# STATISTICS & OPERATIONS RESEARCH SUBJECT AREA

## 200 LEVEL COURSE

**ST 201 Probability Theory (3 credits)**
(Prerequisite: ST 102)
Joint distribution of two (or more) discrete or continuous random variables, Marginal distribution, Conditional distribution, Independence of random variables, Expectation, Conditional expectation, Covariance, Correlation coefficient, Transformations involving two or more random variables, Probability density functions of (a) sum and difference, (b) product and quotient of two random variables,
Random samples, Empirical distributions, Order statistics, Distributions of MIN $X_i$, MAX $X_i$ etc., Distributions of sample mean and sample variance; t, F and $\chi^2$ distributions and their properties, Laws of large numbers, Central limit theorem.

Recommended texts
1. Canavos G.C. (1984), *Applied Probability and Statistical methods*
2. Freund J.E. (1994) *Mathematical Statistics*, Prentice Hall
3. Wackerly D. Mendenhall W. & Scheaffer R.L. (1995) M*athematical Statistics with Applications*, Duxbury Press.

**ST 203 Theory of Statistics (3 credits)**
Some practical assignments will be given for this course. (Prequisite: ST 201)
**Estimation**: Point estimation: Properties of estimators; Unbiasedness, Consistency, Relative efficiency, Efficiency, Sufficiency, Factorization theorem, Rao-Blackwell theorem, UMVUE, Exponential families, Cramer-Rao inequality, Methods of obtaining estimators; Method of moments, Maximum likelihood estimators etc.
Interval estimation: Constructing confidence intervals for population parameters under various assumptions, Tolerance limits.
**Testing Hypothesis**: Tests on population parameters, Tests on independent and paired samples, Neyman-Pearson lemma, Uniformly Most Powerful tests, Likelihood Ratio tests.

Recommended texts
1. Canavos G.C. (1984) *Applied Probability and Statistical methods*, Little, Brown & Company.
2. Freund J.E. (1994) M*athematical Statistics*, Prentice Hall
3. Hogg R.V. (1978) & Craig A.T., *Introduction to Mathematical Statistics*, Prentice Hall .

**ST 204 Sampling Techniques (2 credits )**
Some practical assignments will be given for this course. (Prequisite: ST 203)
Principal steps in a Sampling Survey, Probability sampling, Simple random sampling, Sampling proportions and percentages, The estimation of sample size, Stratified random sampling, Methods of allocations, Ratio estimators, Regression estimators, Introduction to Cluster sampling and Systematic sampling, Estimating the population size.

Recommended texts
1. Cochran W.G. ( 1977) *Sampling Techniques*, John Wiley & Sons.
2. Scheaffer R.L. (1996) Mendenhall W., and Ott L., E*lementary Survey Sampling*, Duxbury Press.

**ST 205 Statistical Simulation (2 credits)**
(Prerequisites: CS 102, CS 103, ST 203)
Introduction and overview of simulation analysis, Modeling and estimating input processes, Random-number generation, Generation of random variates, vectors, and processes, Statistical analysis of simulation output, Comparison, ranking, and selection of simulation models, Variance-reduction techniques, Designing simulation experiments, gradient estimation, and optimization, Monte Carlo simulation
Some practical assignments will be given for this course
Recommended Texts:
1. *Simulation Modeling and Analysis*, Law and Kelton (2003)
2. *Graphical Simulation Modeling and Analysis Using Sigma for Windows*, L.W. Schruben( 2001)

**ST 206 Introduction to Data Mining (2 credits)**
(Prerequisites: CS 101, ST 101)
Introduction, Basic Data Mining Tasks, Database / OLTP Systems, Fuzzy Sets and Fuzzy Logic, Information Retrieval, Decision Support Systems, Dimensional Modeling, Data Warehousing, OLAP, Web Search Engines, Statistics, Machine Learning, Pattern Matching.
Data Mining Techniques, A statistical perspective on Data Mining, Similarity Measures, Decision Trees, Neural Networks, Genetic Algorithms. Classification – Statistical Based Algorithms, Distance-Based Algorithms, Decision Tree Based Algorithms
Some practical assignments will be given for this course

Recommended Texts:
1. *Data Mining, Introductory and Advanced Topics*, M.H. Dunham (2003)
2. *Principles of Data Mining*, Hand DJ et al, MIT Press (2001)

**CS 201 Data Structures (2 credits)**
(Prerequisites: CS 101, CS 104, CS 105)
Data Structures: linear and non linear data structures. Arrays, lists: linked list, ordered linked list, and doubly linked list; push down stacks; queues: FIFO queue and deque. Tree structures – trees in general, binary search tree (BST), root insertion to BST, splay tree, 2-3-4 trees, radix tree and red-black tree; Graphs; Implementation of depth first search, breadth first search; Hashing: initial hash, collisions, separate chanining.

Recommended Texts:
1. Sedgwick R., Algorithms in C, Addition Wesley, 1998
2. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
3. Gregory L., Heilemen; Data Structures, Algorithms, & Object-Oriented programming; McGraw-Hill

**CS 202 Data Structures Practicals (1 credits)**
(Prerequisites: CS 104, CS105, CS 201)
Implementation of data structures studied in CS 201 using C, C++ and Java.

