Detailed syllabus of semester – I

Course Code	Course Title	Credits
PSCS101	**Analysis of Algorithms and Researching Computing**	**04**

Unit I: Design strategies

The Role of Algorithms in Computing: Algorithms as a technology. Getting Started: Insertion sort, Analyzing algorithms, Designing algorithms. Growth of Functions: Asymptotic notation, Standard notations and common functions. Divide-and-Conquer: The maximum-subarray problem, Strassen's algorithm for matrix multiplication, The substitution method for solving recurrences. Probabilistic Analysis and Randomized Algorithms: The hiring problem, Indicator random variables, Randomized algorithms.

Unit II: Advanced Design and Analysis Techniques

Dynamic Programming: Rod cutting, Elements of dynamic programming, longest common subsequence. Greedy Algorithms: An activity-selection problem, Elements of the greedy strategy, Huffman codes. Elementary Graph Algorithms: Representations of graphs, Breadth-first search, Depth-first search. Minimum Spanning Trees: Growing a minimum spanning tree, Algorithms of Kruskal and Prim. Single-Source Shortest Paths: The Bellman-Ford algorithm, Single-source shortest paths in directed acyclic graphs, Dijkstra's algorithm.

Unit III: Number-Theoretic Algorithms and NP – Completeness

Elementary number-theoretic notions, Greatest common divisor, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element, The RSA public-key cryptosystem NP-Completeness: Polynomial time, Polynomial-time verification, NP-completeness and reducibility, NP-complete problems. Approximation Algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, subset-sum problem.

Unit IV: Researching Computing

Introduction, purpose and products of research, overview of research process, internet research, participants and research ethics, reviewing literature, design and creation, experiments, Quantitative data analysis, presentation of research.

Text book:

- Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, PHI Learning Pvt. Ltd-New Delhi (2009).
- Researching Information Systems and Computing, Brinoy J Oates, Sage Publications India Pvt Ltd (2006).

References:

- Algorithms, Sanjoy Dasgupta , Christos H. Papadimitriou, Umesh Vazirani, McGraw-Hill Higher Education (2006)
- Grokking Algorithms: An illustrated guide for programmers and other curious people, MEAP, Aditya Bhargava, http://www.manning.com/bhargava
- Research Methodology, Methods and Techniques, Kothari, C.R.,1985, third edition, New Age International (2014) .
- Basic of Qualitative Research (3rd Edition), Juliet Corbin & Anselm Strauss:, Sage Publications (2008).

Course Code	Course Title	Credits
PSCS102	**Advanced Networking Concepts**	**04**

Unit I: Networking

Internet and Intranet, Protocol layer and their services, Network Applications like Web, HTTP, FTP and Electronic Mail in the Internet, Domain Name System, Transport-Layer Services, Multiplexing and Demultiplexing, UDP, TCP, TCP Congestion Control, Network Layer, Virtual Circuit and Datagram Networks, Need of Router, The Internet Protocol (IP), Routing Algorithms, Routing in the Internet.

Unit II: Network Virtualization

Need for Virtualization, The Virtual Enterprise, Transport Virtualization-VNs, Central Services Access: Virtual Network Perimeter, A Virtualization Technologies primer: theory, Network Device Virtualization, Data-Path Virtualization, Control-Plane Virtualization, Routing Protocols.

Unit III: Adhoc Networking

Introduction, application of MANET, challenges, Routing in Ad hoc networks, topology & position based approaches, Routing protocols: topology based, position based, Broadcasting, Multicasting, & Geocasting, Wireless LAN, Transmission techniques, MAC protocol issues, Wireless PANs, The Bluetooth technology.

Unit IV: Wireless Sensor networks:

Need and application of sensor networks, sensor networks design considerations, empirical energy consumption, sensing and communication range, design issues, localization scheme, clustering of SNs, Routing layer, Sensor networks in controlled environment and actuators, regularly placed sensors, network issues, RFID as passive sensors.

Text book:

- Computer Networking: A Top-Down Approach 6th edition, James F. Kurose, Keith W. Ross, Pearson (2012).
- Network Virtualization, Victor Moreno, Kumar Reddy, Cisco Press (2006).
- Ad Hoc and Sensor Networks: Theory and Applications 2nd edition; Carlos de Morais Cordeiro, Dharma Prakash Agrawal, World Scientific Publishing Company; 2 edition (2011)

Reference book:

- TCP/IP Protocol Suite 4 edition, Behrouz Forouzan, McGraw-Hill Science (2009)
- Mobile Ad Hoc Networks: Current Status and Future Trends, Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz, CRC Press(2011)
- Fundamentals of Sensor Network Programming: Applications and Technology, S.

Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley-IEEE Press (2010).

Course Code	Course Title	Credits
PSCS103	**Advanced Database Systems**	**04**

Unit I: Distributed Database Concepts

Definition of Distributed databases and Distributed Database Management System (DDBMS), Distributed transparent system. DDBMS Architecture: DBMS standardization, Global, Local, External, and Internal Schemas, Architectural models for DDBMS. Distributed database design: Design problem of distributed systems, Design, strategies (top-down, bottom-up), Fragmentation, Allocation and replication of fragments. Query Processing Overview, Query Optimization.

Unit II: Transaction Processing in Distributed databases and Parallel databases

Transaction Management: Definition and examples, formalization of a transaction, ACID properties, classification of transaction. Concurrency Control: definition, execution schedules, examples, locking based algorithms, timestamp ordering algorithms, deadlock management. DBMS reliability: Definitions and Basic Concepts, Local Recovery Management, In-place update, out-of-place update, Distributed Reliability Protocols, Two phase commit protocol, Three phases commit protocol. Parallel Database System: Definition of Parallel Database Systems. Parallel query evaluation: Speed up and scale up, Query Parallelism: I/O Parallelism (Data Partitioning) Intra-query Parallelism, Inter –Query Parallelism, Intra Operation Parallelism, Inter Operation Parallelism.

