Department of Computer Science & Engineering

University of Kalyani

Syllabus for Ph.D. Coursework

Paper – 1: A) Literature Review: (Marks - 25)

Left to the department

B) Research Methodology: (Marks - 25)

Left to the department

Paper – 2: Computer Applications: (Marks - 50)

Left to the department

Paper – 3: Subject upgradation: (Marks – 100 [Written test – 80 + Internal assessment – 20])

Papers available: (One paper is to be chosen as directed by supervisor)

- Pattern Recognition, Image Processing and Data Mining
- Remote Sensing and GIS
- Network Security, Steganography, Coding Theory and Data Compression
- Advanced Algorithms and Multidimensional Search Techniques
- Soft Computing
- Biological Data Mining
- Network Biology
- Optical and Sensor Networks
- Semantic Web and Link Data
- Wireless and Mobile Systems
- Cloud Computing

Detailed Syllabus for Paper – 3

Pattern Recognition, Image Processing and Data Mining

Pattern Recognition: Basic Concept of Pattern Recognition, Fundamental Problems in Pattern Recognition Systems, Design Concepts and Methodologies, Linear Decision Functions, Pattern Classification by Distance Functions, Pattern Classification by Likelihood Functions, Trainable Pattern Classifiers - The Deterministic Approach.
Image Processing: Digital Image Fundamentals, Image enhancement in the Spatial and Frequency Domain, Image Segmentation, Morphological Image Processing.
Data Mining and Soft Computing: Introduction to Data Mining and soft computing, What is Soft Computing? Role of Fuzzy sets, Neural networks, Rough Sets, Genetic Algorithm, Wavelets and their Hybridization in Data Mining, Classification and clustering in Data Mining, Multimedia Data Mining

Remote Sensing and GIS

Introduction – Perspectives and concept of remote sensing, special applications. Geophysical Remote Sensing – external fields, magnetic, geophysical remote sensing: Gravity, crust dynamics seismology. Electromagnetic spectrum; The photon, Distribution of Radiant energies, Sensor technology, Spectral signatures- Interpretation and classification. Signatures and Sensors, Image Processing & Interpretation, Fundamentals of image processing, image representation, Spatial domain and transformation domain image processing, Enhancement techniques using soft computing tools in spatial as well as spectral domain, optimization based image processing. Features and classification techniques, GIS Applications, latest trends of GIS applications.

Network Security, Steganography, Coding Theory and Data Compression

Security & Steganograpgy: Modern tools and techniques of security, soft computing based security, Fundamentals of steganography, Spatial and transform domain steganograpgy, Hash based steganography, Handles and adjustments, Genetic Algorithm based steganography, Audio & Video steganography, latest trends on steganography.
Digital Communication, Codes preliminaries: Block codes, Single Parity Check codes, Product code, Repetition codes, Hamming Codes, Minimum Distance Block codes, problems. Linear code: Linear Code definition, generator matrices, parity check matrices, error syndromes, error detection and correction, shortened and extended linear codes, related problems.
Cyclic codes: Concept of Cyclic codes, polynomials, generator polynomials, parity check polynomials, dual cyclic codes, generator and parity check matrices of cyclic codes, related problems.
Galois fields: Galois field elements of GF(23), GF(24), GF(25), primitive field elements, irreducible polynomials, minimal polynomial, related problems. Coding theory application, Application of coding theory in different fields.
Transformations: Basics of transformations and its utility, Fourier transformation, Discrete Fourier Transformations, Discrete Cosine Transformation, Wavelet Transformation and its varieties, Z transforms, Binomial Transformation, Group Transformations.

Advanced Algorithms and Multidimensional Search Techniques

Fundamentals: Review of asymptotic notations, review of basic data structures, and review of basic algorithms.
Sorting and Searching: Review of classical sorting and searching techniques and their analysis.
Advanced Data Structures: K-d tress, Range tress and fractional cascading, Interval Tress, Priority Search Tress, Segment Trees, Skip lists, Amortized analysis, Fibonacci Heaps, Perfect Hashing.
Divide and Conquer: Introduction, Binary Search and Merge sort, Quick Sort and their analysis, Matrix multiplication, Finding the closest pair of points.
Greedy Approach: Introduction, Shortest Path Problem, Minimum Spanning Tree problem: Prim's and Kruskal's Algorithms, Fractional Knapsack problem.
Dynamic Programming: Introduction, Longest Common Subsequence problem, Matrix chain multiplication, Knapsack problem.
Randomized Algorithms: Introduction, Las Vegas and Monte Carlo Algorithms, Contention resolution in distributed system, finding the global min-cut, Testing String Equality, Randomized Divide-and-Conquer: Median finding and Quick sort, Randomized approach for finding the closest pair of points.
Approximation Algorithm: Introduction, Polynomial Approximation Schemes: Knapsack problem, Fully Polynomial Approximation Schemes: The subset-sum problem, Center selection problem.
Techniques in Computational Geometry: Introduction, Geometric Preliminaries, the Convex Hull Problem, Computing the Diameter of a Set of Points, Line segment intersection, Polygon Triangulation: Guarding an Art gallery, Nearest-Point Voronoi Diagram, Delaunay triangulation, Line-point duality.

