherian and Artinian modules and rings, Hilbert basis theorem, Wedderburn – Artin theorem.

REFERENCES:
Measurable sets-Lebesgue outer measure, Lebesgue measure, Properties of measurable sets, Borel sets and their measurability characterization of measurable sets, Non measurable set

Measurable functions- Definition and properties, Simple, Step and characteristics function, Continuous function, sets of measure Zero, Sequence of functions, Egoroff's Convergence in measure, Riesz theorem.


Lebesgue $L^p$ spaces- The classes $L^p$, Holder and Minkowski inequalities, $L^p$ Banach Spaces, Convergences in the mean.

REFERENCES:


Compactness - Basic properties of compactness.
Continuous functions and compact sets, compactness and Finite Intersection Property,
Sequentially and Countably compact sets, Local compactness in Metric space
Equivalence of compactness, countable compactness and sequential compactness in
metric space.
Connected spaces, connectedness on the real line, Components, Locally connected
spaces, totally disconnected spaces.
Nets – Topology and convergence of Nets, Hausdorffness and nets ,Filters and their
convergence, ultra filters.
Tychonoff product topology in terms of standard sub-base and its characterization,
Projection Maps.
Connectedness and product space, Compactness and product space (Tychonoff”s
theorem)

REFERENCES:
1. G.F. Simmons : Introduction to Topology and Modern Analysis, McGraw -Hill
   1963
   Delhi.
Entire Functions- Weierstress factorization theorem Gamma function and its properties, Riemann Zeta function, Riemann’s functional equation, Runge’s theorem, Mittag-Leffler’s theorem.

Analytic continuation, uniqueness of direct analytic continuation, Uniqueness of analytic continuation along curve, Power series method of analytic continuation, Schwartz’s Reflection Principle.

Monodromy theorem and it consequences.

Canonical product, Jensen’s formula, Poisson–Jenson Formula, Hadamard’s three circles theorem, Order of and entire function.

Exponent of convergence, Borel’s theorem, Hadamard’s factorization theorem.

The range of and analytic function, Bloch’s theorem, The little Picard theorem.

Schottky’s theorem, Montel Caratheodory and the Great Picard theorem.

Univarient functions, Bieberbach’s conjecture (statement only) and the “1/4 – theorem”.

REFERENCES:

4. J.N. Sharma. : Functions of a complex variable, Krishna PrakashanMandir, Meerut
Grammar and Language- Phase structure grammar, Rewriting Rules, Derivation, sentential forms, context-sensitive context, Free and Regular grammars and language, Notion of syntax, Analysis, Polish Notation, Conversion of Infix experience to Polish Notation, The Rename Polish Notation.

Introductory Computability Theory- Finite state Machines and their Transition, Table diagrams, Equivalence of Finite state Machines, reduced machines, Homomorphism Finite automata, and equivalence of its power to that of Deterministic finite automata, Moore and Mealy Machines, Turing machines and partial recursive functions.

Graph Theory- Definition of (undirected) graph, paths, Circuits Cycles & Sub graphs, Induced Sub graphs, Degree of a vertex, Connectivity, Planar Graphs and their properties, Trees, Euler’s Formula for connected planner Graphs. Complete and complete Bipartite graphs, Kuratowski’s Theorem(statement only), and it’s use, Spanning trees. Cut sets. Fundamental cut sets and cycles, Minimal spanning trees. Matrix representation of graphs, Euler’s theorem on the Existence of Eulerian Paths, and circuit, Directed Graphs, In degree and out degree of a vertex, Weighted undirected Graphs.

REFERENCES:
3. N. Deo: Graph Theory with applications to Engineering and Computer Sciences. Prentice Hall of India.
Signed measure, Hahn decomposition theorem, mutually singular measures, Radon-Nikodym theorem, Lebesgue decomposition, Riesz representation theorem, Extension theorem (Caratheodory)

Lebesgue-Stieltjes integral, product measures, Fubini’s theorem, Tunnelle’s theorem, Integral operator, Inner measure, Extension by set of measure zero, Caratheodory outer measure. Hausdorff measure, Differentiation and Integration, Decomposition into absolutely continuous and singular parts.

