STATISTICS & OPERATIONS RESEARCH SUBJECT AREA

400 LEVEL COURSES

ST 401 Actuarial Statistics (2 credits)
(Prerequisite: ST 203)
Economics of uncertainty. Risk theory and utility. Jensen's inequality. Sums of random variables and convolutions. Applications to individual risk models. Failure rates and the force of mortality. Mixtures of random variables and mixtures of distributions. Loss distributions, Reinsurance. Risk models, Estimating distribution by simulation. Actuarial applications of statistical inference. Compound distribution. Collective risk models. Ruin theory. Lundberg's Inequality, Introduction to credibility theory. Compound stochastic processes. Applications of risk theory in insurance problems. No claims discounting. Run off triangles.

Recommended Texts:
1. *An Introduction to the Mathematics of Finance* (Chapters 1-4), J.J. McCutcheon and W.F. Scott.,(1998)
2. *Life Contingencies* (Chapters 1-6)A. Neill.(1999)
3. *Actuarial Mathematics* (Chapters 3-8), N.L. Bowers Jr, ... [et al.].(2001)
4. *Mathematical Models for the Growth of Human Populations*, .H. Pollard (1997)

ST 402 Statistical Data Mining (3 credits)
(Prerequisites: ST 206, ST 305)
Classification –Neural Network Based Algorithms, Rule Based Algorithms, Combining Techniques.
Clustering – Similarity and Distance Measures, Hierarchical Algorithms, Partitional Algorithms, Clustering Large Data Bases, Clustering with Categorical Attributes, Comparison.
Association Rules – Large Item Sets, Basic Algorithms, Parallel and Distributed Algorithms, Comparing Approaches, Incremental Rules, Advanced Association Rule Techniques, Measuring the Quality of Rules.
Web Mining – Web Content Mining, Web Structure Mining, Web Usage Mining.
Spatial Mining – Spatial Data Overview, Spatial Data Mining Primitives, Generalization and Specialization, Spatial Rules, Spatial Classification Algorithm, Spatial Clustering Algorithms.
Temporal Mining – Modeling Temporal Events, Time Series, Pattern Detection, Sequences, Temporal Association Rules.
Some practical assignments will be given for this course
Recommended Texts:
1. *Data Mining Introductory and Advanced topics*, M.H. Dunham (2003)
2. *Predictive Data Mining*, Weiss SM & Indurkhya N, Morgan Kaufmann (1997)
3. *Principles of Data Mining*, Hand DJ et al, MIT Press (2001)

ST 403 Statistics for Bioinformatics (2 credits)
(Prerequisites: CS 207, CS 208)
Review of the following in the context of bioinformatics: Basic probability, statistical inference, stochastic processes, computer intensive approaches to statistical inference, applications. Mathematical models and computational methods of statistical genetics including mendelian genetic traits, population genetics, pedigree relationships and gene identity, meiosis and recombination, linkage detection, multipoint linkage analysis. Course work involves some computation in a Unix environment.

Recommended Texts:
1. *Biological Sequence Analysis*, R. Durbin, S. Eddy, A. Krogh and G. Mitchison (1998)
2. *Statistical Methods in Bioinformatics, An Introduction*, W. J. Evans, G.R. Grant (2001)

ST 404 Stochastic Processes (2 credits)
(Prerequisites: ST 201, ST 203)
Introduction to Stochastic processes: Markov Chains, Markov Processes with Discrete state space, Markov Processes with Continuous state space, Stationary processes, Branching Processes, Stochastic processes in Queueing and Reliability

Recommended Text:
1. *Stochastic Processes*, J. Medhi (1996)

ST 405 Multivariate methods II (2 credits)
(Prerequisite: ST 305)
Discriminant analysis of two group and multiple groups, Principal component analysis (PCA). Interpretation using illustrative examples. Factor analysis. Comparison with PCA, factor loadings, rotations, Interpretation, Canonical correlation, Covariance structure models.
Some practical assignments will be given for this course

Recommended Texts:
1. *Multivariate Statistical inference & Applications,* A.C. Rencher(1990)
2. *Applied Multivariate Statistical Analysis,* R.A. Johnson and D.W. Wichern (1982)

ST 406 Bayesian Statistics II (2 credits)
(Prerequisite: ST 308)
Decision Rules; Making Decisions when data is not available: Specifying a prior distribution, Making decisions with only prior information; Making Decisions when data is available: Decision trees, Expected Value of Perfect Information (EVPI), Expected Value of Sample Information (EVSI), Non-informative and natural conjugate prior, Bayesian confidence intervals.

