AMITY UNIVERSITY
UTTAR PRADESH

FORMAT FOR COURSE CURRICULUM

Course Title: Applied probability and statistics
Credit Units:3

L	T	P/S	SW/FW	TOTAL CREDIT UNITS
3	0	0	0	3

Course Level: UG
Course Code: CSE416

Course Objectives: Computation plays a central role in modern statistics and machine learning. This course aims to cover topics needed to develop a broad working knowledge of modern computational statistics. We seek to develop a practical understanding of how and why existing methods work, enabling effective use of modern statistical methods. Achieving these goals requires familiarity with diverse topics in statistical computing, computational statistics, computer science, and numerical analysis.

Pre-requisites:
Basic knowledge of Mathematics and Statistics

Course Contents/Syllabus:

	Weightage (%)
Module I Deterministic optimization	**25%**
Newton-Raphson, conjugate gradients, preconditioning, quasi-Newton methods, Fisher scoring, EM and its various derivatives **Numerical recipes for linear algebra: matrix inverse, LU, Cholesky decompositions, low-rank updates, SVD, banded matrices, Toeplitz matrices and the FFT, Kronecker products (separable matrices), sparse matrix solvers**	
Module II Convex Analysis	**20%**
Convex analysis: convex functions, duality, KKT conditions, interior point methods, projected gradients, augmented Lagrangian methods, convex relaxations **Applications: support vector machines, splines, kriging, isotonic regression, LASSO and LARS regression**	
Module III Markov Models	**15%**
Hidden Markov models, forward-backward algorithm, Kalman filter, Markov random fields	
Module IV Deterministic integration:	**15%**

Gaussian quadrature, quasi-Monte Carlo. Application: expectation propagation	
Module V Monte Carlo methods	**25%**
Rejection sampling, importance sampling, variance reduction methods (Rao-Blackwellization, stratified sampling) **MCMC methods: Gibbs sampling, Metropolis-Hastings, Langevin methods, Hamiltonian Monte Carlo, slice sampling. Implementation issues: burnin, monitoring convergence Sequential Monte Carlo (particle filtering)**	

Course Learning Outcomes:
After completion of the course, student will be able to:

- **Basic understanding of computational statistics.**
- **Basic understanding of convex analysis.**
- **Optimization Techniques understanding.**
- **Able to understand Moneo Carlo Methods.**
- **Able to understand Markov Methods.**

Pedagogy for Course Delivery:

The course will be taught in theory and practical based mode. The class will be taught using theory and case based method. Online teaching will be used. Online resources like NPTEL Youtube etc will be used. The instructor will discuss computation problems to the students for better understanding of the concept. The instructor will provide Some self learning online resources to students.

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total
100%		**100**

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment 40%					End Term Examination 60%
Components (Drop down)	**Attendance**	**Class Test**	**HA**	**Quiz**	**EE**
Weightage (%)	5	15	10	10	60

Lab/ Practical/ Studio Assessment:

	Continuous Assessment/Internal Assessment				End Term Examination		
Components (Drop down							
Weightage (%)							

Text:

- **Computational. Statistics. Geof H. Givens and Jennifer A. Hoeting. Hoboken, NJ: John Wiley &. Sons**
- **Monte Carlo Statistical Methods, Robert and Casella, Springer**
- **Convex Optimization. Boyd and Vandenberghe, Cambridge University Press**

References:

- **Practical methods of optimization, Fletcher, Wiley**
- **Optimization theory and methods, Sun and Yuan, Springer optimization and its applications**
- **Introduction to Stochastic Search and Optimization: Estimation, Simulation, and Control, JC Spall, Wiley**

Additional Reading:

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Any other Study Material:

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