Detailed syllabus of semester– III

Course Code	Course Title	Credits
TPGCS301	**Ubiquitous Computing**	**04**

Learning Outcome:

1. Explain the general principles of Ubiquitous Computing and the key technical and social factors driving the change towards post-desktop paradigms
2. Explain the main implications of Ubiquitous Computing for system design, development and deployment.
3. Explain reference approaches used in Ubiquitous Computing and evaluate their applicability in specific application scenarios

Unit I: Basics of **Ubiquitous Computing**

Examples of Ubiquitous Computing Applications, Holistic Framework for UbiCom: Smart DEI, Modeling the Key Ubiquitous Computing Properties, Ubiquitous System Environment Interaction, Architectural Design for UbiCom Systems: Smart DEI Model, Smart Devices and Services, Service Architecture Models, Service Provision Life Cycle.

Unit II: Smart Mobiles, Cards and Device Networks

Smart Mobile Devices, Users, Resources and Code, Operating Systems for Mobile Computers and Communicator Devices, Smart Card Devices, Device Networks. Human–Computer Interaction (HCI): Explicit HCI, Implicit HCI, User Interfaces and Interaction for Devices, Hidden UI Via Basic Smart Devices, Hidden UI Via Wearable and Implanted Devices, Human Centered Design (HCD).

Unit III: Smart Environments

Tagging, Sensing and Controlling, Tagging the Physical World, Sensors and Sensor Networks, Micro Actuation and Sensing: MEMS, Embedded Systems and Real Time Systems, Control Systems.

Unit IV: Ubiquitous Communication

Audio Networks, Data Networks, Wireless Data Networks, Universal and Transparent Audio, Video and Alphanumeric Data Network Access, Ubiquitous Networks, Network Design Issues.

Text book:

- Ubiquitous Computing Smart Devices, Environments and Interactions, Stefan Poslad, Wiley, 2009.

References:

- Ubiquitous Computing Fundamentals. John Krumm, Chapman & Hall/CRC 2009.
- Ambient intelligence, wireless networking and ubiquitous computing, Vasilakos, A., & Pedrycz, W. ArtechHouse, Boston, 2006.
- http://www.eecs.qmul.ac.uk/~stefan/ubicom.

Course Code	Course Title	Credits
TPGCS302	**Blockchain & Cryptocurrency**	**04**

Learning outcome: Blockchain and Cryptocurrency is vastly discussed now days in all research domains to bring the decentralization. This course is to understand Blockchain and its main application cryptocurrency. Students will learn how this system works and how can they utilize and what application can be build. After successful completion of this course, students will be familiar with blockchain and cryptocurrency concepts. Also they can build their own application using the learned concepts.

Unit I: Introduction

Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete.

Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.

Unit II: Introduction to Blockchain

Blockchain: Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.

Unit III: Distributed Consensus

Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.

Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin

Unit IV: Cryptocurrency Regulation

Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy.

Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain

Text Books:

- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
- Wattenhofer, The Science of the Blockchain, Inverted Forest Publishing, 2016
- A. Antonopoulos, Mastering Bitcoin: Programming the Open Blockchain, O'Reilly, Second Edition, 2017.
- Paul Vigna & Michael J. Casey, The age of cryptocurrency, Picador, 2016

References:

- Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System

Course Code	Course Title	Credits
TPGCS**3031**	**Elective I- Track A: Cloud Computing -II** **(Cloud Computing Technologies)**	**04**

Learning outcome:

1. The fundamental ideas behind Cloud Computing & the evolution of the paradigm, its applicability; benefits, as well as current and future challenges;
2. The basic ideas and principles in data center design; cloud management techniques and cloud software deployment considerations;
3. Different CPU, memory and I/O virtualization techniques
4. cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage;

Unit I: Parallel and Distributed Computing

Elements of parallel computing, elements of distributed computing, Technologies for distributed computing: RPC, Distributed object frameworks, Service oriented computing Virtualization – Characteristics, taxonomy, virtualization and cloud computing.

Unit II: Computing Platforms

Cloud Computing definition and characteristics, Enterprise Computing, The internet as a platform, Cloud computing services: SaaS, PaaS, IaaS, Enterprise architecture, Types of clouds.

Unit III: Cloud Technologies

Cloud computing platforms, Web services, AJAX, mashups, multi-tenant software, Concurrent computing: Thread programming, High-throughput computing: Task programming, Data intensive computing: Map-Reduce programming.

Unit IV: Software Architecture

Dev 2.0 platforms, Enterprise software: ERP, SCM, CRM

Custom enterprise applications and Dev 2.0, Cloud applications.

Text book:

- Enterprise Cloud Computing Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010
- Mastering In Cloud Computing, Rajkumar Buyya, Christian Vecchiola And Thamari Selvi S, Tata Mcgraw-Hill Education, 2013
- Cloud Computing: A Practical Approach, Anthony T Velte, Tata Mcgraw Hill, 2009

References:

- Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), Michael J. Kavis, Wiley CIO, 2014
- Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More, Kris Jamsa, Jones & Bartlett Learning, 2013

Course Code	Course Title	Credits
TPGCS**3032**	**Elective I- Track B: Cyber and Information Security- II** **(Cyber Forensics)**	**04**

Learning Outcome:

Analyze and resolve **security** issues in networks and computer systems to secure an **IT** infrastructure. Design, develop, test and evaluate secure software. Develop policies and procedures to manage enterprise **security** risks.

