Thakur Educational Trust's (Regd.)

THAKUR COLLEGE OF SCIENCE & COMMERCE

Autonomous College Permanently Affiliated to University of Mumbai

(NAAC Accredited with Grade 'A' [3rd Cycle] & ISO 9001:2015 Certified)

Syllabus for
M.Sc. Part II
Program: Master of Science
Course: Computer Science (TPGCS)

Choice Based Credit System (CBCS)
With effect from
Academic Year 2021-2022

Preamble

This syllabus is an extension of the syllabus for semester - I and semester – II of MSc Computer Science . As mentioned in the syllabus of semester I and II, the intended philosophy of the new syllabus is to meet following guidelines:

- Give strong foundation on core Computer Science subjects.
- Expose student to emerging trends in a gradual and incremental way.
- Prepare student community for the demands of ICT industry.
- Offer specialization on a chosen area.
- Create research temper among students in the whole process.

This syllabus for the semester - III and semester – IV has tried to continue the steps initiated in the semester- I and semester –II to meet the goals set. This proposes two core compulsory subjects in semester III. The student has to continue with the tracks they have taken in the semester II as elective subjects. The syllabus also includes project proposal as part of the practical course in elective subjects.

The semester – IV will have one compulsory subject. Student can choose one subject as specialization out of the two electives he or she has been pursuing since the semester – II. That means, there will be four specializations in the semester IV as mentioned below:

- Cloud Computing
- Cyber and Information Security
- Business Intelligence and Big Data Analytics
- Machine Learning

The syllabus also offers an internship and project implementation in the semester – IV, each of which has weights equivalent to a full course. By introducing different electives as tracks in semester –II, espousing more of that tracks in the semester –III and offering the opportunity to choose the specialization based on the tracks pursed in semester –IV will give the student the added advantage of high level competency in the advanced and emerging areas of computer science. This will definitely equip the student with industry readiness as internship in an IT or IT-related organization gives a practical exposure to what is learned and what is practiced. The strong foundation given in the core courses in different semesters will give enough confidence to the learner to face and adapt to the changing trends and requirements of industry and academia.

As one can easily notice, the syllabus offers lots of emphasis on student driven learning and learning through experience. Research is embedded in the course structure. By introducing Researching Computing in semester – I, Case study in semester – II, Project Proposal in semester – III and Project Implementation in semester – IV (which together has a weightage equivalent to almost two theory courses), the syllabus prepares a strong army of budding computer science researchers. The syllabus designed on the firm believe that by focusing on student driven research on cutting edge and emerging trends with lots of practical experience will make the learning more interesting and stimulating. It is hoped that the student community and teacher colleagues will appreciate the thrust, direction and treatment given in the syllabus.

We acknowledge the contributions of experts from BOS and industry for making the syllabus more relevant. Thanks to one and all who have directly or indirectly helped in this venture.

Structure of the syllabus

Semester-III

The syllabus offers four theory courses and two practical courses in semester-III. Of the four theory courses, two are compulsory courses. The remaining two are electives. Each elective course has two tracks (track A and track B for elective I and track C and track D for elective II). A student is expected to continue with the track they have chosen in semester-II.

The syllabus proposes four subjects in semester-III. Each subject has theory and practical components.

Semester–III: Theory courses

The four theory courses offered in semester-III are:

(i) Ubiquitous Computing

(ii) Blockchain & Cryptocurrency

(iii) Elective - I

- (a) Track A: Cloud Computing – II (Cloud Computing Technologies)
- (b) Track B: Cyber and Information Security – II (Cyber Forensics)

(iv) Elective – II

- (a) Track C: Business Intelligence and Big Data Analytics – II (Mining Massive Data sets)
- (b) Track D: Machine Learning – II (Advanced Machine Learning)

A student is expected to continue with the same tracks he or she has taken in semester-II for elective –I and elective –II. Each of these theory courses (compulsory as well as elective) is of four credits each and is expected to complete in 60 hours. The details are shown in the following table.

