RayatShikshanSanstha's

Karmaveer Bhaurao Patil College Vashi, Navi Mumbai

Autonomous College

[University of Mumbai]

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of Course	M.Sc. II Computer Science
2	Eligibility for Admission	M.Sc. I
3	Passing Marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Years/Semesters	One year/Two semester
6	Level	P.G.
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic year	2019-20

AC - 02/03/2019
Item No- 2.16

RayatShikshanSanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI.
NAVI MUMBAI
(AUTONOMOUS COLLEGE)
Sector-15- A, Vashi, Navi Mumbai - 400 703

Syllabus for M.Sc. II Computer Science

Program: M.Sc. Computer Science

Course: M.Sc. II Computer Science

(Choice Based Credit, Grading and Semester System with effect from the academic year 2019-20)

Preamble

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.

Thanks to one and all who have directly or indirectly helped in this venture.

Scheme of examination for Each Semester:

Continuous Internal Evaluation: 40 Marks(Common Test-20 Marks & 20 Marks for- Mini Projects, Presentation, Online Course, Case Study, Assignment, Analysis In Statistics, Report Writing, Interviews, Paper Review, Surprise Test, Research Paper, Data Analysis).

Semester End Examination: 60 Marks will be as follows-

I.	**Theory:** The Semester End Examination for theory course work will be conducted as per the following scheme.	
	Each theory paper shall be of two and half hour duration.	
	All questions are compulsory and will have internal options.	
	Q – I	From Unit – I (having internal options.) 12 M
	Q – II	From Unit – II (having internal options.) 12 M
	Q – III	From Unit – III (having internal options.) 12 M
	Q – IV	From Unit – IV (having internal options.) 12 M
	Q – V	Questions from all the FOUR Units with equal weightage of marks allotted to each Unit. 12 M
II.	Practical	The Semester End Examination for practical course will be conducted as per the following scheme.

Sr. No.	**Particulars of Semester End Practical Examination**	**Marks**
1	Laboratory Work	40
2	Journal	05
3	Viva	05
	TOTAL	**50**

M.Sc. II Computer Science Syllabus

Choice Based Credit, Grading and Semester System

Academic year 2019-2020

SEMESTER - III

CODE	COURSE TYPE	SUBJECT	SCHEME OF INSTRUCTION (PERIOD PER WEEK)		SCHEME OF EXAMINATION (MAX MARKS)			NO. OF CREDITS
			TH	LAB	CIA	SEE	TOTAL	
PGCS301	CORE	Ubiquitous Computing	4	4	40	60	100	4
PGCS302	CORE	Social Network Analysis	4	4	40	60	100	4
PGCS303	ELECTIVE - I	Cloud Computing –II (Cloud Computing Technologies)	4	4	40	60	100	4
PGCS304	ELECTIVE - I	Cyber and Information Security- II (Cyber Forensics)	4	4	40	60	100	4
PGCS305	ELECTIVE - II	Business Intelligence and Big Data Analytics –II	4	4	40	60	100	4
PGCS306	ELECTIVE - II	Machine Learning –II (Advanced Machine Learning)	4	4	40	60	100	4
PGCPS 301	CORE SUBJECT PRACTICAL	PGCS301+PGCS302		8			100	4
PGCPS 302	CORE SUBJECT PRACTICAL	PGCS303/PGCS304 + PGCS305/PGCS306		8			100	4
						TOTAL	600	24

SEMESTER - IV

CODE	COURSE TYPE	SUBJECT	SCHEME OF INSTRUCTION (PERIOD PER WEEK)		SCHEME OF EXAMINATION (MAX MARKS)			NO. OF CREDITS
			TH	LAB	CIA	SEE	TOTAL	
PGCS401	CORE	Simulation and Modeling	4	4	40	60	100	4
PGCS402	SPECIALIZATION	Cloud Computing –III (Building Clouds and Services)	4	4	40	60	100	4
PGCS403	SPECIALIZATION	Cyber and Information Security- II (Cryptography and Crypt Analysis)	4	4	40	60	100	4
PGCS404	SPECIALIZATION	Business Intelligence and Big Data Analytics –II I (Intelligent Data Analysis)	4	4	40	60	100	4
PGCS405	SPECIALIZATION	Machine Learning –III (Computational Intelligence)	4	4	40	60	100	4
PGCSP401	CORE SUBJECT + SPECIALIZATION PRACTICAL	PGCS401+PGCS402/ PGCS403/ PGCS404/ PGCS405	-	8			100	4

PGCSP402	INTERNSHIP	INTERNSHIP WITH INDUSTRY	-	4	200	10
PGCSP403	PROJECT	PROJECT IMPLEMENTATION	-	4	150	6
				TOTAL	650	28

Note: TH-Theory, CIA- Continuous Internal Assessment, SEE-Semester End Examination.

