Syllabus for Six-Month Pre registration Course Work of Ph. D. Programme In Computer Science

(w.e.f. January, 2016)

Course Structure & Examination Pattern of the Ph. D Programmes in Computer Science

1. There shall be four courses in the One-Semester Course work for the Ph. D programmes conducted in Dibrugarh University comprising with the following components:

   Course I : Research Methodology (Core)
   Course II : Optional (Intra/ Inter-Department)
   Course III : Optional (to be offered by the prospective Supervisor concerned)
   Course IV : Assignment (under guidance of the prospective Supervisor concerned)

2. The distribution of marks of the course work shall be below:

Courses	Internal Assessment	End Semester Examination	Total
Course I	40	60	100 Marks
Course II	40	60	100 Marks
Course III	40	60	100 Marks
Course IV	80 (Assignment Writing)	20 (Viva on the Assignment)	100 Marks
Total			400 Marks

Total Credit (16-20)

3. Candidates shall have to secure a minimum of 45% marks in aggregate to pass a paper individually.

4. There shall be internal assessment of 40 marks in each theory paper to be awarded against the following:

   Sessional Exam I - 15 Marks
   Sessional Exam II - 15 Marks
   Seminar Presentation - 10 Marks

5. The mode of Internal Assessment (IA) shall be decided and implemented by the Department/ Centre concerned. The mode of IA shall have to be communicated to the Controller of Examinations, Dibrugarh University at the time of submission of IA marks.

6. Examination & Declaration of Results:

(a) The IA of a student shall be conducted by the course teacher of the student concerned. The marks of the IA shall be submitted to the Controller of Examinations, Dibrugarh University by the Head of the Department/ Director of the Centre concerned.

(b) The End Semester examinations shall be conducted by the Controller of Examinations, Dibrugarh University in consultation with the Head of the Department/ Director of the Centre concerned.

(c) The result shall be declared by the Controller of Examinations.

(d) The examinations shall be conducted as per the existing examination ordinance of the University.

7. The result of the candidates appeared in the examination for Ph.D. Course Work shall be awarded in the following Grade system:

Letter Grade with meaning		**Grade Point**
O	Outstanding	10 (Marks securing above 95%)
A^+	Excellent	9 (Marks securing 90%-95%)
A	Very Good	8(Marks securing 80% -90%)
B^+	Good	7(Marks securing 70% -80%)
B	Above Average	6(Marks securing 60% -70%)
C	Average	5(Marks securing 50% -60%)
P	Pass	4 (Marks securing 45% -50%)
F	Fail	0(Marks securing below 45%)
Ab	Absent	0

A student obtaining Grade F shall be considered failed and will be required to reappear in the examination.

8. Every candidate shall be given a maximum of two consecutive chances (including the first regular chance) for passing the examination. Not appearing in an examination after becoming eligible to appear in the same amounts to losing a chance.

9. The candidates who have failed the examination in the first chance shall have to clear the same in the second and last chance, which shall be held within three months from the date of declaration of results.
   A candidate shall have to appear in the second chance only in the failed paper(s) to pass the examination.

10. The candidates passed in the Ph.D. Pre-registration Course Work with not below the Latter Grade **B** shall be eligible to go for Ph.D. registration.

11. Matters not covered by the above Regulations shall be decided as per the other statutory provisions of the University.

COURSE I: RESEARCH METHODOLOGY

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Formal research requires scientifically tested methodologies that envisage approaches to outcomes. This course includes different methodologies adopted for doing research, some of the pitfalls and hurdles which students have encountered during their Ph.D works. The course also gives a glimpse of LaTeX and MATLAB software.

COURSE OBJECTIVE:

The primary objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods.

LEARNING OUTCOMES:

On successful completion of this module, the student should be able to (1) provide an overview of the research process, (2) Define their research problems, (3) Identify the associated research questions arising, including both descriptive and either explanatory or exploratory questions.

DETAILED SYLLABUS

Section A: Basic Aspects

Unit I: Fundamentals of Computer Science Research ***Marks: 10***

Basic issues of Computer Science, Objects and avenues of Computer Science research Methodology of Computer Science research, various methods adopted for doing research in Computer Science.

Unit II: Computer Science Research Preparation ***Marks: 15***

How to organize a paper, How to write a mathematical statement viz. theorem, remark, proof etc. How to write Abstract and Bibliography, Review of Literature, Preparation of a talk and seminar paper, preparation of a synopsis/ project.

Section B: Computer Application

Unit I: Manuscript Preparation using Latex ***Marks: 20***

Use of Latex, Preparation of a manuscript using Latex (research Paper and Seminar Presentation)

Unit II: Use of Mathematical Software ***Marks: 15***

Mathematica, Matlab, maple for obtaining solutions for various Mathematical Problems.