Baire sets, Baire measure, continuous functions with compact support, Regularity of measures on locally compact spaces.

REFERENCES:
Partial Differential Equations

Laplace's Equation – Fundamental solution, Mean value formulae, Properties of Harmonic function, Green function, Energy method.


Non-linear first order PDE, complete integrals, Envelopes characteristics, Hamilton Jacobi equations (calculus of variations, Hamilton’s ODE), Conservation Laws, Representation of solutions, Separation of variables.

Laplace and Fourier Transforms and their applications, Legendre Transform.

Attraction – Attraction of rod, disc, spherical shell and sphere, spherical shell of finite thickness.

Surface integral of normal attraction (Application & Guass’s theorem) Laplace and Poisson equations, work done by self-attracting system.

REFERENCES:
2. Gupta, Kumar & Sharma: Classical - Mechanics, Pragati Prakashan,
SEMESTER-III  
PAPER-III (OPTIONAL)  
PROGRAMMING IN C (WITH ANSI FEATURES)-I

An overview of programming, Programming language, Classification- C Essentials  
Program Development Functions, Anatomy of a C Function, Variables and Constants,  
Expressions, Assignment Statements, Formatting Source Files, Continuation Character,  
The Pre-processor.  
Scalar Data Types– Declaration, Different Types of Integers, Different kinds of Integer  
Constants, Floating- Point Types, Initialization, Mixing Types, Explicit Conversions-Casts,  
Enumeration Types, The Void Data Type, Typedefs, Finding the Address of an object Pointers.  
Control Flow– Conditional Branching, The Switch Statement, Looping, Nested Loops,  
The break and continue Statements, The go to statement. Infinite Loops.  
Operators and Expressions– Precedence and Associativity, Unary Plus and Minus  
operators, Binary arithmetic operators, Arithmetic assignment operators, Increment and  
Decrement Operators, Comma Operator, Relational Operators, Logical Operators, Bit-  
Manipulation Operators, Bitwise Assignment Operators, Cast Operator, Size of  
Operators, Conditional Operator, Memory Operators.  

REFERENCES:  
1. Peter A. Darnell and Philip E. Margolis, C: A Software Engineering Approach,  
2. Brian W. Kernighan & Dennis M. Ritohie: The C Programme Language, 2nd  

PRACTICAL  
The break-up of marks for third Semester’s Practical will be as under:  

<table>
<thead>
<tr>
<th>Sr. No.</th>
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FUZZY SETS AND THEIR APPLICATIONS-I

Fuzzy sets- Basic definitions α – cuts, Convex fuzzy sets, Basic operations on fuzzy sets, Types of fuzzy sets, properties of α – cuts, representation of fuzzy sets, First and Second decomposition theorem, Extension Principle for fuzzy sets, fuzzy complements, the two characterization theorems on fuzzy complements t-norms and t-conorms, Algebraic product and sum, bounded difference and sum, statements of characterization for t-norms and t-conorms, combination of operators.

Fuzzy Arithmetic- Fuzzy numbers, Arithmetic operations on fuzzy numbers, Lattices of fuzzy numbers, fuzzy equations.

Fuzzy Relations- Fuzzy relations on fuzzy sets, fuzzy binary relations and fuzzy equivalence relations, Fuzzy morphism, standard composition, sup i composition, inf-wi composition of fuzzy relations.

Fuzzy Relations Equations- Problem partitioning, solution methods, fuzzy relation equations based upon sup i composition and inf-wi composition, approximate solution.