Detailed syllabus of Semester – III

Class: M.Sc Part II	**Branch**: Computer Science	**Semester: III**	
Subject :**Ubiquitous Computing**			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	2	50
	Total	—	150

Course: PGCS301	**Ubiquitous Computing (Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Recognize major concepts and components of ubicom systems, ubiquitous computing applications and holistic frameworks. 2. Evaluate the usage of smart cards, device networks,human computer devices, implanted devices and human centered design. 3. Explain the principles of distributed computing, mobile computing and their applications using sensor controllers.	

	4. Determine the emerging topics embedded systems, real-time systems and control systems of pervasive and ubiquitous computing as well as context-aware computing and their applications.	
Unit I:	**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.	**15 L**
Unit II:	**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).	**15 L**
Unit III:	**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.	**15 L**
Unit IV:	**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.	**15 L**
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. **Links:** 1) http://www.eecs.qmul.ac.uk/~stefan/ubicom. 2) http://pervasivecomputing.se/M7012E_2014/material/Wiley.Ubiquitous.Computing.Smart. Devices.Environments.And.Interactions.May.2009.eBook.pdf		

Sr. No.	List of Practical Experiments on PGCS301
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

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** III	
Subject: Social Network Analysis			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	__	40
	Semester End Practical Examination	4	50

	Total	—	150

Course: PGCS302	**Social Network Analysis (Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Represent social network relationships through graph theory 2. Analyse the social network relationship and ties between different egos networks using a page ranking algorithm. 3. Compare different Similarity and dissimilarity distance measuring approaches 4. Analyse two mode Bi-partite data structures.	
Unit I	**Introduction to social network analysis (SNA)** Introduction to networks and relations- analyzing relationships to understand people and groups, binary and valued relationships, symmetric and asymmetric relationships, multimode relationships, Using graph theory for social networks analysis- adjacency matrices, edge-lists, adjacency lists, graph traversals and distances, depth-first traversal, breadth-first traversal paths and walks, Dijkstra's algorithm, graph distance and graph diameter, social networks vs. link analysis, ego-centric and socio-centric density.	**15 L**
Unit II	**Networks, Centrality and centralization in SNA** Understanding networks- density, reachability, connectivity, reciprocity, group-external and group-internal ties in networks, ego networks, extracting and visualizing ego networks, structural holes, Centrality- degree of centrality, closeness and betweenness centrality, local and global centrality, centralization and graph centers, notion of importance within network, Google pagerank algorithm, Analyzing network structure bottom-up approaches using cliques, N-cliques, N-clans, K-plexes, K-cores, F-groups and top-down approaches using components, blocks and cut-points, lambda sets and bridges, and factions.	**15 L**
Unit III	**Measures of similarity and structural equivalence in SNA** Approaches to network positions and social roles- defining equivalence or similarity, structural equivalence, automorphic equivalence, finding equivalence sets, brute force and Tabu search, regular equivalence, equivalence of distances: Maxsim, regular equivalence, Measuring similarity/dissimilarity- valued relations, Pearson correlations covariance and cross-products, Understanding clustering- agglomerative and divisive clusters, Euclidean, Manhattan, and squared distances, binary relations, matches: exact, Jaccard, Hamming,	**15 L**
Unit IV	**Two-mode networks for SNA** Understanding mode networks- Bi-partite data structures, visualizing two-mode data, quantitative analysis using two-mode Singular value decomposition (SVD) analysis, two-mode factor analysis, two-mode correspondence analysis, qualitative analysis using two-mode core-periphery analysis, two-mode factions analysis, affiliation and attribute	**15 L**

	networks.	

Text book:

- Introduction to Social Network Methods: Robert A. Hanneman, Mark Riddle, University of California, 2005 [Published in digital form and available at http://faculty.ucr.edu/~hanneman/nettext/index.html].
- Social Network Analysis for Startups- Finding connections on the social web: MaksimTsvetovat, Alexander Kouznetsov, O'Reilly Media, 2011.
- Social Network Analysis- 3rd edition, John Scott, SAGE Publications, 2012.