REFERENCE BOOKS:

1. A Primer of Mathematical Writings, S.G. Krantz, University Press, 1997.
2. Handbook of writing of Mathematical Sciences, SIAM, Philadelphia, Pensylvenia, 2nd ed., 1998.
3. E-resource: Methmath research.htm (To be supplied by the Centre/ Department)
4. A Primer to LATEX Tutorials, Ed. E. Krishnan, Indian Tex users group, Trivandrum, India, 2003 September. E-resource: http://www.tug.org.in/tutorials.html.
5. J. Zobel, Writing For Computer Science, New York: Springer-Verlag, 1997.
6. J. Paradis and M. Zimmerman, The MIT Guide to Science and Engineering Communication, Cambridge, MA: MIT Press, 1997.
7. A. Friedland, Writing Successful Science Proposals. Yale University Press, 2000.
8. W. Strunk, Jr., E. White, C. Osgood, R. Angell. The Elements of Style. Allyn and Bacon, 2000.

JOURNALS:

1. The Computer Journal, Oxford University Press, ISSN: 1460-2067 (Online), 0010-4620 (Print)
2. Applied Computing and Informatics, Elsevier, ISSN: 2210-8327.

COURSE II: OPTIONAL (Intra / Inter Departmental)

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

(*Any one from the following*)

GROUP (A): COMPUTER NETWORKS

Total marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

This course introduces students to computer networks and concentrates on building a firm foundation for understanding Data Communications and Computer Networks. The course provides the student with fundamental knowledge of the various aspects of computer networking and enables students to appreciate recent developments in the area. The course is pre-requisite to any studies related to Cognitive Radio Networks, Communication Networks, Network Design Problems etc.

COURSE OBJECTIVE:

The objective of the course is to make students familiarized with the state-of-the-art in network protocols, architectures, and applications, process of networking research and Constraints and thought processes for networking research.

LEARNING OUTCOME:

Upon completing the course, the student will be able to describe the basics of data communication, various types of computer networks and design communication protocols.

DETAILED SYLLABUS:

Unit I: Network Analysis ***Marks: 25***

Vertex degrees: Degree Distribution, Degree Correlation, Distance Statistics.
Clustering Co-efficient: Local View, Global View, Centrality

Unit II: Computer Networks ***Marks: 35***

Review of Computer Network Architecture and Subnet Layers.
Computer Networks: Small area Networks, Large area Networks.
Measuring topology of the internet, The AS topology.
Peer-to-peer (P2P) overlay networks, Chord P2P networks, The Chord Graph.
The organization of the Web, Measuring the topology of the Web.
Characteristics of Web graphs.

REFERENCES BOOKS:

1. Steen marten Van, "Graph Theory and Complex Networks: An introduction", 2010.
2. A. S. Tanenbaum, David J. Wetherall, "Computer Networks", 5e, PHI, 2011.
3. M. E. J. Newman, "Networks: An introduction", Oxford University Press, 2010.
4. J. Kurose, K. W. Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", Addison-Wesley, 5th Edition, 2009.
5. L. L. Peterson and B. S. Davie, "Computer networks: a systems approach", 5th Edition, Morgan Kaufmann Publishers, 2011.
6. W. Stallings, "Data and computer communications", 10th edition, Prentice Hall, 2013.

JOURNALS:

1. Computer Networks, Elsevier, ISSN: 1389-1286.
2. Journal of Network and Computer Application, Elsevier, ISSN: 1084-8045.

GROUP (B): CRYPTOGRAPHY AND NETWORK SECURITY

Total marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

This course will discuss common security weaknesses, vulnerabilities, attack methods, and mitigation approaches. It also provides a comprehensive list of security issues related to general networking design and development.

COURSE OBJECTIVES:

The objective of this course is to make students familiarized with the security threats, and the security services and mechanisms to counter them, and comprehend and apply relevant cryptographic techniques.

LEARNING OUTCOME:

The students will be able to apply security principles to system design, identify and investigate network security threats and conduct research in network security.

DETAILED SYLLABUS:

Unit I: ***Marks: 20***

Introduction to Cryptography- Services, Mechanism and Attacks – The OSI Security Architecture – A Model for Network Security – Classical Encryption Techniques – Symmetric Cipher Model – Substitution Techniques – Transporation Techniques – Rotor Machines – Steganography.

Unit II: ***Marks: 20***

Simplified DES – Block Cipher Principles – The Data Encryption Standard – The Strength of DES – Differential and Linear Cryptanalysis – Block Cipher Design Principles – Block Cipher Modes of Operation.