Semester III – Theory courses

Course Code	Course Nomenclature	Lecture In Hours	Credits
TPGCS301	Ubiquitous Computing	60	4
TPGCS302	Blockchain & Cryptocurrency	60	4
TPGCS3031	Elective I - Track A: Cloud Computing –II (Cloud Computing Technologies)	60	4
TPGCS3032	Elective I - Track B: Cyber and Information Security- II (Cyber Forensics)		
TPGCS3033	Elective II - Track C: Business Intelligence and Big Data Analytics –II (Mining Massive Data sets)	60	4
TPGCS3034	Elective II - Track D: Machine Learning –II (Advanced Machine Learning)		
Total Credits for Theory courses in Semester III			16

Semester–III: Practical Laboratory Courses

The syllabus proposes two laboratory courses of 4 credits each. The laboratory experiments from the first two theory courses (TPGCS301 and TPGCS302) are combined together and are proposed as the first practical course (TPGCSP501). Similarly, the laboratory experiments from the elective courses are combined together and taken as the second practical course (TPGCSP502). The following table summarizes the details of the practical courses in the semester –III.

Semester-III: Practical Laboratory Courses

Course Code	Course Title	No of Hours	Credits
TPGCSP501	**Ubiquitous Computing and Blockchain & Cryptocurrency**	60+60= 120	04
TPGCSP502	**Elective I and Elective II**	60+60= 120	04
Total Credits for Practical Laboratory courses in Semester–III			08

Project Proposal: The syllabus introduces a project proposal in the semester-III under lab course TPGCSP405. As per this, a student is expected to select a topic for project based on the specialization he or she is planning to take in the semester-IV. Needless to say, the project proposal will be based on a topic related to the elective the student has been pursuing in semester –II and semester-III and intends to continue in semester-IV as specialization.

The proposal will contain introduction, related works, objectives and methodology. The implementation, experimental results and analysis will be part of the Project implementation in the semester-IV.

Semester –IV

The syllabus proposes two subjects in semester-IV, each with theory and practical components. In addition, there will be internship with industry and a project implementation. The important feature of the semester-IV is the specialization a student can choose. A student can choose a specialization based on the electives one has been pursuing since semester–II. Since there are two electives in semester-III, a student can drop one and choose the other as the specialization in semester–IV.

Semester–IV: Theory courses

The two theory courses offered in semester-IV are:

(i) Artificial Intelligence

(ii) Specialization

(a) Track A: Cloud Computing – III (Building Clouds and Services)

(b) Track B: Cyber and Information Security–III (Cryptography and Crypt Analysis)

(c) Track C: Business Intelligence and Big Data Analytics – III (Intelligent Data Analysis)

(d) Track D: Machine Learning – III (Computational Intelligence)

Each of these courses (core as well as the specialization) is expected to complete in 60 hours. The details are given in the following table.

Semester-IV: Theory courses

Course Code	Course Nomenclature	Lecture In Hours	Credits
TPGCS401	Artificial Intelligence	60	4
TPGCS4021	Specialization - Track A: Cloud Computing –III (Building Clouds and Services)	60	4
TPGCS4022	Specialization - Track B: Cyber and Information Security- II (Cryptography and Crypt Analysis)		
TPGCS4023	Specialization - Track C: Business Intelligence and Big Data Analytics –III (Intelligent Data Analysis)		
TPGCS4024	Specialization - Track D: Machine Learning –III (Computational Intelligence)		
Total Credits for Theory courses in Semester-IV			08

Semester–IV: Practical Laboratory courses

The syllabus proposes one laboratory course of 4 credits.

Semester-IV: Practical course

Course Code	Course Title	No of hours	Credits
TPGCSP403	Artificial Intelligence and Specialization	60+60= 120	04

Semester–IV: Internship with industry

The syllabus proposes an internship for about 8 weeks to 12 weeks to be done by a student. It is expected that a student chooses an IT or IT-related industry and formally works as a full time intern during the period. The student should subject oneself with an internship evaluation with proper documentation of the attendance and the type of work he or she has done in the chosen organization. Proper certification (as per the guidelines given in Appendix 1 and 2) by the person, to whom the student was reporting, with Organization’s seal should be attached as part of the documentation.