Reference book:

- Exploratory Social Network Analysis with Pajek, Second edition: Wouter de Nooy, Andrej Mrvar, Vladimir Batagelj, Cambridge University Press, 2011.
- Analyzing Social Networks, Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson, SAGE Publications, 2013.
- Statistical Analysis of Network Data with R: Eric D. Kolaczyk, GáborCsárdi, Springer, 2014.
- Network Analysis: Methodological Foundations, (Editors) UlrikBrandes, Thomas Erlebach. Springer, 2005.
- Models and Methods in Social Network Analysis: (Editors) Peter J. Carrington, John Scott,Stanley Wasserman, Cambridge University Press, 2005.

Links:

1) http://www.faculty.ucr.edu/~hanneman/nettext/C11_Cliques.html
2) https://www.safaribooksonline.com/library/view/social-network-analysis/9781449311377/ch04.html

Sr. No.	**List of Practical Experiments on PGCS302**
1.	Write a program to compute the following for a given a network: (i) number of edges, (ii) number of nodes; (iii) degree of node; (iv) node with lowest degree; (v)the adjacency list; (vi) matrix of the graph.
2.	Perform following tasks: (i) View data collection forms and/or import onemode/ two-mode datasets; (ii) Basic Networks matrices transformations
3.	Compute the following node level measures: (i) Density; (ii) Degree; (iii) Reciprocity; (iv) Transitivity; (v) Centralization; (vi) Clustering.
4.	For a given network find the following: (i) Length of the shortest path from a given node to another node; (ii) the density of the graph; (iii) Draw egocentric network of node G with chosen configuration parameters.
5.	Write a program to distinguish between a network as a matrix, a network as an edge list, and the network as a sociogram (or “network graph”) using 3 distinct networks representatives of each.
6.	Write a program to exhibit structural equivalence, automatic equivalence, and regular equivalence from a network.
7.	Create sociograms for the persons-by-persons network and the committee-by committee network for a given relevant problem. Create one-mode network and two-node network for the same.
8.	Perform SVD analysis of a network.

9.	Identify ties within the network using two-mode core periphery analysis.
10.	Find “factions” in the network using two-mode faction analysis.
Note: One may use programming languages like R, Python, Pajeketc and open software/tools like (i) EGONet; (ii) Ora; (iii) Netlogo; (iv) Pajek; and (v) NetDraw; to do the practical experiments.	

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** III	
Subject: Cloud Computing –II (Cloud Computing Technologies)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	__	40
	Semester End Practical Examination	4	50
	Total	__	150

Course: PGCS303	**Cloud Computing –II (Cloud Computing Technologies)** **(Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Define the concepts, key technologies, strengths, and limitations of cloud computing 2. Identify the architecture and infrastructure of cloud computing,including SaaS, PaaS, IaaS. 3. Develop enterprise applications by implementing Cloud computing.	

	4. Describe various frameworks and platforms in cloud technologies using web services.	
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.	**15 L**
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.	**15 L**
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.	**15 L**
Unit IV	**Software Architecture** Dev 2.0 platforms, Enterprise software: ERP, SCM, CRM Custom enterprise applications and Dev 2.0, Cloud applications.	**15 L**

Text book:

- Enterprise Cloud Computing Technology, Architecture, Applications, GautamShroff, Cambridge University Press, 2010
- Mastering In Cloud Computing, RajkumarBuyya, Christian Vecchiola And ThamariSelvi 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,

Links:

1) https://www.slideshare.net/wajpayeeragini/enterprise-cloud-computing-by-g-shroff

Sr. No.	List of Practical Experiments on PGCS303
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 using TryStack.

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.

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** III	
Subject: Cyber and Information Security- II (Cyber Forensics)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS304	**Cyber and Information Security- II (Cyber Forensics) (Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Define the objectives of computer forensics in law enforcement, evidence, case studies, investigation, computer forensic techniques, Vulnerabilities and Computer forensics Technologies. 2. Apply the various techniques of data recovery, data hiding, evidence collection rules, Verification & Authentication. 3. Analyze Network based evidence, Principles of internetworking, protocols, various acquisition methods, NIDS & NIPS Systems. 4. Determine the concepts of mobile forensics using identification and data interception using web proxies and evidence analysis .	
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	**15 L**

	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 Evidence, 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.	**15 L**
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.	**15 L**
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.	**15 L**

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, SatishBommisetty, RohitTamma, Heather Mahalik, PACKT Publishing, 2014.