Unit I: Computer Forensic Fundamentals: Introduction to Computer Forensics and objective, the Computer Forensics Specialist, Use of Computer Forensic in Law Enforcement, Users of Computer Forensic Evidence, Case Studies, Information Security Investigations. Types of Computer Forensics Technology: Types of Military Computer Forensic Technology, Types of Law Enforcement Computer Forensic Technology, Types of Business Computer Forensic Technology, Specialized Forensics Techniques, Hidden Data, Spyware and Adware, Encryption Methods and Vulnerabilities, Protecting Data from Being Compromised, Internet Tracing Methods, Security and Wireless Technologies. Types of Computer Forensics Systems: Study different Security System: Internet, Intrusion Detection, Firewall, Storage Area, Network Disaster Recovery, Public Key Infrastructure, Wireless Network, Satellite Encryption, Instant Messaging (IM), Net Privacy, Identity Management, Biometric, Identity Theft.

Unit II: Data Recovery: Data Recovery and Backup, Role of Data Recovery, Hiding and Recovering Hidden Data. Evidence Collection: Need to Collect the Evidence, Types of Evidences, The Rules of Evidence, Collection Steps. Computer Image Verification and Authentication: Special Needs of Evidence Authentication. Identification of Data: Timekeeping, Forensic Identification and Analysis of Technical Surveillance Devices, Reconstructing Past Events: How to Become a Digital Detective, Useable File Formats, Unusable File Formats, Converting Files.

Unit III: Network Forensics: Sources of Network Based Evidence, Principles of Internetworking, Internet Protocol Suite. Evidence Acquisition: Physical Interception, Traffic Acquisition Software, Active Acquisition. Traffic Analysis: Protocol Analysis, Packet Analysis, Flow Analysis, Higher-Layer Traffic analysis. Statistical Flow Analysis: Sensors, Flow Record Export Protocols, Collection and Aggregation, Analysis. Wireless: the IEEE Layer 2 Protocol Series, Wireless Access Point, Wireless Traffic Capture and Analysis, Common Attacks, Locating Wireless Devices. Network Intrusion Detection and Analysis: NIDS/NIPS Functionality, Modes of Detection, Types of NIDS/NIPS, NIDS/NIPS Evidence Acquisition.

Unit IV: Network Devices and Mobile Phone Forensics: Sources of Logs, Network Architecture, Collecting and Analyzing Evidence, switches, routers, firewalls, interfaces Web Proxies: Need to Investigate Web Proxies, Functionality, Evidence, Squid, Web Proxy Analysis, Encrypted Web Traffic. Mobile Phone Forensics: Crime and Mobile Phones, Voice, SMS and Identification of Data Interception in GSM, Mobile Phone Tricks, SMS Security, Mobile Forensic.

Text book:

- Computer Forensics Computer Crime Scene Investigation, John R. Vacca, Second Edition, 2005.
- Network Forensics, Sherri Davidoff, Jonathan HAM, Prentice Hall, 2012.
- Mobile Phone Security and Forensic: A Practical Approach, Second Edition, Iosif I. Androulidkis, Springer, 2012.

References:

- Digital forensics: Digital evidence in criminal investigation", Angus M.Marshall, John – Wiley and Sons, 2008.
- Computer Forensics with FTK, Fernando Carbone, PACKT Publishing, 2014.
- Practical Mobile Forensics, Satish Bommisetty, Rohit Tamma, Heather Mahalik, PACKT Publishing, 2014.

Course Code	Course Title	Credits
TPGCS**3033**	**Elective I- Track C: Business Intelligence and Big Data Analytics –II (Mining Massive Data sets)**	**04**

Learning outcome:

1. Enable to recognise, understand and apply the language, theory and models of the field of **business analytics**.
2. Foster an ability to critically analyse, synthesise and solve complex unstructured **business** problems.

Unit I: Introduction To Big Data

Big data: Introduction to Big data Platform, Traits of big data, Challenges of conventional systems, Web data, Analytic processes and tools, Analysis vs Reporting, Modern data analytic tools, Statistical concepts: Sampling distributions, Re-sampling, Statistical Inference, Prediction error. Data Analysis: Regression modeling, Analysis of time Series: Linear systems analysis, Nonlinear dynamics, Rule induction, Neural networks: Learning and Generalization, Competitive Learning, Principal Component Analysis and Neural Networks, Fuzzy Logic: Extracting Fuzzy Models from Data, Fuzzy Decision Trees, Stochastic Search Methods.

Unit II: MAP REDUCE

Introduction to Map Reduce: The map tasks, Grouping by key, The reduce tasks, Combiners, Details of MapReduce Execution, Coping with node failures. Algorithms Using MapReduce: Matrix-Vector Multiplication, Computing Selections and Projections, Union, Intersection, and Difference, Natural Join. Extensions to MapReduce: Workflow Systems, Recursive extensions to MapReduce, Common map reduce algorithms.