Semester–IV: Internship

Course code	Course Title	No of hours	Credits
TPGCSP404	Internship with industry	300	06

Semester–IV: Project Implementation

The syllabus proposes project implementation as part of the semester–IV. The project implementation is continuation of the project proposal the students has submitted and evaluated in semester-III. The student is expected to continue with the proposal made and examined in the semester-III and implement the same in the semester–IV. In addition, experimental set up, analysis of results, comparison with results of related works, conclusion and future prospects will be part of the project implementation. A student is expected to make a project implementation report and appear for a project viva. He or she needs to spend around 200 hours for the project implementation, which fetches 6 credits. The details are given below:

Semester–IV: Project Implementation

Course Code	**Course Title**	**No of hours**	**Credits**
TPGCSP405	Project Implementation	200	06

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.

<table>
<tr><th colspan="2">Course Code</th><th>Course Title</th><th>Credits</th></tr>
<tr><td colspan="2">TPGCS <b>P3033</b></td><td><b>Practical Course on Elective II-Track C: Business Intelligence and Big Data Analytics - II
(Mining Massive Data sets -I)</b></td><td><b>02</b></td></tr>
<tr><td>No</td><td colspan="3">List of Practical Experiments</td></tr>
<tr><td>1</td><td colspan="3">Generate regression model and interpret the result for a given data set.</td></tr>
<tr><td>2</td><td colspan="3">Generate forecasting model and interpret the result for a given data set.</td></tr>
<tr><td>3</td><td colspan="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).</td></tr>
<tr><td>4</td><td colspan="3">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)</td></tr>
<tr><td>5</td><td colspan="3">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.</td></tr>
<tr><td>6</td><td colspan="3">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.</td></tr>
<tr><td>7</td><td colspan="3">Write a program to construct different types of k-shingles for given document.</td></tr>
<tr><td>8</td><td colspan="3">Write a program for measuring similarity among documents and detecting passages which have been reused.</td></tr>
<tr><td>9</td><td colspan="3">Write a program to compute the n- moment for a given stream where n is given.</td></tr>
<tr><td>10</td><td colspan="3">Write a program to demonstrate the Alon-Matias-Szegedy Algorithm for second moments.</td></tr>
<tr><td colspan="4">Note: The experiments may be done using software/tools like Hadoop / WEKA / R / Java etc.</td></tr>
</table>

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.

Scheme of Examination for Theory Courses

There will be internal and external examination for the theory courses. The weightage of internal/external and scheme of examination will be as per common guidelines provided by the University for the PG courses in the faculty of Science.

Scheme of Examination for Practical Courses

There will not be any internal examination for practical courses.

External Examination for practical courses:

The evaluation of the external examination of practical course is given below:

<table>
<tr><th>Sr No</th><th>Semester</th><th>Course Code</th><th colspan="2">Particular</th><th>No of questions</th><th>Marks per question</th><th>Total Marks</th></tr>
<tr><td rowspan="4">1</td><td rowspan="4">III</td><td rowspan="3">TPGCS <b>P301</b></td><td colspan="2">Laboratory experiment question</td><td>2</td><td>40</td><td>80</td></tr>
<tr><td colspan="2">Journal</td><td>-</td><td>10</td><td>10</td></tr>
<tr><td colspan="2">Viva</td><td>-</td><td>10</td><td>10</td></tr>
<tr><td colspan="3">Marks for each course</td><td colspan="3">100</td></tr>
<tr><td rowspan="6">2</td><td rowspan="6">III</td><td rowspan="6">TPGCSP 302</td><td colspan="2">Laboratory experiment question</td><td>2</td><td>25</td><td>50</td></tr>
<tr><td colspan="2">Journal</td><td>-</td><td>10</td><td>10</td></tr>
<tr><td colspan="2">Viva</td><td>-</td><td>10</td><td>10</td></tr>
<tr><td rowspan="3">viva on Project Proposal</td><td colspan="2">Documentation</td><td>10</td><td rowspan="3">30</td></tr>
<tr><td colspan="2">Presentation</td><td>10</td></tr>
<tr><td colspan="2">Viva</td><td>10</td></tr>
<tr><td colspan="2"></td><td colspan="3">Total Marks</td><td colspan="3">100</td></tr>
</table>