Links:

1) http://sitlib.sethu.ac.in/e-books/CSE%20and%20IT%20books/Computer%20

Forenscis%20John%20R.%20Vacca.pdf

2) https://books.google.co.in/books?id=hqjWCwAAQBAJ&printsec=frontcover&dq=Mobile+Phone+Security+and+Forensic:+A+Practical+Approach,+Second+Edition+pdf&hl=en&sa=X&ved=0ahUKEwiP3ZKCr4XdAhWafH0KHReYC0YQ6AEIKDAA#v=onepage&q&f=false

Sr. No.	**List of Practical Experiments on PGCS304**
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.

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** III	
Subject: Business Intelligence and Big Data Analytics –II (Mining Massive Data sets)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS305	**Business Intelligence and Big Data Analytics –II (Mining Massive Data sets) (Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Describe the Big Data, Statistical concepts, Data Analysis,neural network and fuzzy logic. 2. Illustrate the various algorithms using mapreduce. 3. Explain shingling of documents using various applications such as jaccard's similarity and methods of high degree of similarity,locality sensitive hashing. 4. Summarize the stream concepts, decaying windows, Real time analytics platform(RTAP)	
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.	**15 L**
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	**15 L**

	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.	**15 L**
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).	**15 L**

Text book:

- Mining of Massive Datasets, AnandRajaraman 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

Links:

1) **http://infolab.stanford.edu/~ullman/mmds/book.pdf**
2) **http://freecomputerbooks.com/Mining-of-Massive-Datasets.html**

Sr. No.	List of Practical Experiments on PGCS305
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.	

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** III	
Subject: Machine Intelligence - II (Advanced Machine Learning Techniques)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS306	**Machine Intelligence - II (Advanced Machine Learning Techniques) (Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Discuss detailed knowledge on Basics of Probability, Conditional Probability and various distributions 2. Explain the concepts of Monte Carlo simulation inference in Machine learning 3. Summarize the distribution of scenarios using confidence intervals 4. Describe the various terms related to neural networks, such as activation, backpropagation and feedforward.	
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.	**15 L**
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.	**15 L**
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).	**15 L**

	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.	**15 L**

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): EthemAlpaydın, 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)

Links:

1) https://class.coursera.org/pgm/lecture/preview
2) https://doc.lagout.org/science/Artificial%20Intelligence/Machine%20learning/Machine%20Learning_%20A%20Probabilistic%20Perspective%20%5BMurphy%202012-08-24%5D.pdf

Sr. No.	**List of Practical Experiments on PGCS306**
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.

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.

Detailed syllabus of semester – IV

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** IV	
Subject: Simulation and Modeling			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS401	**Simulation and Modeling** **(Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Describe the need of simulation and time to simulate for the development process to initiate the real problem using framework and development of conceptual model. 2. Interpret the principle and techniques of simulation methods and intellectual concepts of verification and validation of models, dealing with initialization of models. 3. Analyze the components of continuous and discrete systems,communication between agents and building agent based models to simulate any system from different fields. 4. Simulates any discrete system using queuing systems,statecharts at runtime and statecharts for dynamic objects.	
Unit I	**Introduction** Introduction to Simulation, Need of Simulation, Time to simulate, Inside simulation software: Modeling the progress of Time, Modeling Variability, Conceptual Modeling: Introduction to Conceptual modeling, Defining conceptual model, Requirements of the conceptual model, Communicating the conceptual model, Developing the Conceptual Model: Introduction, A framework for conceptual modeling, methods of model simplification.	**15 L**
Unit II	**Model Verification and Validation** Data Collection and Analysis: Introduction, Data requirements, Obtaining data, Representing unpredictable variability, Selecting statistical distributions. Obtaining Accurate Results: Introduction, The nature of simulation models and simulation output, Issues in obtaining accurate simulation results, example model, dealing with initialization bias: warm-up and initial conditions, Selecting the number of replications and run-length. Searching the Solution Space: Introduction, The nature of simulation experimentation, Analysis of results from a single scenario, Comparing alternatives, Search experimentation, and Sensitive analysis. Verification, Validation and	**15 L**