Unit III: Object Oriented, Temporal and Spatial Databases:

Object Oriented Database: Object Identity, Object structure, Type Constructors , Encapsulation of Operations, Methods, Persistence, Type and Class Hierarchies, Inheritance, Complex Objects, Object-oriented DBMS , Languages and Design: ODMG Model, Object Definition Languages (ODL), Object Query Languages (OQL). Temporal

and Spatial Database: Introduction to Temporal Database: Time ontology, structure, and granularity, Temporal data models, Temporal relational algebras. Introduction to Spatial Database: Definition, Types of spatial data, Geographical Information Systems (GIS), Conceptual Data Models for spatial databases, Logical data models for spatial databases: rastor and vector model. Physical data models for spatial databases: Clustering methods (space filling curves), Storage methods (R-tree). Query processing.

Unit IV: Deductive, Active, Multimedia and XML Databases

Deductive Database: Introduction to recursive queries, Datalog Notation, Clause Form and Horn Clauses, Interpretation of model: Least Model semantics, The fixed point operator, safe Datalog program, recursive query with negation. Active Database: Languages for rule specification: Events, Conditions, Actions. XML and Database: Structure of XML Data, XML Document Schema, Querying and Transformation, Storage of XML Data. Introduction to multimedia database systems.

Text book:

- Distributed Database; Principles & Systems By Publications, Stefano Ceri and Giuseppo Pelagatti,, McGraw-Hill International Editions (1984)
- Database Management Systems, 3rd edition, Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill (2002).
- Fundamentals of Database Systems, 6thEdition, Elmasri and Navathe, Addison. Wesley (2003).
- Unifying temporal data models via a conceptual model, C.S. Jensen, M.D. Soo, and R.T. Snodgrass: Information Systems, vol. 19, no. 7, pp. 513-547, 1994.
- Spatial Databases: A Tour by Shashi Shekhar and Sanjay Chawla, Prentice Hall, 2003 (ISBN 013-017480-7)
- Principles of Multimedia Database Systems, Subramanian V. S. Elsevier Publishers, 2013.

References:

- Principles of Distributed Database Systems; 2nd Editied By M. Tamer Ozsu and Patrick Valduriez, Person Education Asia.
- Database System Concepts, 5th edition, Avi Silberschatz , Henry F. Korth , S.

Sudarshan: McGraw-Hill (2010)

- Database Systems: Concepts, Design and Applications, 2nd edition, Shio Kumar Singh, Pearson Publishing, (2011).
- Multi-dimensional aggregation for temporal data. M. Böhlen, J. Gamper, and C.S. Jensen. In Proc. of EDBT-2006, pp. 257-275, (2006).
- Moving objects databases (chapter 1 and 2), R.H. Güting and M. Schneider: Morgan Kaufmann Publishers, Inc., (2005)
- Advanced Database Systems, (chapter 5, 6, and 7), Zaniolo et al.: Morgan Kaufmann Publishers, Inc., (1997).

Course Code	Course Title	Credits
PSCS104	**Robotics and Artificial Intelligence**	**04**

Unit I: Introduction to Robotics

What is a Robot? Definition, History of Robots: Control Theory, Cybernetics, Grey Walter Tortoise, Analog Electronic Circuit, Reactive Theory, Braitenberg's Vehicle, Artificial Intelligence, Vision Based Navigation, Types of Robot Control. Robot Components: Embodiment, Sensors, States, Action, Brains and Brawn, Autonomy, Arms, Legs, Wheels, Tracks, and What really drives them effectors and actuators: Effector, Actuator, Passive and Active Actuation, Types of Actuator, Motors, Degree of freedom Locomotion: Stability, Moving and Gaits, Wheels and Steering, Staying on the path. Manipulators: Endeffectors, Teleoperation, Why is manipulation hard? Sensors: Types of Sensors, Levels of Processing, Passive and Active sensors, Switches, Light sensors, Resistive position sensor.

Unit II: Sonar, Lasers and Cameras:

Ultrasonic and Sonar sensing, Specular Reflection, Laser Sensing, Visual Sensing, Cameras, Edge Detection, Motion Vision, Stereo Vision, Biological Vision, Vision for Robots, Feedback or Closed Loop Control: Example of Feedback Control Robot, Types of feedback control, Feed forward or Open loop control.

Unit III: Languages for Programming Robot:

Algorithm, Architecture, The many ways to make a map, What is planning, Cost of planning, Reactive systems, Action selection, Subsumption architecture, How to sequence behavior through world, hybrid control, Behavior based control and Behavior Coordination, Behavior Arbitration, Distributed mapping, Navigation and Path planning.

Unit IV: Artificial Intelligence

Introduction, State space search: Generate and test, Simple search, Depth First Search (DFS), Breadth First Search (DFS), Comparison and quality of solutions. Heuristic Search: Heuristic functions, Best First Search (BFS), Hill Climbing, Local Maxima, Beam search, Tabu search. Finding Optimum paths: Brute force, branch & bound, refine search, Dijkstra's algorithm, A* algorithm. Admissibility of A* algorithm.