Unit III: SHINGLING OF DOCUMENTS

Finding Similar Items, Applications of Near-Neighbor Search, Jaccard similarity of sets, Similarity of documents, Collaborative filtering as a similar-sets problem, Documents, k-Shingles, Choosing the Shingle Size, Hashing Shingles, Shingles built from Words. Similarity-Preserving Summaries of Sets, Locality-Sensitive hashing for documents. The Theory of Locality-Sensitive functions. Methods for high degrees of similarity.

Unit IV: MINING DATA STREAMS

Introduction to streams concepts – Stream data model and architecture, Stream computing, Sampling data in a stream, Filtering streams, Counting distinct elements in a stream, Estimating moments, Counting oneness in a Window, Decaying window, Real time analytics Platform(RTAP).

Text book:

- Mining of Massive Datasets, Anand Rajaraman and Jeffrey David Ullman, Cambridge University Press, 2012.
- Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Michael Minelli, Wiley, 2013

References:

- Big Data for Dummies, J. Hurwitz, et al., Wiley, 2013
- Understanding Big Data Analytics for Enterprise Class Hadoop and Streaming Data, Paul C. Zikopoulos, Chris Eaton, Dirk deRoos, Thomas Deutsch, George Lapis, McGraw-Hill, 2012.
- Big data: The next frontier for innovation, competition, and productivity, James Manyika ,Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, Angela Hung Byers, McKinsey Global Institute May 2011.
- Big Data Glossary, Pete Warden, O'Reilly, 2011.
- Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph, David Loshin, Morgan Kaufmann Publishers, 2013

Course Code	Course Title	Credits
TPGCS**3034**	**Elective I- Track D: Machine Intelligence - II (Advanced Machine Learning Techniques)**	**04**

Learning outcome:

Have a good understanding of the fundamental issues and challenges of **machine learning**: data, model selection, model complexity.

Have an understanding of the strengths and weaknesses of many popular **machine learning** approaches.

Unit I: Probability

A brief review of probability theory, Some common discrete distributions, Some common continuous distributions, Joint probability distributions, Transformations of random variables, Monte Carlo approximation, Information theory. Directed graphical models (Bayes nets): Introduction, Examples, Inference, Learning, Conditional independence properties of DGMs. Mixture models and EM algorithm: Latent variable models, Mixture models, Parameter estimation for mixture models, The EM algorithm.

Unit II: Kernels

Introduction, kernel function, Using Kernel inside GLMs, kernel trick, Support vector machines, Comparison of discriminative kernel methods.

Markov and hidden Markov models: Markov models, Hidden Markov Models (HMM), Inference in HMMs, Learning for HMMs. Undirected graphical models (Markov random fields): Conditional independence properties of UGMs, Parameterization of MRFs, Examples of MRFs, Learning, Conditional random fields (CRFs), applications of CRFs.

Unit III: Monte Carlo inference

Introduction, Sampling from standard distributions, Rejection sampling, Importance sampling, Particle filtering, Applications: visual object tracking, time series forecasting, Rao-Blackwellised Particle Filtering (RBPF). Markov chain Monte Carlo (MCMC) inference: Gibbs sampling, Metropolis Hastings algorithm, Speed and accuracy of MCMC.

Unit IV: Graphical model structure learning

Structure learning for knowledge discovery, Learning tree structures, Learning DAG structure with latent variables, Learning causal DAGs, Learning undirected Gaussian graphical models, Learning undirected discrete graphical models. Deep learning: Deep generative models, Deep neural networks, Applications of deep networks.

Text book:

- Machine Learning: A Probabilistic Perspective: Kevin P Murphy, The MIT Press Cambridge (2012).

References:

- Introducing Monte Carlo Methods with R, Christian P. Robert, George Casella, Springer, 2010
- Introduction to Machine Learning (Third Edition): Ethem Alpaydın, The MIT Press (2015).
- Pattern Recognition and Machine Learning: Christopher M. Bishop, Springer (2006)

- Bayesian Reasoning and Machine Learning: David Barber, Cambridge University Press (2012).
- Statistical And Machine Learning Approaches For Network Analysis, Edited By Matthias Dehmer, Subhash C. Basak: John Wiley & Sons, Inc (2012)
- Practical Graph Mining with R: Edited by Nagiza-F-Samatova et al, CRC Press (2014)
- https://class.coursera.org/pgm/lecture/preview

List of practical Experiments for Semester –III

Course Code	Course Title	Credits
TPGCS**P301**	**Ubiquitous Computing**	**02**

No	List of Practical Experiments
1	Design and develop location based messaging app
2	Design and develop chat messaging app which is a location-based
3	Design and develop app demonstrating Simple Downstream Messaging
4	Design and develop app demonstrating Send Upstream Messages
5	Design and develop app for Device Group Messaging
6	Implementing GCM Network Manager
7	Demonstrate use of OpenGTS (Open Source GPS Tracking System)
8	Context-Aware system Context-awareness is a key concept in ubiquitous computing. The Java Context-Awareness Framework (JCAF) is a Java-based context-awareness infrastructure and programming API for creating context-aware applications
9	Develop application demonstrating Human Computer Interaction
10	Write a Java Card applet