Unit III: ***Marks: 20***

Web Security- Secure Socket Layer- Secure Electronic Transaction, System Security-Intruders and Viruses-Firewalls-Password Security.

REFERENCES BOOKS:

1. Wade Trappe, Lawrence C Washington, “Introduction to Cryptography with coding theory”, 2nd ed. Pearson, 2007.
2. William Stallings, “Cryptography and Network security Principles and Practices”, Pearson/ PHI, 4th ed., 2006.
3. W. Mao, “Modern Cryptography – Theory and Practice”, Pearson Education, Second Edition, 2007.

4. Charles P. Pfleeger, Shari Lawrence Pfleeger, "Security in Computing", 5th edition, Prentice Hall of India, 2015.

JOURNALS:

1. Security and Privacy, IEEE, ISSN: 1540-7993.
2. ACM Transaction on Information and System Security, ISSN: 1094-9224.
3. Journal of Cryptography, Springer ISSN: 0933-2790 (Print), 1432-1378 (Online).

GROUP (C): DATA MINING & DATA WAREHOUSING

Total marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Data mining is the extraction of previously unknown and potentially useful hidden information from large databases. It allows users to analyze data from many different dimensions or angles, categorize it, and summarize the relationships identified.

COURSE OBJECTIVE:

This course helps the students to determine the overall architecture of a data warehouse and techniques and methods for data gathering and data pre-processing using OLAP tools. The different data mining models and techniques will be discussed in this course.

LEARNING OUTCOME:

After going through this course, students will be able to compare various data mining techniques, methods in integrating and interpreting different data sets and obtain improved mechanism for effective and efficient data analysis.

DETAILED SYLLABUS:

Unit I: Data Warehousing ***Marks: 20***

Concept of Data Warehouse, Differences between Operational Databases and Date Warehouse, Multi-dimensional Data Model, Schemas for Multi-dimensional Databases, Data Cube Representations, Data Warehouse Architecture, OLTP vs OLAP, Efficient Query Processing in data Warehouses, Indexing of OLAP data, Meterialization concept.

Unit II: Data Mining ***Marks: 40***

Data Clustering: Partitioning, Hierarchical, Density-based, Grid Based and Model Based Methods; Classification & Prediction: Decision Tree Techniques, Back-Propagation Method, Bayesian Method

Association Rule Mining Techniques: Frequent Itemset Generation, Apriori, Horizontal Method, Sampling Approach, Hashing Approach; Dynamic Association Rule Mining;

REFERENCES BOOKS:

1. Jiawei Han and Micheline Kamber, “Data Mining: Concepts and Techniques”, Morgan Kaufmann, India, 3rd edition., 2011.
2. A K Pujari, “Data Mining Techniques”, University Press, India, 3rd edition, 2013.
3. Han, Manilla and Smyth, “Principles of Data Mining”, PHI, India, 2nd editon. 2006.
4. Sushmita Mitra, Tinku Acharya, “Data Mining: Multimedia, Soft Computing and Bio-Informatics”, Wiley, 2003.

JOURNALS:

1. Data Mining and Knowledge Discovery, Springer, ISSN: 1384-5810 (Print), 1573-756X (Online).
2. Transactions on knowledge Discovery from Data, ACM, ISSN: 1556-4681.

GROUP (D): DESIGN AND ANALYSIS OF ALGORITHM

Total marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

This course introduces concepts related to the design and analysis of algorithms. Specifically, it discusses recurrence relations, and illustrates their role in asymptotic and probabilistic analysis of algorithms. It covers in detail greedy strategies divide and conquer techniques, dynamic programming and max flow - min cut theory for designing algorithms, and illustrates them using a number of well-known problems and applications.

COURSE OBJECTIVE:

The objective of the course is to analyze the asymptotic performance of algorithms, Apply important algorithmic design paradigms and methods of analysis and synthesize efficient algorithms in common engineering design situations.

LEARNING OUTCOME:

Students who complete the course will demonstrate the ability (1) to compare between different data structures, (2) Pick an appropriate data structure for a design situation and can explain what an approximation algorithm is and the benefit of using approximation algorithms, (3) Identify the approximation algorithm and analyze the approximation factor of an algorithm.

DETAILED SYLLABUS:

Unit I: Design and Search Techniques ***Marks: 35***

Divide-and-Conquer, Prune-and-Search, Dynamic Programming, Greedy Algorithms, SEARCHING: Binary Search Trees, Red-Black Trees, Amortized Analysis, Splay Trees.