Text book:

- The Robotics Primer by Maja J Matarić, MIT press Cambridge, Massachusetts, London, England (2007).
- A First course in Artificial Intelligence, Deepak Khemani, Tata McGraw Hill Education (India) private limited (2013)

References:

- Artificial Intelligence: A Modern Approach, 3e, Stuart Jonathan Russell, Peter Norvig, Prentice Hall Publications (2010).
- Artificial Intelligence Illuminated, Ben Coppin, Jones and Bartlett Publishers Inc (2004)
- Artificial Intelligence A Systems Approach, M Tim Jones, Firewall media, New Delhi (2008)
- Artificial Intelligence -Structures and Strategies for Complex Problem Solving., 4/e, George Lugar, Pearson Education (2002).

List of practical Experiments for Semester – I

Course Code	Course Title	Credits
PSCSP1	**Practical Course on Analysis of Algorithms & Researching Computing & Advanced Networking Concepts**	**04**

Sr No	List of Practical Experiments on Analysis of Algorithms and Researching Computing
1	Write a program to implement insertion sort and find the running time of the algorithm.
2	Write a program to implement merge sot algorithm. Compare the time and memory complexity.
3	Given an array of numbers of length l. Write a program to generate a random permutation of the array using (i) permute-by-sorting() and(ii) permute-by-cyclic().
4	Write a program to implement Longest Common Subsequence (LCS) algorithm
5	Write a program to implement Huffman's code algorithm
6	Write a program to implement Kruskal's algorithm.
7	Write a program to implement Dijkstrass's algorithm
8	Write a program to implement Euclid's algorithm to implement gcd of two non negative integers a and b. Extend the algorithm to find x and y such that gcd(a,b) = ax+by. Compare the running time and recursive calls made in each case.
9	Write a program to verify (i) Euclid's theorem (ii) Fermat's theorem.
10	Write a program to implement greedy set cover algorithm to solve set covering problem.

	List of Practical Experiments on Advanced Networking Concepts
1	Create a network with three routers with RIPv2 and each router associated network will have minimum three PC. Show connectivity
2	Create a network with three routers with OSPF and each router associated network will have minimum three PC. Show connectivity
3	Create a network with three routers with BGP and each router associated network will have minimum three PC. Show connectivity.
4	Configure DHCP server and client for DHCP service.
5	Create virtual PC based network using virtualization software and virtual NIC
6	Create network cloud and hosts
7	Create simple Adhoc network
8	Create MANET simulation for AODVUU Network
9	Create Single mobile network
10	Create wireless network in OMNET++
Note: Practical experiments require software tools like INET Framework for OMNeT++ or NS2, Cisco packet tracer 5.3 or higher, virtualization tools-VMware/virtual Box/ virtualPC.	

Course Code	**Course Title**	**Credits**
PSCSP2	**Practical Course on Advanced Database Systems and Robotics & Artificial Intelligence**	**04**

Sr No	List of Practical Experiments on Advanced Database Systems
1	For a given a global conceptual schema, divide the schema into vertical fragments and place them on different nodes. Execute queries on these fragments that will demonstrate distributed databases environment.
2	For a given a global conceptual schema, divide the schema into horizontal fragments and place them on different nodes. Execute queries on these fragments that will demonstrate distributed databases environment.
3	Place the replication of global conceptual schema on different nodes and execute

	queries that will demonstrate distributed databases environment.
4	Create different types that include attributes and methods. Define tables for these types by adding sufficient number of tuples. Demonstrate insert, update and delete operations on these tables. Execute queries on them
5	Create a nested table and insert sufficient number of tuples and execute queries
6	Create a table with multimedia attribute and issue queries on it.
7	Create a temporal database and issue queries on it.
8	Create a table that stores spatial data and issue queries on it.
9	Formulate a database using active rules with row and statement level.
10	Create a XML data base and demonstrate insert, update and delete operations on these tables. Issue queries on it.
	List of Practical Experiments on Robotics & Artificial Intelligence
1	Write a program to create a robot (i) With gear (ii) Without gear and move it forward, left, right
2	Write a program to create a robot with a two motor and move it forward, left, right
3	Write a program to do a square using a while loop, doing steps with a for loop, to change directions based on condition, controlling motor speed using switch case,
4	Write a program to create a robot with light sensors to follow a line
5	Write a program to create a robot that does a circle using 2 motors
6	Write a program to create a path following robot
7	Write a program to register obstacles
8	Write a program to implement Breadth First Search (BFS) algorithm for a given standard problem
9	Write a program to implement Hill Climbing algorithm for a given standard problem.
10	Write a program to implement A* search algorithm for a given standard problem.

Detailed syllabus of semester – II

Course Code	Course Title	Credits
PSCS201	**Advanced Operating Systems**	**04**

Unit I: Linux Operating Systems

Introduction to kernel, Types of kernel (monolithic, micro, exo), Operating system booting process GRUB-I, GRUB-II. Processes, Interprocess Communication, Scheduling.

Unit II: Memory management and virtual memory in Linux

Basic memory management, swapping, virtual memory, Page replacement algorithms, Design issues for paging systems, segmentation. Case Study: Linux memory management .

Unit III: Input/ Output in Linux

Principles of I/O Hardware, Principles of I/O Software, Deadlocks, RAM Disks, Disks, Terminals. File Systems: Files, Directories, File System Implementation, Security, Protection mechanisms in different Linux versions

Unit IV: Android Operating System

The Android Software Stack, The Linux Kernel – its functions, essential hardware drivers. Libraries - Surface Manager, Media framework, SQLite, WebKit, OpenGL. Android Runtime - Dalvik Virtual Machine, Core Java Libraries. Application Framework - Activity Manager, Content Providers, Telephony Manager, Location Manager, Resource Manager. Android Application – Activities and Activity Lifecycle, applications such as SMS client app, Dialer, Web browser, Contact manager

Text book:

- An Introduction to Operating Systems: Concepts and Practice (GNU/Linux), 4th

edition, Pramod Chandra P. Bhatt, Prentice-Hall of India Pvt. Ltd, 2014.