Course Code	Course Title	Credits
TPGCS**P302**	**Blockchain & Cryptocurrency**	**02**

List of Practical experiments

1. Implement Naive Blockchain construction
2. Memory Hard algorithm - Hashcash implementation,
3. Implement Direct Acyclic Graph,
4. Implement - Play with Go-ethereum,
5. Explore - Smart Contract Construction,
6. Implement Toy application using Blockchain,
7. Solve Mining puzzles
8. Implement Public Key Cryptosystems
9. Implement Helium Wallet Construction
10. Demonstrate Cryptocurrency Transaction Processing

Course Code	Course Title	Credits
TPGCS **P3031**	**Practical Course on Elective I-Track A:Cloud Computing-II (Cloud Computing Technologies)**	**02**

Sr No	List of Practical Experiments
1	Execute & check the performance of existing algorithms using CloudSim.
2	Install a Cloud Analyst and Integrate with Eclipse/Netbeans. Monitor the performance of an Existing Algorithms.
3	Build an application on private cloud.
4	Demonstrate any Cloud Monitoring tool.
5	Evaluate a Private IAAS Cloud .
6	Implement FOSS-Cloud Functionality - VDI (Virtual Desktop Infrastructure)
7	Implement FOSS-Cloud Functionality VSI (Virtual Server Infrastructure) Infrastructure as a Service (IaaS)
8	Implement FOSS-Cloud Functionality - VSI Platform as a Service (PaaS)
9	Implement FOSS-Cloud Functionality - VSI Software as a Service (SaaS)
10	Explore FOSS-Cloud Functionality- Storage Cloud
11	Explore GCP / AWS / Azure

Course Code	Course Title	Credits
TPGCS **P3032**	**Practical Course on Elective I-Track B: Cyber and Information Security- II (Cyber Forensics)**	**02**

Sr No	List of Practical Experiments
1	Write a program to take backup of mysql database
2	Write a program to restore mysql database
3	Use DriveImage XML to image a hard drive
4	Write a program to create a log file
5	Write a program to find a file in a directory
6	Write a program to find a word in a file
7	Create forensic images of digital devices from volatile data such as memory using Imager for: (i) Computer System; (ii) Server; (iii) Mobile Device
8	Access and extract relevant information from Windows Registry for investigation process using Registry View, perform data analysis and bookmark the findings with respect to: (i) Computer System; (ii) Computer Network; (iii) Mobile Device; (iv) Wireless Network
9	Generate a report based on the analysis done using Registry View for different case scenario of the following: (i) Computer System; (ii) Computer Network; (iii) Mobile Device; (iv) Wireless Network
10	Create a new investigation case using Forensic Tool: (i) Computer System; (ii) Computer Network; (iii) Mobile Device ;(iv) Wireless Network.

Course Code	Course Title	Credits
TPGCS **P3033**	**Practical Course on Elective II-Track C: Business Intelligence and Big Data Analytics - II (Mining Massive Data sets -I)**	**02**

No	List of Practical Experiments
1	Generate regression model and interpret the result for a given data set.
2	Generate forecasting model and interpret the result for a given data set.
3	Write a map-reduce program to count the number of occurrences of each alphabetic character in the given dataset. The count for each letter should be case-insensitive (i.e., include both upper-case and lower-case versions of the letter; Ignore non-alphabetic characters).
4	Write a map-reduce program to count the number of occurrences of each word in the given dataset. (A word is defined as any string of alphabetic characters appearing between non-alphabetic characters like nature's is two words. The count should be case-insensitive. If a word occurs multiple times in a line, all should be counted)
5	Write a map-reduce program to determine the average ratings of movies. The input consists of a series of lines, each containing a movie number, user number, rating and a timestamp.
6	Write a map-reduce program: (i) to find matrix-vector multiplication; (ii) to compute selections and projections; (iii) to find union, intersection, difference, natural Join for a given dataset.
7	Write a program to construct different types of k-shingles for given document.
8	Write a program for measuring similarity among documents and detecting passages which have been reused.
9	Write a program to compute the n- moment for a given stream where n is given.
10	Write a program to demonstrate the Alon-Matias-Szegedy Algorithm for second moments.
Note: The experiments may be done using software/tools like Hadoop / WEKA / R / Java etc.	

Course Code	Course Title	Credits
TPGCS **P3034**	**Practical Course on Elective II- Track D: Machine Intelligence - II (Advanced Machine Learning Techniques)**	**02**

Sr No	List of Practical Experiments
1	Find probability density function or probability mass function, cumulative distribution function and joint distribution function to calculate probabilities and quantiles for standard statistical distributions.
2	Create a Directed Acyclic Graph (DAG) using (i) set of formulae (ii) set of vectors and (iii) set of matrices. Find parents and children of nodes. Read conditional independence from DAG. Add and remove edges from graph.
3	Create a Bayesian network for a given narrative. Set findings and ask queries [One may use narratives like ‘chest clinic narrative’ and package gRain for the purpose].
4	Implement EM algorithm.
5	Use string kernel to find the similarity of two amino acid sequence where similarity is defined as the number of a substring in common.
6	Demonstrate SVM as a binary classifier.
7	Create a random graph and find its page rank.
8	Apply random walk technique to a multivariate time series.
9	Implement two stage Gibbs Sampler.
10	Implement Metropolis Hastings algorithm.