Unit II: Graph Algorithms ***Marks: 25***

Graph Search, Shortest Paths, Minimum Spanning Trees, Union-Find

REFERENCES BOOKS:

1. Corman et al., “Introduction to Algorithms”, 3rd ed., 2010, PHI.
2. A. Aho, J. Hopcroft, J. Ullman, “The Design and Analysis of Algorithms”, Addison-Wesley, 2002, Pearson.
3. Levitin, “An Introduction to Design and Analysis of Algorithm”, 3rd edition, 2011, Pearson Education India.
4. Sara Baase and Allen Van Gelder, “Computer Algorithms: Introduction to Design and Analysis”, Pearson education (Singapore) Pte. Ltd, New Delhi, 2008.

JOURNALS:

1. Journals of Discrete Algorithms, Elsevier, ISSN: 1570-8667.
2. Algorithmica, Springer, ISSN: 0178-4617 (Print).

GROUP (E): FUZZY SETS & FUZZY LOGIC

Total marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

This course presents some fundamental knowledge of fuzzy sets, fuzzy logic, fuzzy decision making and fuzzy control system.

COURSE OBJECTIVE:

The objectives of this course is to provide an overview of the basic mathematical elements of the theory of fuzzy sets and give emphasis on the differences and similarities between fuzzy sets and classical sets theories.

LEARNING OUTCOME:

Students become capable of representing a simple classical proposition using crisp and fuzzy set, determine characteristic functions, determine different fuzzy propositions using fuzzy set membership function and likewise representing a fuzzy proposition using fuzzy set membership function.

DETAILED SYLLABUS:

Unit I: ***Marks: 40***

Introduction, Fundamentals of Fuzzy Sets, Fuzzy set, Fuzzy Set Relations, Basic Fuzzy set Operations and Their Properties, Operations Unique to Fuzzy sets, Fuzzy Relations, Ordinary (crisp) Relations, Fuzzy Relations Defined on Ordinary Sets, Fuzzy Relations Derived from Fuzzy Sets, Fuzzy Logic, Fuzzy Logic Fundamentals, Fuzzy Control, Fuzzy Control Basics, Case Studies: Extended Fuzzy if-then Rules Tables, Fuzzy Control Expert Systems, Hybrid Systems. Fuzzy Numbers, Alpha-Cuts, Inequalities.

Unit II: ***Marks: 20***

Fuzzy Arithmetic: Extension Principle, Interval Arithmetic, Fuzzy Arithmetic, Fuzzy Functions, Extension Principle, Alpha-Cuts and Interval Arithmetic, Differences. Ordering/ Ranking Fuzzy Numbers, Optimization, Discrete Versus Continuous, Measures of Fuzziness.

REFERENCES BOOKS:

1. Toshinori Munakata, “Fundamentals of the New Artificial Intelligence Neural, Evolutionary, Fuzzy and More”, Second Edition, Springer-Verlag London Limited (2008).
2. Elaine Rich, Kevin Knight, “Artificial Intelligence”, Second Edition, Tata McGraw-Hill (2000).
3. Stuart Russell, Peter Norving, “Artificial Intelligence A Modern Approach”, Third Edition, Prentice-Hall of India (2009).

4. Nikola K. Kasabov, "Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering", MIT Press (1998).
5. G.J. Klir, B. Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications". Prentice Hall of India, 1995

JOURNALS:

1. Fuzzy Logic and the Resolution Principle, ACM, ISSN: 0004-5411.
2. IEEE Transaction on Fuzzy Systems, ISSN: 1063-6706.

GROUP (F): NEURAL NETWORKS USING MAT LAB

Total marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

The course introduces the theory and practice of neural computation. It offers the principles of neurocomputing with artificial neural networks widely used for addressing real-world problems such as classification, regression, pattern recognition, data mining.

COURSE OBJECTIVE:

The objective of the course in neural networks is to introduce the neural networks as means for computational learning and to to present the basic network architectures for classification and regression.

LEARNING OUTCOME:

At the end of the course, students should be able to identify the role of neural networks in engineering, artificial intelligence, and cognitive modeling, analyze various models in the research literature on neural networks in one particular domain, and be able to put new work into the context of that literature.

DETAILED SYLLABUS:

Unit I: ***Marks: 40***

Introduction to Neural Network – Introduction to Artificial Neural Networks – Fundamental models of Artificial Neural Networks – Perceptron networks.
Adaline & Madaline Networks – Associativity Memory Networks.
Feedback Networks- Feed forward Networks- Self Organized future map.

Unit II ***Marks: 20***

Application of Neural Networks- Application of Special Networks, Neural Network Projects with MAT LAB - Fuzzy Systems.