- Operating System Concepts with Java Eight Edition, Avi Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons, Inc., 2009, http://codex.cs.yale.edu/avi/os-book/OS8/os8j
- UNIX and Linux System Administration Handbook, Fourth Edition, Evi Nemeth, Garth Snyder, Tren Hein, Ben Whaley, Pearson Education, Inc, 2011,
- PROFESSIONAL Android™ 4 Application Development, Reto Meier, John Wiley & Sons, Inc. 2012.

References:

- Operating Systems: Design and Implementation, Third Edition, Andrew S. Tanenbaum, Albert S. Woodhull, Prentice Hall, 2006.
- Fedora Documentation, http://docs.fedoraproject.org/en-US/index.html
- Official Ubuntu Documentation, https://help.ubuntu.com/
- Android Developers, http://developer.android.com/index.html.

Course Code	Course Title	Credits
PSCS202	**Design and implementation of Modern Compilers**	**04**

Unit I: Introduction to Compilers

The structure of a compiler, A simple approach to the design of lexical analyzers, Regular expressions, Finite automata, From regular expressions to finite automata, Minimizing the number of states of a DFA, Context-free grammars, Derivations and Parse trees, Parsers, Shift-reduce parsing, Operator-precedence parsing, Top- down parsing, Predictive parsers.

Unit II: Automatic Construction of Efficient Parsers

LR parsers, The canonical collection of LR(0) items, Constructing SLR parsing tables, Constructing canonical LR parsing tables, Constructing LALR parsing tables, Using ambiguous grammars, An automatic parser generator, Implementation of LR parsing tables, Constructing LALR sets of items.

Unit III: Advanced syntax analysis and basic semantic analysis

Syntax-directed translation schemes, Implementation of syntax-directed translators, Initial introduction to the ongoing Tiger compiler, bindings for the Tiger compiler, type-checking expressions, type-checking declarations, activation records, stack frames, frames in the Tiger compiler, translation to intermediate code, intermediate representation trees, translation into trees, declarations, basic blocks and traces, taming conditional branches, liveness analysis, solution of dataflow equations, liveness in the Tiger compiler, interference graph construction.

Unit IV: Dataflow analysis and loop optimization

The principle sources of optimization, Loop optimization: The DAG representation of basic blocks, Dominators, Reducible flow graphs, Depth-first search, Loop-invariant computations, Induction variable elimination, Some other loop optimizations. Dataflow Analysis: intermediate representation for flow analysis, various dataflow analyses, transformations using dataflow analysis, speeding up dataflow analysis, alias analysis.

Text book:

- Compilers: Principles, Techniques and Tools 2nd edition, Alfred V. Aho , Monica S. Lam , Ravi Sethi , Jeffrey D. Ullman , Pearson (2011)
- Modern Compiler Implementation in Java, Second Edition, Andrew Appel and Jens Palsberg, Cambridge University Press (2004).

References:

- Principles of Compiler Design, Alfred Aho and Jeffrey D. Ullman, Addison Wesley (1997).
- Compiler design in C, Allen Holub, Prentice Hall (1990).

Course Code	Course Title	Credits
PSCS2031	**Elective I- Track A: Cloud Computing (Concepts and Design of Web services)**	**04**

Unit I: Web Service as distributed application

The Service Endpoint Interface (SEI) and Service Implementation Bean (SIB), JAX-WS, Publishing Web Service, Calling Web Service from applications developed in different platform, SOAP, Message transport, Service contract, Web Services returning Richer Data types, WSDL structure.

Unit II: SOAP Based Web Services

Structure of SOAP Message (In JAX-WS), SOAP Messaging Architecture, SOAP Header, Client-side SOAP Handler, Generating a Fault, Service-side SOAP Handler, Handler methods, Message Context and Transport Headers, Web Services and Binary Data.

Unit III: REST-style Web Services

What is REST? HTTP methods, Java API for RESTful Web Services (JAX-RS), JAX-RS with Jersey, CRUD RESTful Web Service, SOAP and REST in Harmony, Interoperability between the Java Platform and WCF, WSIT, Web Services Security, Wire-Level Security, WS-Security.

Unit IV: Amazon Web Services (AWS) Essentials

Architecting on AWS, Building complex solutions with Amazon Virtual Private Cloud (Amazon VPC), Leverage bootstrapping and auto configuration in designs, Architect solutions with multiple regions, Employ Auto Scaling design patterns, Amazon CloudFront for caching, Big data services including AWS Data Pipeline, Amazon Redshift and Amazon Elastic MapReduce. AWS OpsWorks.

Text book:

- Java Web Services Up and Running 2nd edition, Martin Kalin, O'Reilly (2013)
- Pro Power Shell for Amazon Web Services, Brian Beach, Apress, 2014.

Reference:

- Programming Amazon EC2, Jurg van Vliet, Flavia Paganelli, O'Reilly Media, 2011.

- JAX-WS Reference Implementation (RI) Project, https://jax-ws.java.net/.
- Java API for RESTful Services (JAX-RS), https://jax-rs-spec.java.net/.
- RESTful Web Services in Java, https://jersey.java.net/.
- AWS Training, http://aws.amazon.com/training.

Course Code	Course Title	Credits
PSCS2032	**Elective I - Track B: Cyber and Information Security (Network and Communication Security)**	**04**

Unit I: Computer Security

Principles of Security, Different Attacks: malicious and non-malicious program, Types of Computer Criminals. Operating System Security: Protected objects and methods of protection. Memory address protection: Fence, Relocation, Base/Bound Registers, Tagged Architecture, Segmentation, Paging, Directory, access control list. Database Security: Security requirements, Integrity, Confidentiality, Availability, Reliability of Database, Sensitive data, Multilevel database, Proposals for multilevel security. .