Detailed syllabus of semester – IV

Course Code	Course Title	Credits
TPGCS**401**	**Artificial Intelligence**	**04**

Learning outcome: 1. To introduce the concepts and techniques of building blocks of Artificial Intelligence and Soft Computing techniques and their difference from conventional techniques. 2. To generate an ability to design, analyze and perform experiments on real life problems using various Neural Network algorithms. 3. To conceptualize Fuzzy Logic and its implementation for various real-world applications. 4. To provide the understanding of Genetic Algorithms and its applications in developing solutions to real-world problems. 5. To introduce the need and concept of hybrid soft computing algorithms.

Course Outcomes: Upon completion of the course, the learners will be able to: 1. Understand AI concepts used to develop solutions that mimic human like thought process on deterministic machines for real-world problems. 2. Analyze and evaluate whether a problem can be solved using AI techniques and analyze the same using basic concepts of AI. 3. Understand the fundamental concepts of Neural Networks, different neural network architectures, algorithms, applications and their limitations. 4. Apply Fuzzy Logic, the concept of fuzziness and fuzzy set theory in various systems. 5. Apply Genetic Algorithms in problems with self-learning situations that seek global optimum. 6. Create solutions to real-world problems using Neural Network, Genetic Algorithms, Fuzzy Logic or their Hybrid systems.

Unit I: Foundations of Artificial Intelligence

Introduction to artificial intelligence; Application areas of artificial intelligence; State space search: Depth first search, Breadth first search; Heuristic search: Best first search, Hill Climbing, Beam Search, Tabu Search; Introduction to randomized search: Simulated annealing, Genetic algorithms, Ant colony optimization; Introduction to expert systems; Introduction to AI-related fields like game playing, speech recognition, language detection machine, computer vision, robotics

Introduction to Soft Computing

Importance of soft computing; Soft computing versus hard computing; Supervised and unsupervised learning; Introduction to main components of soft computing: Fuzzy logic, Neural networks, Genetic algorithms.

Unit II:

Neural Networks

Basic concepts of neural network; Overview of learning rules and parameters; Activation functions; Single layer perceptron and multilayer perceptron; Multilayer feed forward network; Backpropagation networks: Architecture, Algorithm, Variation of standard backpropagation neural network; Radial basis function network; Recurrent neural network; Introduction to Associative Memory; Recent applications

Unit III:

Genetic Algorithms

Difference between traditional algorithms and Genetic Algorithm (GA); Basic concepts of GA; Working principle; Encoding methods; Fitness function; GA Operators: Reproduction, Crossover, Mutation; Convergence of GA; Detailed algorithmic steps; Adjustment of parameters; Multicriteria optimization; Solution of typical problems using genetic algorithm; Recent applications.

Unit IV:

Fuzzy Logic

Concepts of uncertainty and imprecision; Concepts, properties and operations on classical sets and fuzzy sets; Classical & fuzzy relations; Membership functions and its types; Fuzzification; Fuzzy rule-based systems; Defuzzification; Fuzzy propositions; Fuzzy extension principle; Fuzzy inference system; Recent applications.

Text book:

1. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.

2. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, 2nd ed., Wiley India. **Reference Books:**

1. J. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House.

2. D. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, AddisonWesley

3. G. Klir, B. Yuan, Fuzzy Sets and Fuzzy Logic: Theory and A: Theory and Applications, Pearson.

Course Code	Course Title	Credits
TPGCS**4021**	**Specialization: Cloud Computing -III (Building Clouds and Services)**	**04**

Unit I: Cloud Reference Architectures and Security

The NIST definition of Cloud Computing, Cloud Computing reference architecture, Cloud Computing use cases, Cloud Computing standards. Cloud Computing Security-Basic Terms and Concepts, Threat Agents, Cloud Security Threats. Cloud Security Mechanisms, Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO), Cloud-Based Security Groups, Hardened Virtual Server Images.

Unit II: Cloud Computing Mechanisms

Cloud Infrastructure Mechanisms, Logical Network Perimeter, Virtual Server, Cloud Storage Device, Cloud Usage Monitor, Resource Replication Ready-Made Environment. Specialized Cloud Mechanisms, Automated Scaling Listener, Load Balancer, SLA Monitor, Pay-Per-Use Monitor, Audit Monitor, Failover System, Hypervisor, Resource Cluster, Multi-Device Broker, State Management Database. Cloud Management Mechanisms, Remote Administration System, Resource Management System, SLA Management System, Billing Management System.