Recommended Texts:
1. *Statistical Decision Theory and Bayesian Analysis,* J.O. Berger (1985)
2. *Bayes and Empirical Bayes methods for Data analysis,* B.P. Carlin and T.A. Louis (1996)

ST 425/MT 425 Project Work/Industrial Training (3 credits)
Students are expected to carry out an independent research project on a topic assigned to him/her under the supervision of a senior staff member or spent 6 weeks in industry working in a relevant project. At the completion of the project students are expected to write a report and make a presentation.

CS 401 Artificial Intelligence and Expert Systems: (3 credits)
(Prerequisite: CS 301)
Artificial intelligence: Intelligent Agents, Search Techniques, Game Playing, Knowledge and Reasoning, First order logic, Logical reasoning systems, Uncertainty, Probabilistic Reasoning, Simple and complex Decisions, Learning.
Expert systems: Characteristics and components of Expert systems, Machine learning, Knowledge base and bank, Rule Knowledge, Inference engine, transit fare rule, Rule interpreter, Inference tree.

Recommended Texts:
1. Russell, S.J; Norvig, P.; *Artificial Intelligence: A Modern Approach*; Prentice-Hall; 1995

CS 409 Neural networks and Fuzzy logics (3 Credits)
(Prerequisities: CS 401)
Fuzzy system models, Fuzziness and certainty, fuzzy sets, basic properties and characteristics, Domains, Alpha- level sets and support sets, Linear representation, Fuzzy set operators, Conventional (crisp) set operations, basic Zadeh type operations, intersection, union and complement of fuzzy sets, General algebraic operations, Fuzzy set hedges, Fuzzy reasoning, linguistic variables, Fuzzy models, Fuzzy systems and modeling, Design methodologies, modeling and utility software. Parallel and distributed processing, Neuron, Connectivity, Activation function, propagation rule, Learning rules, pattern Preparation, Perceptron, Multilayer perceptron, Associative memory, Hopfield neural networks, Self organizing map (SOM), Adaptive Resonance theory, topologies, Training methods, supervised and unsupervised learning

Recommended Texts:
1. *Artificial Intelligence: A Modern Approach* (Second Edition) by Stuart Russell and Peter Norvig.

MT 409 Selected Topics in Applied Operations Research (2 credits)
(Prerequisites: MT 315, MT 316)
Topics will be selected from significant areas in Operations Research. Topics may vary each year.

MT 410 Optimization of Engineering Design (3 credits)
(Prerequisites: MT 315, MT 316)
Introduction, Single-variable optimization algorithms, Multivariable optimization algorithms, Constrained optimization algorithms, Specialized algorithms, Nontraditional optimization algorithms.

Recommended Text:

1. *Optimization for Engineering Design* (*Algorithms and Examples*), Kalyanmoy Deb, (1999)

MT 411 Optimization Modeling (2 credits)
(Prerequisites: MT 315, MT 316)
Optimization models in Linear programming, Nonlinear programming and Integer programming. Students are expected to develop reasonable modeling skills allowing them to cast appropriate real world problems as optimization problems and solve them with available software.

MT 412 Financial Mathematics (3 credits)
An introduction to options and markets, Interest and present value analysis, Geometric Brownian Motion, Pricing contract via arbitrage, Arbitrage theorem, Black-Scholes option pricing formula, The binomial option pricing model, More results on options, Valuing by expected utility, Exotic options.

Recommended Texts:

1. *An Elementary Introduction to Mathematical Finance. Options and other Topics*, S.M. Ross, (1987)
2. *The Mathematics of Financial Derivatives, A student Introduction,* P. Wilmott, S. Howisan, J. Dewynne,(2000)
3. *Options, Futures and other Derivatives,* J. Hull, Prentice Hall,(1998)