Unit II: Network Security

Different types of network layer attacks, Firewall (ACL, Packet Filtering, DMZ, Alerts and Audit Trials) – IDS,IPS and its types (Signature based, Anomaly based, Policy based, Honeypot based). Web Server Security: SSL/TLS Basic Protocol-computing the keys- client authentication-PKI as deployed by SSL Attacks fixed in v3- Exportability-Encoding-Secure Electronic Transaction (SET), Kerberos.

Unit III: Cloud Security

How concepts of Security apply in the cloud, User authentication in the cloud; How the cloud provider can provide this- Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security- storage considerations, backup and recovery-Virtualization System Vulnerabilities, security management standards- SaaS, PaaS, IaaS availability management- access control- Data security and storage in cloud.

Unit IV: Mobile Security:

Mobile system architectures, Overview of mobile cellular systems, GSM and UMTS

Security & Attacks, Vulnerabilities in Cellular Services, Cellular Jamming Attacks & Mitigation, Security in Cellular VoIP Services, Mobile application security. Securing Wireless Networks: Overview of Wireless Networks, Scanning and Enumerating 802.11 Networks, Attacking 802.11 Networks, Bluetooth Scanning and Reconnaissance, Bluetooth Eavesdropping, Attacking & Exploiting Bluetooth, Zigbee Security & Attacks.

Text book:

- Security in Computing 4th edition, Charles P. Pfleeger, Charles P. Pfleeger, Shari Lawrence Pfleeger, Prentice Hall; 4th edition (2006)
- Mobile and Wireless Security and Privacy, Kia Makki, Peter Reiher, Springer, (2007).
- Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory and practice), Tim Mather, Subra Kumaraswamy, Shahed Latif., O'Reilly Media; 1 edition (2009).

Reference:

- Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley (2010)
- Network Security, Charlie Kaufman, Radia Perlam, Mike Speciner, Prentice Hall, 2nd Edition (2002)
- Cryptography and Network Security 3rd edition, Atul Kahate, Tata McGraw Hill Education Private Limited (2013)
- Network Security, Charlie Kaufman, Radia Perlam, Mike Speciner, Prentice Hall, 2nd Edition (2002)
- Cryptography and Network Security: Principles and practice 6th edition, William Stallings, Pearson Education (2013).

Course Code	Course Title	Credits
PSCS2041	**Elective II - Track C: Business Intelligence and Big Data Analytics (Business Intelligence)**	**04**

Unit I: Introduction to Business Intelligence

Operational and Decision Support System, Data-Information-Knowledge-Decision making-Action cycle. Basic definitions- Business Intelligence; Data warehousing, Business Intelligence architecture, Use and benefits of Business Intelligence. Knowledge Discovery in Databases: KDD process model, Data Pre-processing: Cleaning: Missing Values; Noisy Values; Inconsistent values; redundant values. Outliers, Integration, transformation, reduction, Discretization: Equal Width Binning; Equal Depth Binning, Normalization, Smoothing.

Unit II: Introduction to Business Data Warehouse

Definition of Data warehouse, Logical architecture of Data Warehouse, Data Warehouse model- Enterprise warehouse; Data Marts; Virtual warehouse. Populating business Data Warehousing: data integration and extract, transform, load (ETL).

Unit III: Designing Business Data Warehouse

OLTP and OLAP systems, Designing business information warehouse: Principles of dimensional modeling, Data cubes, Data cube operations, data cube schemas.

Unit IV: Introduction to Data Mining

Data mining definitions and process: business and data understanding. Association Analysis: Definition of association rule, General issues: Support; Confidence; Lift; Conviction, Frequent Item sets: APriori Algorithm; Issues with APriori Algorithm, Data structures: Hash tree and FP tree.

Text book:

- Business Intelligence (2nd Edition), Efraim Turban, Ramesh Sharda, Dursun Delen, David King, Pearson (2013)
- Business Intelligence for Dummies, Swain Scheps, Wiley Publications (2008).
- Building the Data Warehouse, Inmon: Wiley (1993).
- Data Mining: Introductory and Advanced Topics, Dunham, Margaret H, Prentice Hall (2006)
- Data Mining: Practical Machine Learning Tools and Techniques, Second Edition, Witten, Ian and Eibe Frank, Morgan Kaufmann (2011)

Reference:

- Business Intelligence Road Map, Larissa T. Moss, Shaku Atr, Addison-Wesley
- Data Modeling Techniques for Data Warehousing by IBM; International Technical Support Organization, Chuck Ballard, Dirk Herreman, Don Schau, Rhonda Bell, Eunsaeng Kim, Ann Valencic :http://www.redbooks.ibm.com
- Data Mining: Concepts and Techniques, The Morgan Kaufmann Series in Data Management Systems, Han J. and Kamber M. Morgan Kaufmann Publishers, (2000).
- Data Mining with Microsoft SQL Server 2008, MacLennan Jamie, Tang ZhaoHui and Crivat Bogdan, Wiley India Edition (2009).

Course Code	Course Title	Credits
PSCS2042	**Elective II - Track D: Machine Learning (Fundamentals of Machine Learning)**	**04**

Unit I: Learning-Standard Linear methods

Statistical Learning: What Is Statistical Learning, Assessing Model Accuracy. Linear Regression: Simple Linear Regression, Multiple Linear Regressions, Other Considerations in the Regression Model, The Marketing Plan, Comparison of Linear Regression with K-Nearest Neighbors. Classification: An Overview of Classification, Why Not Linear Regression? , Logistic Regression, Linear Discriminant Analysis, ,A Comparison of Classification Methods.