	Confidence: Introduction, Defining Verification and Validation, The difficulties of verification and validation, Methods of verification and validation, Independent verification and validation.	
Unit III	**Modeling and simulation modeling** Types of models, Analytical vs Simulation modeling, Application of simulation modeling, Level of abstraction, Simulation Modeling. Methods, System Dynamics, Discrete Event Modeling, Agent Based modeling: Introduction to Agent, Agent-based modeling**,** Time in agent based models, Space in agent based models, Discrete space, Continuous space movement in continuous space, Communication between agents, Dynamic creation and destruction of agents, Statics on agent population, Condition triggered events and transition in agents. Building agents based models: The problem statement, Phases of modeling, Assumptions, 3 D animation. Dynamics Systems: Stock and flow diagrams, examples of stock and flow diagrams. Multi-method modeling: Architecture, Technical aspects of combining modeling methods, Examples.	**15 L**
Unit IV	**Design and behavior of models** Designing state-based behavior: Statecharts, State transitions, Viewing and debugging Statecharts at runtime, Statecharts for dynamic objects. Discrete events and Event model object: Discrete event, Event-the simplest low level model object, Dynamic events, and Exchanging data with external world. Presentation and animation: Working with shapes, groups and colors, Designing interactive models: using controls, Dynamic properties of controls, 3D Animation. Randomness in Models: Probability distributions, sources of randomness in the model, randomness in system dynamics model, random number generators, Model time, date and calendar: Virtual and real time: The model time, date and calendar, Virtual and real-time execution modes.	**15 L**

Text book:

- Simulation: The Practice of Model Development and Use by Stewart Robinson, John Wiley and Sons, Ltd, 2004.
- The Big Book of Simulation Modeling: Multi Method Modeling by Andrei Borshchev, 2013.

References:

- Agent Based Modeling and Simulation, Taylor S, 2014.
- Simulation Modeling Handbook: A Practical Approach, Christopher A. Chung, 2003.
- Object Oriented Simulation: A Modeling and Programming Perspective, Garrido, José M, 2009.
- Simulation, Modeling and Analysis, Averill M Law and W. David Kelton, "Tata McGraw Hill, Third Edition, 2003.
- Process Control: Modeling, Design and Simulation, Wayne Bequette W, Prentice Hall of India, 2003.

Links:

1) www.geocities.ws/wasubire/modelling/introduction.ppt
2) https://slideplayer.com/slide/10531411/

Sr. No.	List of Practical Experiments on PGCS401

1.	Design and develop agent based model by ● Creating the agent population ● Defining the agent behavior ● Add a chart to visualize the model output. [Use a case scenario like grocery store, telephone call center etc for the purpose].
2.	Design and develop agent based model by ● Creating the agent population ● Defining the agent behavior ● Adding a chart to visualize the model output ● Adding word of mouth effect ● Considering product discards ● Considering delivery time [Use a case scenario like restaurant].
3.	Design and develop agent based model by ● Creating the agent population ● Defining the agent behavior ● Adding a chart to visualize the model output ● Adding word of mouth effect ● Considering product discards ● Consider delivery time ● Simulating agent impatience ● Comparing model runs with different parameter values [Use a scenario like market model]
4.	Design and develop System Dynamic model by ● Creating a stock and flow diagram ● Adding a plot to visualize dynamics ● Parameter Variation ● Calibration [Use a case scenario like spread of contagious disease for the purpose]
5.	Design and develop a discrete-event model that will simulate process by: ● Creating a simple model ● Adding resources ● Creating 3D animation ● Modeling delivery [Use a case situation like a company's manufacturing and shipping].
6.	Design and develop time-slice simulation for a scenario like airport model to design how passengers move within a small airport that hosts two airlines, each with their own gate. Passengers arrive at the airport, check in, pass the security checkpoint and then go to the waiting area. After boarding starts, each airline's representatives check their passengers' tickets before they allow them to board.
7.	Verify and validate a model developed like bank model or manufacturing model
8.	Create defense model to stimulate aircraft behavior
9.	Stimulate the travelling sales man problem to compute the shortest path.
10.	Stimulate the Urban dynamics to address the scenarios like: (a) The problem of public transport line

	(b) To compute the time taken for train to enter the station

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** IV	
Subject : Cloud Computing –III (Building Clouds and Services)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS402	**Cloud Computing –III (Building Clouds and Services)** **(Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Describe the concepts of cloud computing standards, security threats and security mechanisms. 2. Explain various concepts of PKI, IAM, SSO and hardened virtual server images. 3. Define concepts of network perimeter, virtual servers, cloud storage devices in cloud computing. 4. Design the applications and concepts of cloud architectures. 5. Evaluate the process of cloud delivering models, metrics and Cloud Management Mechanisms.	
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.	**15 L**
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,	**15 L**

	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 ManagementArchitecture.	**15 L**
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.	**15 L**

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.

References:

- 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

Links:

1) https://www.openstack.org
2) http://cloudstack.apache.org

Sr. No.	**List of Experiments on PGCS402**
1.	Develop a private cloud using an open source technology.