<table>
<tr><th>Sr No</th><th>Semester</th><th>Course Code</th><th colspan="3">Particular</th><th>No of questions</th><th>Marks per question</th><th>Total Marks</th></tr>
<tr><td rowspan="4">1</td><td rowspan="4">IV</td><td rowspan="3">TPGCSP 403</td><td colspan="3">Laboratory experiment question</td><td>2</td><td>40</td><td>80</td></tr>
<tr><td colspan="3">Journal</td><td>-</td><td>10</td><td>10</td></tr>
<tr><td colspan="3">Viva</td><td>-</td><td>10</td><td>10</td></tr>
<tr><td colspan="5">Total Marks</td><td colspan="2">100</td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">IV</td><td rowspan="5">TPGCSP 404</td><td rowspan="4">Intern-ship</td><td rowspan="3">Internship conduct</td><td colspan="2">Quality and relevance</td><td>40</td><td rowspan="3">100</td></tr>
<tr><td colspan="2">Documentation</td><td>30</td></tr>
<tr><td colspan="2">Presentation</td><td>30</td></tr>
<tr><td colspan="3">Internship Viva</td><td>50</td><td>50</td></tr>
<tr><td colspan="4">Total Marks</td><td colspan="2">150</td></tr>
<tr><td rowspan="5">3</td><td rowspan="5">IV</td><td rowspan="5">TPGCSP 405</td><td rowspan="4">Project Implementation</td><td rowspan="3">Project conduct</td><td colspan="2">Quality and relevance</td><td>40</td><td rowspan="3">100</td></tr>
<tr><td colspan="2">Documentation</td><td>30</td></tr>
<tr><td colspan="2">Presentation</td><td>30</td></tr>
<tr><td colspan="3">Project viva</td><td>50</td><td>50</td></tr>
<tr><td colspan="4">Total Marks</td><td colspan="2">150</td></tr>
</table>

Guide lines for maintenance of journals:

A student should maintain a journal with at least six practical experiments for each part of the practical course. Certified journals need to be submitted at the time of the practical examination.

Guidelines for Project Proposal in Semester - III

- Student should take a topic related to the specialization he or she is planning to take in Semester-IV.
- Should have studied the related topics in the elective he or she has chosen in semester-II and semester- III
- A student is expected to devote at least 2 to 3 months of study as part of topic selection and its documentation.
- The student should be comfortable to implement the proposal in the semester – IV.

Guidelines for Documentation of Project Proposal in Semester –III

Student is expected to make a project proposal documentation which should contain the following:

- **Title:** A suitable title giving the idea about what work is proposed.
- **Introduction:** An introduction to the topic of around 3-5 pages, giving proper back ground of the topic discussed.
- **Related works:** A detailed survey of the relevant works done by others in the domain. Student is expected to refer at least 5 research papers in addition to text books and web-links in the relevant topic. It may be around 7 to 10 pages.
- **Objective:** A detailed objective of the proposal is needed. It may be of 1 to 2 pages.
- **Methodology:** A proper and detailed procedure of how to solve the problem discussed. It shall contain the techniques, tools, software and data to be used. It shall be of around 3 to 5 pages.

The report may be of around 20 pages, which needs to be signed by the teacher in charge and head of the Department. Students should submit the signed project proposal documentation at the time of viva as part of the University examination.

Guidelines for internship in Semester - IV

- Internship should be of 2 to 3 months with 8 to 12 weeks duration.
- A student is expected to find internship by himself or herself. However, the institution should assist their students in getting internship in good organizations.
- The home institution cannot be taken as the place of internship.
- A student is expected to devote at least 300 hours physically at the organization.
- Internship can be on any topic covered in the syllabus mentioned in the syllabus, not restricted to the specialization.
- Internship can be done, in one of the following, but not restricted to, types of organizations:
    - Software development firms
    - Hardware/ manufacturing firms
    - Any small scale industries, service providers like banks
    - Clinics/ NGOs/professional institutions like that of CA, Advocate etc
    - Civic Depts like Ward office/post office/police station/ panchayat.
    - Research Centres/ University Depts/ College as research Assistant for research projects or similar capacities.