REFERENCES BOOKS:

1. Simon Haykin, "Neural Networks - A Comprehensive Foundation", Prentice Hall, 2nd ed., 1999, ISBN 0-13-273350-1
2. Andrew P. Paplinski -- Lecture notes: ~app/CSE5312
3. H. Demuth, M. Beale, Neural Network Toolbox User's Guide. For use with MATLAB, The MathWorks Inc, (file:/sw/matlab/help/fulldocset.html from Unix workstations)
4. Martin T. Hagan, H. Demuth,M. Beale, "Neural Network Design", 2nd Edition, PWS Publishing, 2014, ISBN 0-534-94332-2
5. Christopher M.Bishop, "Pattern Recognition and Machine Learning", Springer, 2006

JOURNALS:

1. Neural Networks, Elsevier, ISSN: 0893-6080.
2. IEEE Transactions on Neural Networks and Learning Systems, ISSN: 2162-237X.

GROUP (G): FUNDAMENTALS OF GAME THEORY

Total marks: 100 (End-Semester: 60 & In-Semester: 40)

INTRODUCTION:

Game Theory applies to any field of studies that involves conflicts of interests among self motivating agents. Game Theory has been widely used in computer related research domains.

COURSE OBJECTIVE:

The objective of the course is to find the importance of competitive and co-operative factors in a Varity of decision problems and to learn how to analyze and structure these problems from a quantitative perspective.

LEARNING OUTCOME:

The students will be able to (1) Compare the different approaches of game theory, (2) Obtain numerical solutions pertaining to Nash equilibrium, (3) Analyze the solution concepts for Games in Strategic forms, (4) Identify the basic characteristics of cooperative Game.

DETAILED SYLLABUS:

Unit I: Basics of Game Theory ***Marks: 12***

Historical background; Zero sum games; non-zero sum games; extensive form games; Cooperative games; Bargaining games; Cooperative versus non-cooperative games;

Unit II: Finite Two person Zero sum games ***Marks: 12***

Saddle point; Minimax and maximin strategies; Solving 2xn and mx2 games; Dominance; Mixed strategy; Linear Programing Methods to solve a two person zero sum game.

Unit III: Finite Two Person non-zero sum games ***Marks: 12***

Basic Definitions; Nash equilibrium; Pure and mixed strategies in Nash equilibrium.

Unit IV: Finite Extensive Form Games ***Marks: 12***

The Extensive Form; The Strategic Form; Backward induction and subgame perfection; Perfect Bayesian equilibrium.

Unit V: Cooperative Game Theory Models ***Marks: 12***

Cooperative Games with Transferable Utility; The Core; The Shapley value; The Nucleolus.

REFERENCES BOOKS:

1. Hans Peter, "Game Theory - A Multi level Approach", 2nd Edition, Springer, 2015.

2. R.P Gilles, "The Cooperative Game Theory of Networks and Hierarchies", Springer 2010.
3. Y Narahari,"Game Theory and Mechanism Design", IISc Press, 2014.
4. M. Osborne, "An Introduction to Game Theory", Oxford University Press, 2003.
5. S. R. Gibbons, "A Primer in Game Theory", Pearson Education, 1992.

GROUP (H): SCIENTIFIC AND ENGINEERING COMPUTATIONS

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

The paper demonstrates the relevance of numerical analysis to a variety of disciplines and provides ample practice for students, with a wealth of examples and exercises. The applications presented in the course demonstrate concisely how numerical methods can be, and often must be, applied in real-life situations.

COURSE OBJECTIVE:

This objective of this course is to gain a theoretical understanding of and a firm basis for future study of, numerical analysis and scientific computing.

LEARNING OUTCOME:

At the end of this course the student will be able to use partial differential equations to model engineering phenomena such as for example circuits and elementary heat transfer.

DETAILED SYLLABUS:

Unit I: Approximating Eigenvalues ***Marks: 20***

Characteristics value problem, The Power method, The QR method, The Householder's method, and Application of Eigenvalues

Unit II: Numerical Solutions to partial Differential Equations ***Marks: 20***

Elliptic partial differential equations, Parabolic partial differential equations, Hyperbolic partial differential equations.

Unit III: Finite Element Method ***Marks: 20***

Weighted Residual methods, Variational methods, Finite elements, Finite element method (Basic concept)

REFERENCE BOOKS:

1. Curtis F. Gerald and Patrick O, Wheatley, "Applied Numerical Analysis", Addison Wesley. (Chapter 6), 7th edition, 2003.
2. Richard L. Burden and J. Douglas Fairs, "Numerical Analysis", Brooks/Cole Publishing Company (Chapter 12), 6th edition, 1996.
3. M. K. Jain, "Numerical Solution of Differential Equations", Wiley Eastern Limited (Chapter -8),1984
4. H. M. Antia, "Numerical methods for Scientists and Engineers", Hindustan Book Agency, New Delhi, 1987

5. M. K. Jain, S. R. K. Iynger and R. K. Jain, "Computational methods for Partial Differential Equations", Wiley Eastern Limited
6. Klaus-Jurgen Bathe, "Finite Element Procedures", Prentice Hall of India Pvt. Limited, 2007.

