Proposed Syllabus for Ph.D. Coursework in Computer Science
to be offered by
Department of Computer & System Sciences
Siksha Bhavana, Visva-Bharati
Santiniketan

With Effect from 2014

PCS 1: Research Methodology and Techniques **[4 Credits]**

PCS 2: Review work in relevant field **[4 Credits]**

PCS 3: Special paper **[4 Credits]**

- **PCS 3.1: Approximation Algorithms**
- **PCS 3.2: Computational Molecular Biology**
- **PCS 3.3: Data Mining**
- **PCS 3.4: Digital Image processing --Techniques and Algorithms**
- **PCS 3.5: Mobile Broadband Network**
- **PCS 3.6: MANET and VANET**
- **PCS 3.7: Scientific Computation**
- **PCS 3.8: SoftComputing**
- **PCS 3.9: Quantum Intelligence**
- **PCS 3.10: Quantum Computing**
- **PCS 3.11: Natural Language processing**
- **PCS 3.12: Document Analysis**
- **PCS 3.13: Cryptography & Network Security**

PCS 1: Research Methodology and Techniques **[4 Credits]**

(i) **Module A:** [1 Credits]
Basics of Word Processing- Microsoft Word, PowerPoint, Latex.

(ii) **Module B:** [1 Credits]
Communication and Comprehension, Literature Survey Methodology.

(iii) **Module C:** [2 Credits]
Frontiers of Computer Science, State-of-art, Overview.

PCS 2: Review work in relevant field **[4 Credits]**

This will consist of the following components:

(i) Dissertation report [2 Credits]
(ii) Presentation [1 Credits]
(iii) Viva-Voce [1 Credits]

PCS 3: Special Topic **[4 Credits]**
(Offered by the department from the following list of subjects)
The aspiring registrant will have to undergo and successfully complete one of the subjects from the following list of subjects.

PCS-3.1 Approximation Algorithms

Review of NP-Completeness theory. Introduction and overview. Basic methodologies and applications: Restriction methods, Greedy methods, Recursive Greedy methods, LP rounding and extension techniques. Methods for designing approximation schemes. Randomized approximation techniques. Approximation preserving reductions. Hardness of approximation: APX-hard or APX-complete classes, reduction, gaps and hardness factors, PCP theorem.

PCS- 3.2 Bioinformatics

A. **Theory**: Introduction to molecular genetics; Sequence alignment and searching- Sequence database searches, pairwise alignment, multiple sequence alignment, dynamic programming, sequence similarity searches, Markov chain, HMM. Phylogeny construction- maximum parsimony, maximum likelihood and distance methods. Overview of protein structures and terminology – RNA secondary structure prediction. Protein motif analysis, clustering of orthologous groups, protein classification and structure prediction, distance matrix analysis.

Microarrays – Overview of technology, gene ontology, gene prediction, gnome analysis, Clustering and Classification – concepts and techniques – hierarchical, K-means, nearest neighbors, application.
[2.5 Credits]

B. **Laboratory**: Studies on genomic and proteomic data source, characteristics and implementation of some techniques. [1.5 Credits]

PCS-3.3 Data Mining

A. **Theory**: Basic concept – techniques and application. Association Rule Discovery concept, frequent itemset, association rule, Basic algorithms – Apriori, Partition, Frequent Pattern(FP)-Tree, Diffsets-based mining, Closed pattern mining, Binary Search Prefix Tree(BSPT), Transaction Pattern Tree(TP-Tree). Classification and clustering – concepts, some techniques of clustering – k-means, k-medoids, Neural Network. Outlier detection – concepts and application. Web and Temporal data mining.
[2.5 Credits]

B. **Laboratory**: Implementation of some of the algorithms mentioned in A.
[1.5 Credits]

PCS – 3.4 Digital Image Processing: Techniques and Algorithm

Introduction to Digital Image, Its Application area, Binarization of a Digital Image, Image thresholding, Image Enhancement, Edge detection, Negative of an Image, Image Segmentation technique: clustering, K-means and fuzzy C-means algorithm, Oustu's Binarization algorithm and their implementation.

Color Image: Various Image Spaces, nor restricted to RGB, HIS, Extension gray level image segmentation to Color images: histogram thresholding, clustering, region growing, edge detection, fuzzy approach and Neural Network, Problem with color images. Extraction of objects from color images.