REFERENCES:

Operations Research and its Scope, Necessity of Operations Research in Industry,
Linear Programming—graphical method of solutions, Simplex Method, Theory of the
Simplex Method, Two phase method, Big M method of solution to LPP, Duality in linear
programming, Duality theorems, Dual Simplex method, Other Algorithms for Linear
Programming—Dual Simplex Method.
Parametric Linear Programming, Upper Bound Technique, Interior Point Algorithm,
Linear Goal Programming, Assignment Problems, Its mathematical formulation, Solution
of assignment problems, Optimality test. Transportation Problems, Formulation of
transportation problems, Solutions of Transportation problems, North-West corner
method, least cost method, Vogel’s approximation method, Test for optimality U-V
method.
Network Analysis—shortest Path Problem, Minimum Spanning Tree Problem, Maximum
Flow I Problem, Minimum Cost Flow Problem, Network simplex Method. Project
Planning and Control I with PERT CPM.

REFERENCES:
1. F.S. Hillier and G.J. Ueberman: Introduction to Operations ResBareft (Sixth
4. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali: Linear Programming
and Network flows, John Wiley 
New York.
Sons, N.Delhi.
New Delhi.
New Delhi.
9. N.S. Kambo, Mathematical Programming Techniques, Affiliated East-West
Press Pvt. Ltd., New Delhi, Madras.
10. S.D.Sharma: Operations Research, KedarNath Ram Nath Publication,
Meerut.
Kinematics- Lagrangian and Eulerian Methods, Equation of continuity, Stream lines, path lines, streak lines, velocity potential, Irrotational and rotational motions, Boundary surfaces, Vortex lines.


Motion of Cylinders- Motion of a general, circular and coaxial cylinders, Circulation about a moving cylinder, Streaming and circulation about a fixed circular cylinder.

REFERENCES:

Measure of Information – Axioms for a measure of uncertainty, The Shannon entropy and its properties, Joint and conditional entropies, Transformation and its properties, Some Intuitive properties of a measure of entropy–Symmetry, normalization, expansibility, boundedness, recursivity, maximality, stability, additivity, subadditivity, nonnegativity, continuity, branching etc and interconnection among them, Axiomatic characterization of the Shannon entropy due to Tverberg and Leo. Information functions, the fundamental equation of Information, information function continuous at the origin, nonnegative bounded information functions, measurable information functions and entropy, The fundamental theorem of Information Theory and its strong and weak converses.

REFERENCES:
Object Oriented Programming – Classes and Scope, Nested Classes, Pointer, Class Members, Class Initialization, Assignment and Destruction, Overload functions and Operators, Templates including class templates, Class inheritance and sub-typing, multiple and virtual Inheritance.

Data Structures - Analysis of Algorithms, q, W,o,w notations; Lists, Stacks, and Queus. Sequential and linked representations, Trees: Binary tree – Search Tree Implementation, B-tree (concept only) Hasing–open and closed; Sorting Insertion sort, shell sort, quick sort, beap sort and their analysis.

REFERENCE:
3. C.J. Date: Introduction to Database System, Addition Wesley.
Normed linear spaces, Banach space and examples, Quotient space of normed linear spaces and its completeness, equivalent norms, Riesz Lemma, basic properties of finite dimensional normed linear spaces and compactness, Weak convergence and bounded linear transformations, normed linear spaces of bounded transformations, dual spaces with examples.


REFERENCES:
PARTIAL DIFFERENTIAL EQUATIONS, MECHANICS & GRAVITATION-II

Generalised co-ordinates, Holonomic and non-holonomic systems, Scleronomic and Rheonomics system, Generalised Potentials.

Lagrange’s equations of first kind, Lagrange’s equations of second kind, Uniqueness of solution, Energy equation for conservation fields.

Hamilton’s variable, Hamilton canonical equations, cyclic coordinates, Routh’s equations.

Poisson’s Bracket, Poisson’s Identity, Jacobi-Poisson Theorem, Lagrange’s Bracket, Motivating problems of calculus of variations, Shortest distance, Minimum surface of revolution, Brachistochrone problem, Isoperimetric problem, Geodesic, Fundamental lemma of calculus of variations, Euler’s equation for one dependent function and its generalization to (i) independent functions, (ii) higher order derivatives, Conditional extremum under geometric constraints and under integral constraints.

Potential of rod, disc, spherical shell and sphere, spherical shell of finite thickness, Distributions for a given potential, Equipotential surfaces, Surface and solid harmonics.