GROUP (I): NONLINEAR SYSTEMS AND NETWORKS

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Nonlinear Dynamics and Chaos effectively demonstrates the power and beauty of the theory of dynamical system. The subject emphasize on different applications which include mechanical vibrations, lasers, biological rhythms, superconducting circuits, insect outbreaks, chemical oscillators, genetic control systems, chaotic waterwheels, and even a technique for using chaos to send secret messages.

COURSE OBJECTIVE:

The objective of the course is see use of nonlinear systems theory to classify the behaviours of the system and to understand the critical transitions occurring when some model or control parameters are varied.

LEARNING OUTCOME:

On completion of this course, the students should be able to analyze nonlinear dynamical systems that give rise to oscillations, waves and patterns and to apply mathematical tools to analyze the dynamics of networks.

DETAILED SYLLABUS

Unit I: Nonlinear dynamics and chaos ***Marks: 20***

Introduction, One dimensional Flows, flows on the line, bifurcation, flows on the circle, two dimensional flows, linear systems, phase plane, limit cycles, chaos

Unit II: Networks ***Marks: 20***

Mathematics of networks, the adjacency matrix weighted networks, directed networks, bipartite networks, planar networks.
Measures and metrics: the large-scale structure of networks

Unit III: Computer algorithms for networks ***Marks: 20***

Basic concepts of algorithms, Running time and computational complexity, storing network data The adjacency matrix, adjacency list, Trees, Other network representation, Heaps
Fundamental network algorithms, Algorithm for degrees and degree distributions, Clustering coefficients, Shortest paths and breadth –first search, Shortest path in networks with varying edge length, Maximum flows and minimum cuts, Matrix algorithms and graph portioning,

Leading eigenvectors and eigenvector centrality, dividing networks into clusters
Network models

REFERENCE BOOKS:

1. Steven H. Strogatz, "Nonlinear Dynamics and Chaos", Levant Books, Kolkata, 1st edition, 2001
2. M. E. J. Newman, "Networks: An Introduction", Oxford University Press, 2010.

GROUP (J): INTRODUCTION TO MACHINE LEARNING**

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Machine Learning is rapidly growing fields of data analysis. For many years data analysis and statistical community has been developing algorithms and methods for discovering patterns in datasets. Besides theoretical knowledge successful research in the areas depends on confided usage of common methods, algorithms and tools along with skills for developing new ones.

COURSE OBJECTIVE:

This course will serve as a comprehensive introduction to various topics in machine learning.

LEARNING OUTCOME:

At the end of the course the students should be able to design and implement machine learning solutions to classification, regression, and clustering problems; and be able to evaluate and interpret the results of the algorithms.

DETAILED SYLLABUS

UNIT 1
Introduction: Defining learning systems, Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation, supervised learning, unsupervised learning, Reinforcement learning.

UNIT 2
Decision Tree Learning: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity, Overfitting, noisy data, and pruning.

UNIT 3
Rule Learning: Translating decision trees into rules. Artificial Neural Networks: Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training.

UNIT 4
Support Vector Machines: Maximum margin linear separators. Bayesian Learning: theory and Bayes rule. Naive Bayes learning algorithm.. Logisitic regression. k-Nearest-neighbor algorithm.

TEXT BOOKS:

1. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Taylor & Francis (CRC)

2. Machine Learning Methods in the Environmental Sciences, Neural Networks, William W Hsieh, Cambridge University Press.

REFERENCES:-

1. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc., 2001
2. Chris Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995

COURSE III: Optional (To be offered by Prospective Supervisor Concerned)

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

(*Any one from the following*)

GROUP (A): REASONING UNDER UNCERTAINTY

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

The course deals with various sources of uncertainty and imprecision in knowledge representation and reasoning and understand the main approaches to dealing with uncertainty

COURSE OBJECTIVE:

The objective of the course is to learn the meaning of uncertainty and explore some theories designed to deal with it and find out what types of errors can be attributed to uncertainty and induction.

LEARNING OUTCOME:

At the end of this course, the student will have knowledge and understanding of Probabilistic modelling of uncertainty and Probabilistic inference.