Guidelines for making Internship Report in Semester –IV

A student is expected to make a report based on the internship he or she has done in an organization. It should contain the following:

- **Certificate:** A certificate in the prescribed Performa (given in appendix 1) from the organization where the internship done.
- **Evaluation form:** The form filled by the supervisor or to whom the intern was reporting, in the prescribed Performa (given in appendix 2).

- **Title:** A suitable title giving the idea about what work the student has performed during the internship.
- **Description of the organization:** A small description of 1 to 2 pages on the organization where the student has interned
- **Description about the activities done by the section where the intern has worked**: A description of 2 to 4 pages about the section or cell of the organization where the intern actually worked. This should give an idea about the type of activity a new employee is expected to do in that section of the organization.
- **Description of work allotted and actually done by the intern:** A detailed description of the work allotted and actual work performed by the intern during the internship period. Intern may give a weekly report of the work by him or her if needed. It shall be of around 7 to 10 pages.
- **Self assessment:** A self assessment by the intern on what he or she has learnt during the internship period. It shall contain both technical as well as inter personal skills learned in the process. It shall be of around 2 to 3 pages.

The internship report may be around 15 pages and this needs to be submitted to the external examiner at the time of University examination.

<u>Guidelines for Research Implementation in Semester - IV</u>

- Student should continue with topic proposed and evaluated at the semester – III.
- The topic has to be related with the specialization he or she has chosen in the semester – IV.
- A student is expected to devote at least 3 to 4 months of efforts for the implementation.
- Student should submit a detailed project implementation report at the time of viva.

Guidelines for Documentation of Project Proposal in Semester –IV

A Student should submit project implementation report with following details:

- **Title:** Title of the project (Same as the one proposed and evaluated at the semester II examination).
- **Implementation details:** A description of how the project has been implemented. It shall be of 2 to 4 pages.
- **Experimental set up and results:** A detailed explanation on how experiments were conducted, what software used and the results obtained. Details like screen shots, tables and graphs can come here. It shall be of 6 to 10 pages.
- **Analysis of the results:** A description on what the results means and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this. It shall be of 4 to 6 pages.
- **Conclusion:** A conclusion of the project performed in terms of its outcome (May be half a page).
- **Future enhancement:** A small description on what enhancement can be done when more time and resources are available (May be half a page).
- **Program code:** The program code may be given as appendix.

The report may be of around 20 pages (excluding program code), which needs to be signed by the teacher in charge and head of the Department. Student should submit the signed project implementation report along with evaluated copy of the project proposal documentation (of semester –III) at the time of Project evaluation and viva as part of the University examination.

- -

Appendix 1

(Proforma for the certificate for internship in official letter head)

This is to certify that Mr/Ms________________________________ of ______________________College/Institution worked as an intern as part of her MSc course in Computer Science of University of Mumbai. The particulars of internship are given below:

Internship starting date: _______________

Internship ending date:________________

Actual number of days worked:______________

Tentative number of hours worked:__________Hours

Broad area of work:____

A small description of work done by the intern during the period:

____

____

____

____

____

____

Signature:

Name:

Designation:

Contact number:

Email:

(seal of the organization)

Appendix 2

(Proforma for the Evaluation of the intern by the supervisor/to whom the intern was reporting in the organization)

Professional Evaluation of intern

Name of intern:____

College/institution:____

[Note: Give a score in the 1-5 scale by putting √ in the respective cells]

Sr No	Particular	Excellent	Very Good	Good	Moderate	Satisfactory
1	Attendance					
2	Punctuality					
3	Adaptability					
4	Ability to shoulder responsibility					
5	Ability to work in a team					
6	Written and oral communication skills					
7	Problem solving skills					
8	Ability to grasp new concepts					
9	Ability to complete task					
10	Quality of work done					

Comments:

____

____

____

Signature:
Name:
Designation:
Contact number:
Email:

(seal of the organization)