2.	Develop a public cloud using an open source 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

Recommended Open Source Technologies for completing practical:

- FOSS-Cloud
- Try Stack
- Apache CloudStack
- OpenStack
- Canonical'sOpenStack Autopilot

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

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** IV	
Subject : Cyber and Information Security (Cryptography and Crypt Analysis)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS403	**Cyber and Information Security (Cryptography and Crypt Analysis)** **(Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Describe elementary number theory, algorithms,quadratic residues,reciprocity and theorems. 2. Summarize the cryptography as ciphers, algorithm modes, cryptographic hash functions. 3. Apply the concepts of RSA algorithms, public key cryptosystems, Diffie-Hellman Key Agreement and Knapsack problem. 4. Memorize key agreement and key agreement scheme, public key infrastructures and models privacy in cryptosystems & Trust model.	
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).	**15 L**
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.	**15 L**
Unit III	**RSA Cryptosystem**	**15 L**

	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.	**15 L**

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.

References:

- Network Security and Cryptography, AtulKahate, 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.

Links:

1) http://www.icst.pku.edu.cn/F/course/Cryptography/CryptographyTheoryandpractice(3ed).pdf
2) http://www2.fiit.stuba.sk/~kvasnicka/Mathematics%20for%20Informatics/Rosen_Discrete_Mathematics_and_Its_Applications_7th_Edition.pdf

Sr. No.	List of Practical Experiments on PGCS403
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.

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** IV	
Subject : Business Intelligence and Big Data Analytics (Intelligent Data Analysis)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS404	**Business Intelligence and Big Data Analytics (Intelligent Data Analysis)** **(Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Describe the distance based algorithms, KNN methods, trees, document classification, regression models and trees. 2. Determine the concept of Eigenvalue, Eigen vectors and decompositions. 3. Analyze the Chi Squared Automatic Interaction Detector. 4. Interpret the Evaluation techniques.	
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.	**15 L**
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	**15 L**

	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.	**15 L**
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.	**15 L**

Text book:

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

References:

- 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.

Links:

1) http://infolab.stanford.edu/~ullman/mmds/book.pdf
2) http://freecomputerbooks.com/Mining-of-Massive-Datasets.html

Sr. No.	List of Practical Experiments on PGCS404
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.	

Class: M.Sc Part II	**Branch**: Computer Science	**Semester:** IV	
Subject : Machine Learning –III (Computational Intelligence)			
Period per Week(Each 48 min)	Lecture	04	
	Practical	04	
Evaluation System		**Hours**	**Marks**
	Semester End Examination	2 hrs 30 min	60
	Continuous Internal Assessment	—	40
	Semester End Practical Examination	4	50
	Total	—	150

Course: PGCS405	**Machine Learning –III (Computational Intelligence)** **(Credits : 4 Lectures/Week: 4)**	**No. of Lectures**
	Expected Learning Outcomes: After successful completion of this course, students would be able to: 1. Discuss Artificial neural networks and reinforcement in machine learning. 2. Explain the concepts of genetics algorithms and working in machine learning. 3. Analyze the Particle Swarm Optimization(PSO). 4. Develop fuzzy logic systems for various applications.	
Unit I	**Artificial Neural Networks**	**15 L**

	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.	**15 L**
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.	**15 L**
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.	**15 L**

Text book:

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

References:

- Computational Intelligence And Feature Selection: Rough And Fuzzy Approaches, Richard Jensen QiangShen, IEEE Press Series On Computational Intelligence, A John Wiley & Sons, Inc., Publication, 2008.
- Computational Intelligence And Pattern Analysis In Biological Informatics, (Editors). UjjwalMaulik, SanghamitraBandyopadhyay, Jason T. L.Wang, John Wiley & Sons, Inc, 2010.
- Neural Networks for Applied Sciences and Engineering: From Fundamentals to Complex Pattern Recognition 1st Edition, SandhyaSamarasinghe, 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, QiangShen, Wiley-IEEE Press, 2008

Links:

1) https://leseprobe.buch.de/images-adb/9b/b8/9bb89e22-4a13-48ad-b9c5-5d341e2bcda4.pdf
2) http://www.shahed.ac.ir/stabaii/Files/CompIntelligenceBook.pdf

Sr. No.	List of Practical Experiments on PGCS405
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.	

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/ punchayat.
    - 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.

GUIDELINES FOR RESEARCH IMPLEMENTATION IN SEMESTER – IV

- 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.

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)