Unit II: Selection and improvements of linear learning methods

Resampling Methods: Cross-Validation, The Bootstrap. Linear Model Selection and Regularization: Subset Selection, Shrinkage Methods, Dimension Reduction Methods, Considerations in High Dimensions.

Unit III: Non-Linear Learning methods

Polynomial Regression, Step Functions, Basis Functions, Regression Splines, Smoothing Splines, Local Regression, Generalized Additive Models, Tree-Based Methods: The Basics of Decision Trees. Bagging, Random Forests, Boosting.

Unit IV: Support Vector machines, Principle Component Analysis and Clustering

Support Vector Machines: Maximal Margin Classifier. Support Vector Classifiers: Support Vector Machines, SVMs with More than Two Classes Relationship to Logistic Regression. Unsupervised Learning: The Challenge of Unsupervised Learning, Principal Components Analysis, Clustering Methods: K-Means Clustering, Hierarchical Clustering, Practical Issues in Clustering.

Text book:

- An Introduction to Statistical Learning with Applications in R: Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer 2013.
- The Elements of Statistical Learning: Data Mining, Inference, and Prediction (Second Edition) : Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer (2008).

Reference:

- Introduction to Machine Learning (Second Edition): Ethem Alpaydın, The MIT Press (2010).
- Pattern Recognition and Machine Learning: Christopher M. Bishop, Springer (2006)
- Bayesian Reasoning and Machine Learning: David Barber, Cambridge University Press (2012)
- Machine Learning: The Art and Science of Algorithms that Make Sense of Data: Peter Flach, Cambridge University Press (2012) Machine Learning for Hackers: Drew Conway and John Myles White, O'Reilly (2012)
- Machine Learning in Action: Peter Harrington, Manning Publications (2012).
- Machine Learning with R: Brett Lantz, Packt Publishing (2013)
- https://class.coursera.org/ml-005/lecture/preview
- https://github.com/josephmisiti/awesome-machine-learning.

List of Practical Experiments for Semester –II

Course Code	Course Title	Credits
PSCSP3	**Practical Course on Advanced Operating Systems & Design and implementation of Modern Compilers**	**04**

Sr No	List of Practical Experiments on Advanced Operating Systems
1	Port 17 is known as the 'Quote of the day service'. When a client connects to port 17 on a server, the server responds with a quote for that day. Write a server program so that it delivers a quote of the day. The quotes should be printable ASCII characters and should contain fewer than 512 characters, although multiple lines are allowed. Since port 17 is considered well known and therefore unavailable, have your server listen to port 6017. Write the client code used to read the quotes returned by the server.
2	Write a client–server application using Java sockets that allows a client to write a message (as a String) to a socket. A server will read this message, count the number of characters and digits in the message, and send these two counts back to the client. The server will listen to port 6100. The client can obtain the String message that it is to pass to the server either from the command line or by using a prompt to the user. One strategy for sending the two counts back to the client is for the server to construct an object containing : a. The message it receives from the client b. A count of the number of characters in the message c. A count of the number of digits in the message.
3	Write a multithreaded Java program that outputs prime numbers. This program should work as follows: The user will run the program and will enter a number on

	the command line. The program will then create a separate thread that outputs all the prime numbers less than or equal to the number entered by the user.
4	Servers can be designed to limit the number of open connections. For example, a server may wish to have only N socket connections open at any point in time. After N connections have been made, the server will not accept another incoming connection until an existing connection is released. Write Java programs to demonstrate the scenario
5	Assuming that a system has a 32-bit virtual address, write a Java program that is passed (1) the size of a page and (2) the virtual address. Your program will report the page number and offset of the given virtual address with the specified page size. Page sizes must be specified as a power of 2 and within the range 1024 — 16384 (inclusive). Assuming such a program is named Address, it would run as follows: java Address 4096 19986 and the correct output would appear as: The address 19986 contains: page number = 4 offset = 3602.

6	Write a Java program that simulates the following disk-scheduling algorithms. Design separate classes that implement the following scheduling algorithms:
	a. FCFS
	b. SSTF
	c. SCAN
	d. C-SCAN
	e. LOOK
	Each algorithm will implement the following interface:
	public interface DiskScheduler
	{
	// service the requests
	// return the amount of head movement

	// for the particular algorithm
	public int serviceRequests();
	}
	The serviceRequests() method will return the amount of head movement required by the disk-scheduling algorithm.

7	Write a program that implements the FIFO and LRU page-replacement algorithms presented in this chapter. First, generate a random page reference string where page numbers range from 0 to 9. Apply the random page-reference string to each algorithm, and record the number of page faults incurred by each algorithm. Implement the replacement algorithms so that the number of page frames can vary as well. Assume that demand paging is used. Design and implement two classes—LRU and FIFO—that extend ReplacementAlgorithm. Each of these classes will implement the insert() method, one class using the LRU page-replacement algorithm and the other using the FIFO algorithm. Test your algorithm with suitable Java programs.
8	Using Worker thread write Android code for a click listener that downloads an image from a separate thread and displays it in an ImageView.
9	Write Android activity that includes each of the fundamental lifecycle methods.
10	Write Android application to demonstrate data storage with following options (any one can be asked in Practical examination): Shared Preferences (Store private primitive data in key-value pairs) Internal Storage (Store private data on the device memory) External Storage (Store public data on the shared external storage) SQLite Databases (Store structured data in a private database) Network Connection (Store data on the web with your own network server).
Note: The above practical experiments require following system requirements: • Linux OS Ubuntu® 14.04 with following configurations (use 64 bit) ➢ GNOME or KDE desktop ➢ GNU C Library (glibc) 2.15 or later ➢ 4 GB RAM	

- Sufficient hard disk space
- At least 1 GB for Android SDK, emulator system images, and caches
- 1280 x 800 minimum screen resolution
- Oracle® Java Development Kit (JDK) 7
- Android Studio.