DETAILED SYLLABUS:

Unit I: Uncertainty and probability ***Marks: 8***

Acting under Uncertainty, Uncertainty & Rational Decisions, Basic Probability Notations, Propositions & Atomic events, Prior & Conditional Probability, Axioms of Probability, Inference using , Full Joint Distributions, Independence, Bayes' rule and its uses

Unit II: Basic Graph Concepts ***Marks: 7***

Graphs, Spanning Trees, Numerically Encoding Graphs, Edge List, Adjacency Matrix, Clique Matrix

Unit III: Probabilistic Reasoning ***Marks 15***

Representing knowledge in Uncertain Domain, Semantics & inference in Bayesian Networks, Extending Probability to First Order Representations, Representing vagueness: Fuzzy sets & Fuzzy Logic

Unit IV: Probabilistic Reasoning over time ***Marks: 15***

Stationary process & Markov Assumptions, Inference in temporal models: filtering, prediction smoothing & Finding most likely sequence, Hidden Markov Models, Kalman filters, Dynamic Bayesian Networks

Unit V: Multi Entity Bayesian Networks ***Marks: 15***

REFERENCE BOOKS:

1. Stuart Russell & Peter Norvig, "Artificial Intelligence: A Modern Approach", third edition, 2009.
2. David Barber, "Bayesian Reasoning & Machine Learning", 2012.
3. Judea Pearl, "Probabilistic Reasoning in Intelligent systems: Networks of Plausible Inference", 1997, Morgan Kaufmann Publishers In.
4. Kathryn Blackmond Laskey, "MEBN: A language for first-order Bayesian knowledge bases", Artificial Intelligence, Volume 172, Issues 2–3, February 2008, Pages 140–178
5. David Poole & Alan Mackworth, "Artificial Intelligence. Foundations of Computational Agents", Cambridge University Press. 2010

GROUP (B): COMPUTER NETWORK ANALYSIS

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Analysis of Computer Networks presents the mathematical theory and techniques necessary for analyzing and modeling high-performance networks. The course generally includes topics in the areas of network metrics, measurements and analysis. The subject emphasizes on the basics of network analysis, discuss the network design procedure and introduce some of the fundamentals of network control.

COURSE OBJECTIVE:

The objective of the course is to understand and analyze network traffic and protocols and network-troubleshooting concepts.

LEARNING OUTCOME:

At the end of the course the student will be able to design, model and analyze different computer network.

DETAILED SYLLABUS

Unit I: Overview ***Marks: 20***

Types of Computer Networks, Seven Layers in OSI model, Comparison with TCP/IP model, Computer Network Topologies

Unit II: Network Analysis ***Marks: 20***

Degree distribution, Degree correlation, Distance statistics, Clustering coefficients, Network transitivity, Centrality

Unit III: Random Networks ***Marks: 20***

Erdös-Rényi networks, Small-world networks, Scale free networks

REFERENCE BOOKS:

1. Computer Networks, "Andrew.S.Tanenbaum and David J. Wetherall", 2013.
2. Maarten van Steen, "Graph Theory and Complex Networks: An Introduction", 2010.

GROUP (C): COOPERATIVE GAMES AND ITS APPLICATIONS TO NETWORKS

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Cooperative game theory deals with situations where objectives of participants of the game are partially cooperative and partially conflicting. It is in the interest of participants to cooperate in the sense of making binding agreements to achieve the maximum possible benefit. When it comes to distribution of benefit/payoffs, participants have conflicting interests. Such situations are usually modeled as cooperative games.

COURSE OBJECTIVE:

The objective of the course is to obtain various solution concepts of co-operative games and apply the solution concepts in real life situation and also to compare the solutions of cooperative games under different set up.

LEARNING OUTCOME:

The students will be able to learn solution concepts for cooperative games and solve evolutionary games.

DETAILED SYLLABUS:

Unit I: The Core ***Marks: 12***

Core and Dominance; Existence of Core Imputations; balanced collections; lattices and hierarchies; the Weber set; Selectope.

Unit II: The Shapley value ***Marks: 12***

Axiomatizations of the Shapley value; the Potential and the Shapley value; The Banzhaf value.

Unit III: The Myerson value ***Marks: 12***

Characterizations in Communication situations; Characterization in Network Games.

Unit IV: The Position value ***Marks: 12***

Characterizations in Communication situations; Characterization in Network Games.

Unit V: Applications of Cooperative Game Theory in Networks ***Marks: 12***

REFERENCE BOOKS:

1. Hans Peter, "Game Theory - A Multi level Approach", Springer, 2nd Edition, 2015.
2. R.P Gilles, "The Cooperative Game Theory of Networks and Hierarchies", Springer 2010.