Unit III: Cloud Computing Architecture

Fundamental Cloud Architectures, Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic Disk Provisioning Architecture, Redundant Storage Architecture. Advanced Cloud Architectures, Hypervisor Clustering Architecture, Load Balanced Virtual Server Instances Architecture, Non-Disruptive Service Relocation Architecture, Zero Downtime Architecture, Cloud Balancing Architecture, Resource Reservation Architecture, Dynamic Failure Detection and Recovery Architecture, Bare-Metal Provisioning Architecture, Rapid Provisioning Architecture, Storage Workload Management Architecture.

Unit IV: Working with Clouds

Cloud Delivery Model Considerations, Cloud Delivery Models: The Cloud Provider Perspective, Building IaaS Environments, Equipping PaaS Environments, Optimizing SaaS Environments, Cloud Delivery Models: The Cloud Consumer Perspective. Cost Metrics and Pricing Models, Business Cost Metrics, Cloud Usage Cost Metrics, Cost Management Considerations. Service Quality Metrics and SLAs, Service Quality Metrics, Service Availability Metrics, Service Reliability Metrics, Service Performance Metrics, Service Scalability Metrics, Service Resiliency Metrics.

Text book:

- Cloud Computing Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, Prentice Hall, 2013.
- Cloud Security - A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley Publishing, Inc., 2010.
- Open Stack Cloud Computing Cookbook, Kevin Jackson, Cody Bunch, Egle Sigler, Packt Publishing, Third Edition, 2015.

Reference:

- Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx, Everett Toews, and Joe, Topjian,OpenStack Operations Guide, O'Reilly Media, Inc, 2014.
- NIST Cloud Computing Standards Roadmap, Special Publication 500-291, Version 2, NIST, July 2013, http://www.nist.gov/itl/cloud/upload/NIST_SP-500-291_Version-2_2013_June18_FINAL.pdf
- https://www.openstack.org
- http://cloudstack.apache.org
- http://www.foss-cloud.org/en/wiki/FOSS-Cloud
- http://www.ubuntu.com/cloud/openstack/autopilot

Course Code	Course Title	Credits
TPGCS**4022**	**Specialization: Cyber and Information Security (Cryptography and Crypt Analysis)**	**04**

Unit I: Introduction to Number Theory

Topics in Elementary Number Theory: O and notations, time estimates for doing arithmetic-divisibility and the Euclidean algorithm, Congruence: Definitions and properties, linear congruence, residue classes, Euler's phi function, Fermat's Little Theorem, Chinese Reminder Theorem, Applications to factoring, finite fields, quadratic residues and reciprocity: Quadratic residues, Legendre symbol, Jacobi Symbol. (proofs of the theorems are not expected to cover).

Unit II: Simple Cryptosystems

Shift Cipher, Substitution Cipher, Affine Cipher, Vigenère Cipher, Vermin Cipher, Hill Cipher, Permutation Cipher, Stream Cipher, Cryptanalysis of Affine Cipher, Substitution Cipher, Vigenère Cipher and Hill Cipher, Block Ciphers, Algorithm Modes, DES, Double DES, Triple DES, Meet-in-Middle Attack, AES, IDEA algorithm. Cryptographic Hash Functions: Hash Functions and Data Integrity, Security of Hash Functions, Secure Hash Algorithm, Message Authentication Code, Nested MACs, HMAC.

Unit III: RSA Cryptosystem

The RSA Algorithm, Primarily Testing, Legendre and Jacobi Symbols, The Solovay-Strassen Algorithm, The Miller-Rabin Algorithm, Factoring Algorithm: The pollard p-1 Algorithm, Dixon's Random Squares Algorithm, Attacks on RSA, The Rabin Cryptosystem. Public Key Cryptosystems: The idea of public key Cryptography, The Diffie-Hellman Key Agreement, ElGamal Cryptosystem, The Pollard Rho Discrete Logarithm Algorithm, Elliptic Curves, Knapsack problem.

Unit IV: Key Distribution and Key Agreement Scheme

Diffie-Hellman Key distribution and Key agreement scheme, Key Distribution Patterns, Mitchell-Piper Key distribution pattern, Station-to-station protocol, MTI Key Agreement

scheme. Public-Key Infrastructure: What is PKI?, Secure Socket Layer, Certificates, Certificate Life cycle, Trust Models: Strict Hierarchy Model, Networked PKIs, The web browser Model, Pretty Good Privacy.

Text book:

- Discrete Mathematics and Its Applications, Kenneth H. Rosen, 7th Edition, McGraw Hill, 2012.
- Cryptography Theory and Practice, 3rd Edition, Douglas R. Stinson, 2005.

Reference:

- Network Security and Cryptography, Atul Kahate, McGraw Hill, 2003.
- Cryptography and Network Security: Principles and Practices, William Stalling, Fourth Edition, Prentice Hall, 2013.
- Introduction to Cryptography with coding theory, second edition, Wade Trappe, Lawrence C. Washington, Pearson, 2005.