PCS -3.5 Interactive Multimedia Subsystem over Cellular Networks

A. **Theory**: GSM, GPRS, UMTS and LTE systems – Network Architecture, Interfaces and Reference Points, Description of Radio Subsystems, RRM, MM, SM, Data Transfer procedures, QoS types, IP Internetworking Model, security architecture; overview of SIM/USIM and application toolkit and interfacing issues; AT commands, Overview of Mobile Internet Protocol – MIPV4 and IPv6, Concepts, entities, Ip over GPRS, UMTS and LTE –GTP Tunnel, The lu-PS Interface and Mobility Management, QoS Management, Packet routing and transport of user data. Overview of WAP; Interactive Multimedia Subsystem (IMS) architecture: Network architecture, Protocols – ISIM applications on UICC.
[2.5 Credits]

B. **Laboratory**: Analysis of application framework and data transfer through network simulator.

[1.5 Credits]

PCS – 3.6 MANET and VANET

Introduction: Characteristics of MANETs. Importance of QoS and Energy Efficiency in MANETs: Fundamentals: The Layered Communication Network. Cross-layer Design, Mobility; Medium Access Control: MAC Protocols, Random Access MAC Protocols: Routing: Unicast Routing, Multicast Routing, Broadcasting Routing, Hierarchically organized Networks; Energy Efficiency and QOS: Energy Efficiency, Quality of Service; Sh-Trace Protocol Architecture: Introduction, Protocol Architecture, Simulations and Analysis; MH-Trace Protocol Architecture: Introduction, Protocol Architecture, Simulations and Analysis; Effects of Channel Errors: Introduction, Related Work, Analytical Model, Simulations and Analysis, Summary; Real-Time Data Broadcasting: Introduction, Broadcast Architectures, Simulations Environment, Low Traffic Regime, High Traffic Regime; Conclusions And Future Research Directions: Conclusions, Future Research Directions. Overview of evolution of Modern Mobile Wireless Communication System, Network architecture; Air Interface description, Mobility Management, Call Control, Supplementary services.

PCS – 3.7 Scientific Computation

Basics of Numerical differentiation and integrations. Underlying theory of Gauss Quadrature Methods Numerical implementation in C or FORTRAN. Approximation methods for Numerical integration. Montecarlo Methods, its application to physical problems. Metropolis algorithm and its algorithm. Method of simulated annealing. Matrix methods diagonalisation and eigen values and eigen vectors. Data Modeling Techniques for two tone and color images.

PCS – 3.8 Soft Computing

A. **Theory**: Introduction to soft computing tools; handling uncertainties by soft computing techniques; Fuzzy set- generalization of crisp set; Fuzzy logic; Fuzzy Mathematics-its application in engineering problems.
Genetic Algorithms- its use in handling optimization problems; Dynamics of Genetic Algorithms; Complexity issues of Genetic Algorithms; Evolutionary Algorithms- generalization of Genetic Algorithm; Drawbacks of Genetic Algorithm; Elements of Genetic programming.
Introduction to Artificial Neural Network- inspiration from Biological neural system; Perceptrons; feed forward and feedback systems in network models;different kinds of learning; recurrent networks; different neural network models- Hoffield, Cohonen, MEMSONN, BDSONN, etc.; use of neural network in Engineering Applications. [2.5 Credits]

B. Laboratory: Assignment on relevant issues. [1.5 Credits]

PCS-3.9 Quantum Intelligence

Introduction: History of Quantum Computing, double-slit experiment; Qubits, axioms of quantum mechanics: Superposition principle, Geometrical interpretation, Measurement in an arbitrary basis, Uncertainty principle; Two-qubit system: Two-qubit, Entanglemen, EPR paradox; Bell's thermo: Properties of Bell states, Bell's experiment; Evolution of quantum system: Evolution of a qubit, Two-qubit gates, Unitary transform, Single qubit gates, No cloning theorem, quantum teleportation; Observales, Schrodinger's equation; Continuous quantum system, free particle in 1D, Uncertainty principle; Particle in a box, simple qubits; Quantum circuits: n qubit system, universial family of gates, Reversible computation; Fourier sampling, Simon's algorithm ; Quantum Fourier Transform, period finding; Shor's factoring algorithm; Grover's algorithm; unstructured quantum search; Quantum Neurodynamics, Quantum Neural Network; Quantum Inspired Intelligent Algorithms; Limits of quantum computation, Quantum Inspired Genetic Algorithm, Fuzz-Quantum Computation.

References:

- Giuliano Benenti , Giulio Casati, giuliano Strini, principle of Quantum Computation and Information-Vol.1:Basic concepts.
- David McMahon, Quantum Computing Explained, John Wiley & Sons.
- Hoi-Kwong Lo, Tim Spiller, Introduction to Quantum Computation and Information, World Scientific Publishing Co. Ltd.
- Leandro dos Santos Coelho, Quantum Inspired Intelligent Systems, Springer.
- Ster, Quantum Theoretic Machines: What is through from the point of view of Physics, Elsevier.
- Vladimir G. Ivancevic, Tijana T. Ivancevic, Quantum Neural Computation, Springer.
- Simon O. Haykin, Neural Networks and Learning Machines (3rd Edition), Pearson, Prentice Hall.
- Sturat Russell, Artificial Intelligence: A Modern Approach (3rd Edition), Prentice Hall.
- Lance D. Chambers, The Practical Handbook of Genetic Algorithms: New Frontiers.
- David E Goldberg, Genetic Algorithm, Pearson Education India.