GROUP (D): MULTIVARIATE STATISTICAL TECHNIQUES

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Multivariate statistics is a subdivision of statistics encompassing the simultaneous observation and analysis of more than one outcome variable. Multivariate statistics concerns understanding the different aims and background of each of the different forms of multivariate analysis, and how they relate to each other. The practical implementation of multivariate statistics to a particular problem may involve several types of univariate and multivariate analyses in order to understand the relationships between variables and their relevance to the actual problem being studied.

COURSE OBJECTIVES:

This course helps the students to establish groups of similar entities test for and describe differences among groups of entities or predict group membership, extract gradients of variation in dependent variables explainable by independent variables.

LEARNING OUTCOME:

After completing this course students should gain a deeper understanding of the principles of statistical modeling and some of its important applications and the ability to pursue further studies in this and related areas.

DETAILED SYLLABUS:

Introduction to Multivariate Statistical Techniques.

Unit I: Principal Component Analysis (PCA)

Introduction ; Population and Sample Principal Components; Method of extraction of Principal Components; Properties of PC; Graphical Displays, Invariance and Scaling, Functional PCA, Summarizing sample variations by PCs.

Unit II: Canonical Correlation Analysis (CCA)

Introduction; Canonical variate and Canonical correlations; Population & Sample canonical correlation Analysis; Invariance, Interpretation of canonical correlation Analysis.

Unit III: Support Vector Machine

Linear Support Vector Machines, Non-Linear Support Vector Machines

REFERENCE BOOKS:

1. Modern Multivariate Statistical Techniques-A J Izeman, Springer Text in Statistics, 2008
2. Applied Multivariate Statistical Analysis – Richard A. Johnson, Dean W. Wichern, 6th edition, 2007;
3. Linear Statistical Inference and its Applications – Rao CR, John Wiley, 2002.
4. Multivariate Statistical Methods - Donald F. Morrison, McGraw Hill, 2003.
5. Principal Component Analysis- I.T. Jolliffe, 2nd edn, Springer Text in Statistics, 2nd edition, 2002.

GROUP (E): Speech Processing**

Total Marks: 100 (*End-Semester: 60 & In-Semester: 40*)

INTRODUCTION:

Advanced Digital Signal Processing. Speech processing has been one of the main application areas of digital signal processing for several decades now, and as new technologies like voice over IP, automated call centres, voice browsing and biometrics find commercial markets, speech seems set to drive a range of new digital signal processing techniques for some time to come. This course provides not only the technical details of ubiquitous techniques like linear predictive coding, Mel frequency cepstral coefficients and hidden Markov models, but the rationale behind their application to speech and an understanding of speech as a signal.

COURSE OBJECTIVE:

This course aims to:

a. Familiarize you with modeling the vocal tract as a digital, linear time-invariant system.
b. Convey details of a range of commonly used speech feature extraction techniques.
c. Familiarize you with the practical aspects of speech processing, including robustness, and applications of speech processing, including speech enhancement, speaker recognition and speech recognition.
d. Give you practical experience with the implementation of several components of speech processing systems.

LEARNING OUTCOME:

After successful completion of this course, you should be able to:

a. Express the speech signal in terms of its time domain and frequency domain representations and the different ways in which it can be modelled.
b. Derive expressions for simple features used in speech classification applications.
c. Implement components of speech processing systems, including speech recognition and speaker recognition, in PRAAT etc.
d. Deduce the behaviour of previously unseen speech processing systems and hypothesize about their merits

DETAILED SYLLABUS:

UNIT – I

Fundamentals of Digital Speech Processing :

Anatomy & Physiology of Speech Organs, The process of Speech Production, Digital models for speech signals, Basics of Digital Speech Signal Processing.

UNIT – II

Speech Analysis Tools:

Introduction to PRAAT, Wave Surfer, SFS, and Audacity.

UNIT – III

Linear predictive coding (LPC) analysis

Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Parameters.

UNIT – IV

Speaker Recognition

Introduction to Hidden markov model (HMM) for speech recognition, Recognition techniques, Features that distinguish speakers, Speaker Recognition Systems,
Speaker Verification System , Speaker Identification System.

REFERENCE BOOKS :

1. Digital processing of speech signals - L.R Rabiner and S.W.Schafer. Pearson Education.
2. Speech Communications : Human & Machine - Douglas O'Shaughnessy, 2nd ed., IEEE Press.
3. Digital processing of speech signals. L.R Rabinar and R W Schafer,1978, PHI.
4. Discrete Time Speech Signal Processing : principles and Practice - Thomas F. Quateri, PE.

COURSE IV: ASSIGNMENT

(Under Guidance of Prospective Supervisor Concerned)

Total Marks: 100 (*80% Assignment Writing & 20% Viva on Assignment*)