Surface density in terms of surface harmonics.

REFERENCES:
2. Gupta, Kumar & Sharma: Classical - Mechanics, Pragati Prakashan,
5. H. Goldstern: Classical Mechanics, Addition Wesley.
Arrays—Declaring an Array, Array and Memory, Initializing Arrays, Encryption and Decryption
Storage Classes— Fixed vs. Automatic Duration, Scope, Global variables, The Register Specifier, ANSI rules for the syntax and Semantics of the storage – class keywords.
Structures and Unions— Structures, Dynamic Memory Allocation, Linked Lists,Unions enumDeclarations
Input and Output— Streams, Buffering, The<St dio.h>H eader File, Error Handling, Opening and Closing a File, Reading and Writing Data, Selecting an I/O Method, Un-bufferedI/O Random Access, The standard library for Input/ Output.

REFERENCES:

PRACTICAL

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</table>
Possibility Theorem- Fuzzy measures, evidence theory, possibility theory versus probability theory
Fuzzy Logic- An overview of classical logic, Multivalued logics, Fuzzy propositions, Fuzzy quantifiers, Linguistic Hedges, Inference from conditional and qualified fuzzy proposition, the compositional rule of inference.
Approximate reasoning- An overview of fuzzy expert systems, Fuzzy implications and their selection, Multi conditional approximate reasoning, the role of fuzzy relation equations
An introduction to fuzzy control- Fuzzy controllers, Fuzzy rule base, Fuzzy inference engine, Fuzzification, Defuzzification and various Defuzzification methods (the centre of area, the centre of maxima, and the mean of maxima methods.)
Decision Making in Fuzzy Environment- Individual decision making, Multi person decision making, Multi criteria decision making, Multistage decision making, Fuzzy ranking methods, Fuzzy linear programming

REFERENCES:

Dynamic Programming– Deterministic and Probabilistic Dynamic programming
Game Theory– Two–Person, Zero-Sum Games, Games with Mixed Strategies, Graphical Solution, Solution by Linear Programming.
Integer Programming– Branch and Bound Technique.
Queueing system- Deterministic Queueing system, probability distribution in Queueing, classification of Queueing models, Poission Queueing system ((M/M/I): (∞/FIFO), (M/M/I): (/SIRO) (M/M/I): (N/FIFO)), Inventory control : The concept of EOQ, Deterministic inventory problem with no shortages.

REFERENCES:
Motion of Elliptic Cylinder- Streaming Past a fixed Elliptic cylinder, Rotating Elliptic cylinder, Kinetic Energy, Circulation.
Motion in Three Dimensions- Motion of a sphere in a liquid at rest at in infinity, Liquid streaming Past a Fixed sphere, Concentric spheres, Equation of motion of a sphere, Stoke’s stream function.
Vortex Motion- Vortex motion and its elementary properties, Kelvin’s proof, Conservation of Velocity, Strength of a Vortex Tube, Rectilinear vortices with circular and elliptice section, Pressure distribution, Rankine Combine Vortex, Vortex Pair, Image of a vortex filament in a plane, Karman street.

REFERENCES:

Information Functions- The general solution of the fundamental equation of information, Derivations and their role in the study of information functions.

Continuous Channels- The time-discrete Gaussian channel. Uncertainty of an absolutely continuous random variable, the converse to the coding theorem for time–discrete Gaussian channel. The time-discrete Gaussian channel, Band limited channels.

Noiseless Coding- In-gradients of noiseless coding problem, uniquely decipherable codes, Necessary and Sufficient condition for the existence of instantaneous codes, Construction of optimal codes.

Discrete Memory less Channel- Classification of channels, Information processed by a channel, Calculation of channel capacity, Decoding schemes, the ideal observer.

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Database System-Role of Database system, Database system Architecture, Introduction to Relational Algebra and Relational Circuits. SQL–Basic features, including views, Integrity contains, Database design–Normalization up to BCNF. Operating System– User Interface, Processor Management, I/O Management Memory Management, Concurrently and Security, Network and Distributed System.

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