Course Code	Course Title	Credits
TPGCS**4023**	**Specialization: Business Intelligence and Big Data Analytics (Intelligent Data Analysis)**	**04**

Unit I: Clustering

Distance/Similarity, Partitioning Algorithm: K-Means; K-Medoids, Partitioning Algorithm for large data set: CLARA; CLARANS, Hierarchical Algorithms: Agglomerative (AGNES); Divisive (DIANA), Density based clustering: DBSCAN, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism.

Unit II: Classification

Challenges, Distance based Algorithm: K nearest Neighbors and kD-Trees, Rules and Trees based Classifiers, Information gain theory, Statistical based classifiers: Bayesian classification, Document classification, Bayesian Networks. Introduction to Support

Vector Machines, Evaluation: Confusion Matrix, Costs, Lift Curves, ROC Curves, Regression/model trees: CHAID (Chi Squared Automatic Interaction Detector). CART (Classification And Regression Tree).

Unit III: Dimensionality Reduction

Introduction to Eigen values and Eigen vectors of Symmetric Matrices, Principal-Component Analysis, Singular-Value Decomposition, CUR Decomposition.

Unit IV: Link Analysis And Recommendation Systems

Link analysis: PageRank, Efficient Computation of PageRank, Topic-Sensitive PageRank, Link Spam. Recommendation Systems: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction.

Text book:

- Mining of Massive Datasets, Anand Rajaraman and Jeffrey David Ullman, Cambridge University Press, 2012.
- Data Mining: Introductory and Advanced Topics, Margaret H. Dunham, Pearson, 2013.

Reference:

- Big Data for Dummies, J. Hurwitz, et al., Wiley, 2013.
- Networks, Crowds, and Markets: Reasoning about a Highly Connected World, David Easley and Jon Kleinberg, Cambridge University Press, 2010.
- Lecture Notes in Data Mining, Berry, Browne, World Scientific, 2009.
- Data Mining: Concepts and Techniques third edition, Han and Kamber, Morgan Kaufmann, 2011.
- Data Mining Practical Machine Learning Tools and Techniques, Ian H. Witten, Eibe Frank, The Morgan Kaufmann Series in Data Management Systems, 2005.
- Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL and Graph, David Loshin, Morgan Kaufmann Publishers, 2013.

Course Code	Course Title	Credits
TPGCS**4024**	**Specialization: Machine Learning -III (Computational Intelligence)**	**04**

Unit I: Artificial Neural Networks

The Artificial Neuron, Supervised Learning Neural Networks, Unsupervised Learning Neural Networks, Radial Basis Function Networks, Reinforcement Learning, Performance Issues.

Unit II: Evolutionary Computation

Introduction to Evolutionary Computation, Genetic Algorithms, Genetic Programming, Evolutionary Programming, Evolution Strategies, Differential Evolution, Cultural Algorithms, Co-evolution.

Unit III: Computational Swarm Intelligence

Particle Swarm Optimization(PSO) - Basic Particle Swarm Optimization, Social Network Structures, Basic Variations and parameters, Single-Solution PSO. Advanced Topics and applications. Ant Algorithms- Ant Colony Optimization Meta-Heuristic, Cemetery Organization and Brood Care, Division of Labor, Advanced Topics and applications.

Unit IV: Artificial Immune systems, Fuzzy Systems and Rough Sets

Natural Immune System, Artificial Immune Models, Fuzzy Sets, Fuzzy Logic and Reasoning, Fuzzy Controllers, Rough Sets.

Text book:

- Computational Intelligence- An Introduction (Second Edition): Andries P. Engelbrecht, John Willey & Sons Publications (2007).

Reference:

- Computational Intelligence And Feature Selection: Rough And Fuzzy Approaches, Richard Jensen Qiang Shen, IEEE Press Series On Computational Intelligence, A John Wiley & Sons, Inc., Publication, 2008.
- Computational Intelligence And Pattern Analysis In Biological Informatics, (Editors). Ujjwal Maulik, Sanghamitra Bandyopadhyay, Jason T. L.Wang, John Wiley & Sons, Inc, 2010.

- Neural Networks for Applied Sciences and Engineering: From Fundamentals to Complex Pattern Recognition 1st Edition, Sandhya Samarasinghe, Auerbach Publications, 2006.
- Introduction to Evolutionary Computing (Natural Computing Series) 2nd ed, A.E. Eiben , James E Smith, Springer; 2015.
- Swarm Intelligence, 1st Edition, Russell C. Eberhart, Yuhui Shi, James Kennedy, Morgan Kaufmann, 2001
- Artificial Immune System: Applications in Computer Security, Ying Tan, Wiley-IEEE Computer Society, 2016.
- Computational Intelligence and Feature Selection: Rough and Fuzzy Approaches 1st Edition, Richard Jensen, Qiang Shen, Wiley-IEEE Press, 2008

List of Practical Experiments for Semester – IV

Course Code	Course Title	Credits
TPGCS **P401**	**Practical course on Artificial Intelligence**	**02**

List of Practical Experiments

1. Implement Breadth first search algorithm for Romanian map problem.
2. Implement Iterative deep depth first search for Romanian map problem.
3. Implement A* search algorithm for Romanian map problem.
4. Implement recursive best-first search algorithm for Romanian map problem.
5. Implement decision tree learning algorithm for the restaurant waiting problem.
6. Implement Genetic Algorithms for Staff Planning
7. Implement ANN
8. Implement feed forward back propagation neural network learning algorithm for the restaurant waiting problem.
9. Implement the Perceptron Algorithm
10. Implement Fuzzy Inference System
11. Solve Fuzzy Control Systems: The Tipping Problem
12. Implement Naive Bayes' learning algorithm for the restaurant waiting problem.