List of Experiments on Design and implementation of Modern Compilers

1	Write a program to convert the given NDFA to DFA.
2	Write a program to convert the given Right Linear Grammar to Left Linear Grammar form.
3	Write a program to illustrate the generation on SPM for the input grammar.
4	Write a program to illustrate the generation on OPM for the input operator grammar
5	Implement a simple program analyzer and interpreter for the straight-line programming language
6	Add semantic actions to your parser to produce abstract syntax for the MiniJava language together with a PrettyPrintVisitor
7	Design a set of visitors, which translate a MiniJava program into intermediate representation trees
8	Implement the translation to Assem instructions for your favorite instruction set (let μ stand for Sparc, Mips, Alpha, Pentium, etc.) using maximal munch.
9	Write a code to generate the DAG for the input arithmetic expression.
10	Write a program to demonstrate loop unrolling and loop splitting for the given code sequence containing loop.

Course Code	Course Title	Credits
PSCSP2	**Practical Course on Elective I and Elective II**	**04**

Sr No	**List of Practical Experiments on** **Elective I-Track A:Cloud Computing (Concepts and Design of Web services)**
1	Develop Time Server service that returns current time in Java and call it from clients developed in Java, PHP, Android and .NET.
2	Develop Web service in Java that returns complex data types (e.g. as List of friends).
3	Develop Web service in Java that returns matrix multiplication by Strassen's algorithm. Two matrices will be entered at run time by client. Server does the matrix multiplication and returns answer to client.
4	Demonstrate CRUD operations with suitable database using SOAP or RESTful Web service.
5	Develop Micro-blogger application (like Twitter) using RESTful Web services.
6	Develop application to consume Google's search / Google's Map RESTful Web service.
7	Develop WCF service returning response in JSON type.
8	Develop application to download image/video from server or upload image/video to server using MTOM techniques.
9	Using AWS Flow Framework develop application that includes a simple workflow. Workflow calls an activity to print hello world to the console. It must define the basic usage of AWS Flow Framework, including defining contracts, implementation of activities and workflow coordination logic and worker programs to host them.
10	Using AWS Flow Framework develop application, 'Booking' for making a

	reservation, including flight and rental car.
Note: The following software is required for conducting the above experiments. • OS: Linux OS Ubuntu® 14.04 (use 64 bit) / Windows 7 (64 bit) • JDK 1.7 • LAMP/WAMP Server • AWS SDK for Java • Microsoft Visual Studio 10 • Android Studio.	
List of Practical Experiments on Elective I-Track B: Cyber &Information Security (Network & Comm. Security)	
1	Write a program to store username and password in an encrypted form in a database to implement integrity lock.
2	Write SQL query to retrieve sensitive information from less sensitive queries
3	Write SQL query to create a view to implement concept of views and commutative filter in distributed databases.
4	Write a program to implement SSL.
5	Write a program to send an encrypted email.
6	Write a program to digitally sign MIME to create an ‘opaque’ signature.
7	Write a program to generate DSA SSH key.
8	Write a program to implement multilevel security.
9	Write a program to Demonstrates how to encrypt and decrypt the content of an XML node using 128-bit CBC AES encryption.
	List of Practical Experiments on Elective II -Track C: Business Intelligence & Big Data Analytics (Business Intelligence)
1	Create tables using different applications.
2	Develop an application to design a warehouse by importing various tables from external sources.

3	Develop an application to creating a fact table and measures in a cube.
4	Develop an application to create dimension tables in a cube and form star schema.
5	Develop an application to create dimension tables in a cube and form snowflake schema.
6	Develop an application to create a dimension table from Parent-Child schema.
7	Develop an application to demonstrate operations like roll-up, drill-down, slice, and dice.
8	Develop an application to demonstrate processing and browsing data from a cube.
9	Develop an application to pre process data imported from external sources.
10	Create association rules by considering suitable parameters.
	List of Practical Experiments on **Elective II -Track D: Machine Intelligence** **(Fundamentals of Machine Intelligence)**
1	Implement simple linear regression model on a standard data set and plot the least square regression fit. Comment on the result. [One may use inbuilt data sets like Boston, Auto etc]
2	Implement multiple regression model on a standard data set and plot the least square regression fit. Comment on the result. [One may use inbuilt data sets like Carseats, Boston etc].
3	Fit a classification model using following: (i) logistic regression (ii) Linear Discriminant Analysis (LDA) and (iii) Quadratic Discriminant Analysis (QDA) on a standard data set and compares the results. [Inbuilt datasets like Smarket, Weekly, Auto, Boston etc may be used for the purpose].
4	Fit a classification model using K Nearest Neighbour (KNN) Algorithm on a given data set. [One may use data sets like Caravan, Smarket, Weekly, Auto and

	Boston].
5	Use bootstrap to give an estimate of a given statistic. [Datasets like Auto, Portfolio and Boston etc may be used for the purpose].
6	For a given data set, split the data into two training and testing and fit the following on the training set: (i) Linear model using least squares (ii) Ridge regression model (iii) Lasso model (iv) PCR model (v) PLS model Report test errors obtained in each case and compare the results. [Data sets like College, Boston etc may be used for the purpose].
7	For a given data set, perform the following: (i) Perform the polynomial regression and make a plot of the resulting polynomial fit to the data. (ii) Fit a step function and perform cross validation to choose the optimal number of cuts. Make a plot of the fit to the data. [Use data set like Wage for the purpose].
8	For a given data set, do the following: (i) Fit a classification tree (ii) Fit a regression tree [One may choose data sets like Carseats, Boston etc for the purpose].
9	For a given data set, split the dataset into training and testing. Fit the following models on the training set and evaluate the performance on the test set: (i) Boosting (ii) Bagging (iii) Random Forest [Data sets like Boston may be used for the purpose].
10	Fit a support vector classifier for a given data set. [Data sets like Car, Khan, Boston etc may be used for the purpose].