Recommended Texts:
1. Standish T. A.; *Data Structures in Java*; Addison-Wesley; 1998
2. Deitel, H. M.; Deitel, P. J.; *Java how to Program*; Prentice Hall; 1999

**CS 203 Database Management Systems (2 credits)**
(Prerequisites: CS 101, CS 104, CS 105)
*Overview:* What is a database? Data and metadata. *Conceptual Modeling:* Entities, attributes, associations, functional determination, 3-level structure, graphical representation. *Relational Databases:* Relational algebra, Relational databases and tables, Query languages. The entity-relationship model, Logical organization of databases; Physical organization of databases; Characteristics of disks and disk blocks, Storage of relations, Query processing and optimization, Concurrency control; Transactions, Serializability, Locking, Recovery, Functional dependencies and forms, Introduction to Distributed DBMS, OO DBMS, ORDBMS.

Recommended Texts:
1. Connolly, Begg; *Database Systems: A Practical Guid to Design, Implementation and Management*; 3rd Edition; Addison-Wesley; ISBN:0-201-70857-4.
2. Ramez Elmasri and Shamkant B. Navathe; *Fundermentals of Database Systems*; 5th Edition; ISBN-10: 0321369572
3. Date, C. J.; *An Introduction to Database Systems*; Addison-Wesley; 2000

**CS 204 Programming using Database Management Systems (1 credits)**
(Prerequisites: CS 104, CS 105, CS 202, CS 203)
Computer programming using database management packages such as Informix, Sybase, Oracle and FoxPro on PCs and workstations. Programming assignments: A variety of progressively more complex assignments.

Recommended Texts:
1. Loney, K.; Koch, G.; *Oracle 8i: The complete reference*; McGraw Hill ; 2000

**MT 202 Real Analysis II (3 credits)**
(Prerequisite: MT 105)
Cauchy sequences, Convergence tests, Absolute and conditional convergence, Power series, Integration and differentiation of power series, Taylor series, Uniform continuity, Upper and lower Riemann integrals, Characterization of Riemann integrable functions, Functions of several variables, Limits and continuity, Partial derivatives, Differentials, Chain rule, Extrema of functions of several variables, Lagrange Multipliers.

Recommended Texts:
1. S. R. Lay (1986), *Analysis An Introduction to Proof*, Prentice-Hall
2. T. M. Apostol (1974), *Mathematical Analysis*, Addison-Wesley

**MT 204 Mathematical Methods ( 3 credits)**
(Prerequisite: MT 101)
**Differentiation of Vectors:** Scalar and vector point functions and their partial derivatives with respect to coordinate variables, Gradient of a scalar point function; Directional derivative, Divergence and curl of a vector point function**. Integration of Vectors:** Line integrals and their evaluation using parametric representation, Surface integrals, Green's theorem in the plane Stokes theorem, Circulation and flux of a vector point function, Volume integrals, Divergence theorem, Irrotational and Solenoidal vector fields, Orthogonal Curvilinear Coordinates, Grad, Div, Curl in OCC, Cylindrical polar and spherical coordinate systems, Use of these coordinate systems in evaluation of surface and volume integrals. **Special Solution of Laplaces Equation:** Solutions in two-dimensions, Axi-symmetric solutions. **Integral Transforms:**
Laplace transforms; Elementary Properties, Inverse Laplace transform and its properties, Convolution theorem and its use in evaluation of integrals, Uses of Special functions connected with Laplace transform, Evaluation of integrals using LT, Applications in ODE and integro-differential equations, Applications in PDE, Fourier Transforms; Infinite-Fourier sine/cosine transforms and their inverse formulae, Finite-Fourier sine/cosine transforms, Derivation of inverse formulae, Use of Fourier series, Boundary value problems-Use of Fourier transforms.

Recommended Texts:
1. M.R. Spiegel (1968), *Vector Analysis*, McGraw-Hill
2. M.D. Raisinghania (1997), *Vector Analysis*, S. Chand & Comp. Ltd.
3. M.D. Raisinghania (1995), *Integral Transforms*, S. Chand & Comp. Ltd.

**MT 209 Graph Theory (2 credits)**
Isomorphism of Graphs, Paths, Circuits, Eulerian graphs, Hamiltonian graphs, Shortest path problem, Chinese postman problem, Directed graphs, Graph Colouring, Four colour problem, Proof of five colour theorem, Planar graphs, **Trees and Searching:** Properties of trees, Travelling salesman problem, Tree Analysis of sorting algorithms, Hall's Theorem, Transversal theory, Applications to game theory.

Recommended Texts:
1. F. Harary (1988), *Graph Theory*, Narosa Publishing House
2. R. J. Wilson (1996), *Introduction to Graph Theory*, Addison-Wesley Longman

**MT 210 Advanced Linear Programming (3 credits)**
(Prerequisite: MT 109)
Transportation problem, Assignment problem, Goal programming, Dantzig-Wolf Decomposition algorithm, Interior point algorithms, Bounded variable Simplex algorithm.
Some practical assignments will be given for this course.

Recommended Text:
1. *Linear programming and Network Flows*, Mokhtar S. Bazaraa, Operations Research, Kanti Swarup, (1997)

**MT 211 Integer Programming (3 credits)**
(Prerequisite: MT 210)
Introduction to Integer Programming, Modeling and applications, Dual of Primal Cutting Plane algorithms, Branch and Bound Enumerations, Search Enumerations, Partitioning in Mixed Integer Programming, Group Theory in Integer programming.
Some practical assignments will be given for this course.

Recommended Text:
1. *Integer programming, Applications and Computations*, Hamdy A. Taha., (1998)

**MT 212 Operations Research II (2 credits)**
(Prerequisite: MT 109)
Theory of games, Queuing theory, Inventory management.

Recommended Text:

1. *Operations Research,* Kanti Swarup., (1987)