Course Code	Course Title	Credits
TPGCS **P4021**	**Practical Course on Specialization: Cloud Computing (Building Clouds and Services)**	**02**

Sr No	List of Practical Experiments
1	Develop a private cloud using any suitable technology.
2	Develop a public cloud using any suitable technology.
3	Explore Service Offerings, Disk Offerings, Network Offerings and Templates.
4	Explore Working of the following with Virtual Machines • VM Lifecycle • Creating VMs • Accessing VMs • Assigning VMs to Hosts
5	Explore Working of the following with Virtual Machines • Changing the Service Offering for a VM • Using SSH Keys for Authentication
6	Explore the working of the following: Storage Overview • Primary Storage

	• Secondary Storage
7	Explore the working of the following: Storage Overview • Working With Volumes • Working with Volume Snapshots
8	Explore managing the Cloud using following: • Tags to Organize Resources in the Cloud • Reporting CPU Sockets
9	Explore managing the Cloud using following: • Changing the Database Configuration • File encryption type
10	Explore managing the Cloud using following: • Administrator Alerts • Customizing the Network Domain Name

Note

Recommended Technologies for completing practical:

- FOSS-Cloud
- Apache CloudStack
- OpenStack
- Canonical's OpenStack Autopilot
- GCP
- AWS
- Azure

Recommended Configuration: Desktop PC Core I5 with minimum 250 GB Hard Drive and minimum 8 GB RAM

Course Code	Course Title	Credits
TPGCS **P4022**	**Practical Course on Specialization: Cyber & Information Security (Cryptography and Crypt Analysis)**	**02**

Sr No	List of Practical Experiments
1	Write a program to implement following: • Chinese Reminder Theorem • Fermat's Little Theorem
2	Write a program to implement the (i) Affine Cipher (ii) Rail Fence Technique (iii) Simple Columnar Technique (iv) Vermin Cipher (v) Hill Cipher to perform encryption and decryption.
3	Write a program to implement the (i) RSA Algorithm to perform encryption and decryption.
4	Write a program to implement the (i) Miller-Rabin Algorithm (ii) pollard p-1 Algorithm to perform encryption and decryption.
5	Write a program to implement the ElGamal Cryptosystem to generate keys and perform encryption and decryption.
6	Write a program to implement the Diffie-Hellman Key Agreement algorithm to generate symmetric keys.
7	Write a program to implement the MD5 algorithm compute the message digest.
8	Write a program to implement different processes of DES algorithm like (i) Initial Permutation process of DES algorithm, (ii) Generate Keys for DES algorithm, (iii) S-Box substitution for DES algorithm.
9	Write a program to encrypt and decrypt text using IDEA algorithm.
10	Write a program to implement HMAC signatures.

Course Code	Course Title	Credits
TPGCS **P4023**	**Practical Course on Specialization: Business Intelligence & Big Data Analytics (Intelligent Data Analysis)**	**02**

Sr No	List of Practical Experiments
1	Pre-process the given data set and hence apply clustering techniques like K-Means, K-Medoids. Interpret the result.
2	Pre-process the given data set and hence apply partition clustering algorithms. Interpret the result
3	Pre-process the given data set and hence apply hierarchical algorithms and density based clustering techniques. Interpret the result.
4	Pre-process the given data set and hence classify the resultant data set using tree classification techniques. Interpret the result.
5	Pre-process the given data set and hence classify the resultant data set using Statistical based classifiers. Interpret the result.
6	Pre-process the given data set and hence classify the resultant data set using support vector machine. Interpret the result.
7	Write a program to explain different functions of Principal Components.
8	Write a program to explain CUR Decomposition technique.
9	Write a program to explain links to establish higher-order relationships among entities in Link Analysis.
10	Write a program to implement step-by-step a Collaborative Filtering Recommender System.

The experiments may be done using software/ tools like R/Weka/Java etc.

Course Code	Course Title	Credits
TPGCS **P4024**	**Practical Course on Specialization: Machine Intelligence (Computational Intelligence)**	**02**

Sr No	List of Practical Experiments
1	Implement feed forward neural network for a given data.
2	Implement Self Organizing Map neural network.
3	Implement Radial Basis Function neural network with gradient descent.
4	Implement a basic genetic algorithm with selection, mutation and crossover as genetic operators.
5	Implement evolution strategy algorithm.
6	Implement general differential evolution algorithm.
7	Implement gbest and lbest of PSO.
8	Implement simple Ant colony optimization algorithm.
9	Implement basic artificial immune system algorithm.
10	Apply different defuzzification methods for centroid calculation of a given fuzzy rule base.

Note: The above practical experiments may use programming languages like C, Java, R etc.