11	Perform the following on a given data set: (i) Principal Component Analysis (ii) Hierarchical clustering. [Data set like NC160, USArrests etc may be used for the purpose].
Note: The above practical experiments require the R Software.	

Scheme of Examination for Theory Courses

There will be an 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 particulars of the external examination for each practical course are given below:

Sr No	Semester	Course Code	Particular	No of questions	Marks/ question	Total Marks
1	I	**PSCSP1**	Laboratory experiment question with internal choice	2	40	80
2			Journal	-	10	10
3			Viva	-	10	10
		Total Marks		100		
1	I		Laboratory experiment question with internal choice	2	40	80

Semester III – Theory courses

Course Code	Course Nomenclature	Lecture In Hours	Credits
PSCS 301	Ubiquitous Computing	60	4
PSCS 302	Social Network Analysis	60	4
PSCS 3031	Elective I - Track A: Cloud Computing –II (Cloud Computing Technologies)	60	4
PSCS 3032	Elective I - Track B: Cyber and Information Security- II (Cyber Forensics)		
PSCS 3033	Elective II - Track C: Business Intelligence and Big Data Analytics –II (Mining Massive Data sets)	60	4
PSCS 3034	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 (PSCS301 and PSCS302) are combined together and are proposed as the first practical course (PSCSP5). Similarly, the laboratory experiments from the elective courses are combined together and taken as the second practical course (PSCSP6). 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
PSCSP5	Ubiquitous Computing and Social Network Analysis	60+60= 120	04
PSCSP6	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 PSCSP6. 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) Simulation and Modeling

(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**
PSCS 401	Simulation and Modeling	60	4
PSCS 4021	Specialization - Track A: Cloud Computing –III (Building Clouds and Services)	60	4
PSCS 4022	Specialization - Track B: Cyber and Information Security- II (Cryptography and Crypt Analysis)		
PSCS 4023	Specialization - Track C: Business Intelligence and Big Data Analytics –III (Intelligent Data Analysis)		
PSCS 4024	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. The laboratory experiments from the two theory courses are combined together and are proposed as the first practical course (PSCSP7).

Semester-IV: Practical course

Course code	Course Title	No of hours	Credits
PSCSP7	Simulation & Modeling 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
PSCSP8	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
PSCSP9	Project Implementation	200	06

Detailed syllabus of semester– III

Course Code	Course Title	Credits
PSCS301	**Ubiquitous Computing**	**04**

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
PSCS302	Social Network Analysis	04

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.

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.

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,

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 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: Maksim Tsvetovat, 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, Gábor Csárdi, Springer, 2014.
- Network Analysis: Methodological Foundations, (Editors) Ulrik Brandes, Thomas Erlebach. Springer, 2005.
- Models and Methods in Social Network Analysis: (Editors) Peter J. Carrington, John Scott,Stanley Wasserman, Cambridge University Press, 2005.

Course Code	Course Title	Credits
PSCS3031	**Elective I- Track A: Cloud Computing -II (Cloud Computing Technologies)**	**04**

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
PSCS3032	**Elective I- Track B: Cyber and Information Security- II (Cyber Forensics)**	**04**

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
PSCS3033	**Elective I- Track C: Business Intelligence and Big Data Analytics –II (Mining Massive Data sets)**	**04**

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
PSCS3034	**Elective I- Track D: Machine Intelligence - II (Advanced Machine Learning Techniques)**	**04**

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
PSCSP301	**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
PSCSP302	**Social Network Analysis**	**02**

Sr No	List of Practical Experiments
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 one-mode/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 a 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, Pajek etc and open software/ tools like (i) EGONet; (ii) Ora; (iii) Netlogo; (iv) Pajek; and (v) NetDraw; to do the practical experiments.

Course Code	**Course Title**	**Credits**
PSCSP3031	**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 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

Course Code	Course Title	Credits
PSCSP3032	**Practical Course on Elective I-Track B: Cyber and Information Security- II (Cyber Forensics)**	**02**

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

Course Code	Course Title	Credits
PSCSP3033	**Practical Course on Elective II-Track C: Business Intelligence and Big Data Analytics - II (Mining Massive Data sets -I)**	**02**

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

Course Code	Course Title	Credits
PSCSP3034	**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
PSCS401	**Simulation and Modeling**	**04**

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.

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 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.

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.

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.

Course Code	Course Title	Credits
PSCS4021	**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
PSCS4022	**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
PSCS4023	**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
PSCS4024	**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**
PSCSP401	**Practical course on Simulation and modeling**	**02**

Sr No	List of Practical Experiments
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

Course Code	**Course Title**	**Credits**
PSCSP4021	**Practical Course on Specialization: Cloud Computing (Building Clouds and Services)**	**02**

Sr No	List of Practical Experiments
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

Note

Recommended Open Source Technologies for completing practical:

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

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

Course Code	Course Title	Credits
PSCSP4022	**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
PSCSP2023	**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
PSCSP2024	**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.