Soft Computing

Fuzzy Logic and Approximate Reasoning: Conventional and fuzzy sets: Basic concepts of fuzzy logic. Fuzzy expressions: Basic principles of fuzzy logic and fuzzy inference rules, fuzzy relations, fuzzy operators, realization of fuzzy systems using fuzzy relations. Application of fuzzy logic in vision, pattern recognition, robotics and linguistics. Approximate reasoning in Experts Systems, Fuzzy sets in approximate reasoning, Fuzzy propositions in approximate reasoning. Basic principles of approximate reasoning and rules of inference.
Genetic Algorithms (GAs): Introduction to GAs, Binary encodings of candidate solutions, Schema Theorem and Building Block Hypothesis, Genetic operators – crossover and mutation, parameters for GAs, Reproduction mechanism for producing Offspring, Darwinian Principle in evaluating objective function. Convergence Analysis: Simple GA schemes, Stochastic models: GA approaches to optimization problems. Multiobjective GAs. Basic Concepts and Principles of Neural Networks (NNs) and Learning Systems. Learning with GAs and Artificial NNs (ANNs); Composite use of Fuzzy Logic, ANNs and GAs. Perceptron Training, Back propagation learning, Applications in pattern classification and image understanding.

Biological Data Mining

Introduction to data mining; Introduction to molecular biology; biological data – genomic, proteomic, transcriptomic data, biological networks;
Association rule discovery – apriori algorithm, FP-growth algorithm, GA based rule mining, Applications in biological data (gene expression analysis, protein interaction prediction);
Clustering – K-means, FCM, hierarchical clustering, density-based clustering, GA- based clustering, Applications in biological data (grouping co-expressed genes/miRNAs, clustering biological network data);
Biclustering – Limitation of clustering, need of biclustering, Cheng & Church biclustering, GA-based biclustering, Applications in biological data (grouping co-expressed genes/miRNAs, protein-protein interaction analysis and prediction);
Classification – K-nn, decision tree, Naive Bayes, support vector machine, Applications in biological data (supervised classification of genes/miRNAs, protein interaction prediction, miRNA target prediction);
Feature selection – Unsupervised vs. Supervised, filter vs. Wrapper, GA-based feature selection, Applications in biological data (Identifying marker genes/miRNAs, selecting best feature set for optimized classification/clustering).

Network Biology

Introduction to cell biology and networks;
Network properties and topologies;
Random network, scale-free network and small-world network models;
Network modules;
Functional subnetwork inference;
Differential network biology;
Regulatory networks;
Network integration;
Systems biology;
Network dynamics;
Disease analysis with networks.

Optical and Sensor Networks

Computer Networks, Communication Systems, Optical Networks, Optical Fiber Principles and Operation, Wavelength Division Multiplexing (WDM) Network Architecture, Routing and Wavelength Assignment (RWA) Problems, Classification and Different Existing Heuristics, Multi-fiber WDM Networks and Different Existing Algorithms, Provisioning, Traffic Grooming, Protection and Reliability of Optical Networks.
Sensor Network and its Challenges, Different Data Gathering Techniques, Security of Sensor Networks.

Semantic Web and Linked data

Introduction: History of Web, World Wide Web, Internet, Working Mechanism of Web, Importance of Document on the Web, URL, IRI, Namespace, Domain.
Semantic Web: What is Semantic? What is Semantic Web? Semantic Web Road Map, Comparison between Semantic Web and Traditional Web, Semantic Web Layer Cake and Their Significance, Vision of Semantic Web, Short Introduction to Ontology.
Preliminary Knowledge on XML, RDF, RDFa, Microdata.
RDF (Resource Description Framework) & RDF Schema: Introduction to RDF, Different Features and Components of RDF, Detail Study of RDF Class, Property, Instances, Restriction, Domain and Range of Properties and their Use with Examples, Different Notations of RDF: RDF/XML, N3, NTRIPLES, Turtle.
Ontology: What is Ontology? Different Types of Ontology (Upper Ontology, Domain Ontology etc.), Reusability of Ontology, Heterogeneity Problem among Ontologies, Discussion about the Problem and its Solution, Different Building Blocks of an Ontology (Domain Ontology).
Linked Data Web and Semantic Web: Introduction to Linked Data, Relation between Linked Data and Semantic Web, Linked Data Principles and Design Consideration, Publishing Linked Data, Consuming Linked Data, Discussion on Traditional Web of Documents and Web of Data.
Introduction to Current Research and Development Work going on Semantic Web: Introduction to Different Stages to Develop a Complete Semantic Web Application and Linked Data, Introduction to Different Available Tools.

Wireless and Mobile Systems

Probability, Statistics and Traffic Theories, Mobile Radio Propagation, Channel Coding
The Cellular Concept, Multiple Radio Access, Multiple Division Techniques, Channel Allocation
Mobile Communication Systems
Existing Wireless Systems
Satellite Systems, Network Protocols
Ad Hoc Sensor Networks
Wireless LANs and PANs
Recent Advances of wireless and mobile networks

Cloud Computing

Parallel and Distribution Systems
Cloud Infrastructure
Cloud Computing: Applications and Paradigms
Cloud Resource Virtualization
Cloud Resource Management and Scheduling
Networking Support
Storage Systems
Cloud Security
Complex Systems and Self Organization
Cloud Application Development