Academic Council 26/02/2015

Item No. 4.42

UNIVERSITY OF MUMBAI

Syllabus for Semester-I and Semester -II
Program: M.Sc.
Course: Computer Science

(Credit Based Semester and Grading System with effect from the academic year 2015–2016)

Preamble

This syllabus is an honest attempt to include following ideas, among other things, into practice:

- Bring a new approach to syllabus, not a revision of the existing syllabus.
- Create a unique identity for MSc in Comp Science distinct from similar degrees in other related subjects.
- Recommend provision for specialization in MSc Computer Science degree.
- Offers focus on core Computer Science subjects.
- Incorporate advanced and most recent trends.
- Identify and nurture research temper among students.
- Offer provision for internship with industry.
- Focus, as far as possible, only on open source software.

This syllabus for the semester I and semester II has tried to initiate steps to meet these goals. By extending the syllabus to semester III and semester IV, it is assumed that these goals will be met to a larger extent.

The syllabus proposes to have four core compulsory courses in semester I. Semester II proposes two compulsory courses and two elective courses. Each elective has two tracks of courses based on a recent and emerging area. It is expected that a student continues to take that track for each elective in the semester III and specializes in one of those in the semester IV.

In order to give an impetus to research among students, one of the courses in semester I gives an overview on how to do research in Computer Science. Provision for case study in the practical course of the elective in the semester II is an attempt to translate that theory into practice. It is assumed that, with this back ground, a student can take up a challenging research project in the semester III and semester IV.
In a nutshell, the core philosophy of the syllabus is to (i) give strong foundation on core Computer Science subjects;(ii) expose the student to emerging trends in a gradual and incremental way; (iii) offer specialization on a chosen area (iv) create a research temper among students in the whole process; (v) prepare student community for the demands of ICT industry.

We hope that the student and teaching community will appreciate the thrust, direction and treatment given to the courses in the syllabus. We sincerely believe that a student who takes up this course will be better fit for industry as he or she will have strong foundation on fundamentals and exposure to advanced and emerging trends. We earnestly believe that by focusing on student driven research, learning will be more interesting and stimulating.

We thank all the industry experts, senior faculties and our colleagues department of Computer Science of different colleges as well as University of Mumbai; who have given their valuable comments and suggestions, which we tried to incorporate. We thank the Chairperson and members of the Adhoc Board of Studies in Computer Science of University for their faith in us. Thanks to one and all who have directly or indirectly helped in this venture.

Structure of the syllabus

This is the syllabus for the semester –I and semester –II of MSc Computer Science program of University of Mumbai to be implemented from the year 2015-2016. The syllabus offers four theory courses and two practical courses each in each semester. One noteworthy feature of the syllabus is the introduction of Electives in different tracks in the semester II. Each elective has two tracks (track A and track B for elective I and track C and track D elective II). It is assumed that a student will continue with that track in the semester III and choose only one elective in the semester IV, the subject in which he or she wants to specialize in.

Semester I

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

Semester –I: Theory courses

The four theory courses offered in semester I are:

(i) Analysis of Algorithms and Researching Computing

(ii) Advanced Networking Concepts

(iii) Advanced Database Systems and

(iv) Robotics & Artificial Intelligence.

Each of these courses is of four credits each and is expected to complete in 60 hours. The following table gives the details of the theory courses in Semester -I.

Semester – I: Theory courses

Course code	Course Title	No of hours	Credits
PSCS101	Analysis of Algorithms and Researching Computing	60	04

PSCS102	Advanced Networking Concepts	60	04
PSCS103	Advanced Database Systems	60	04
PSCS104	Robotics and Artificial Intelligence	60	04
Total Credits for Theory courses in Semester -I			16

Semester –I: Practical Lab courses

The syllabus proposes two laboratory courses of 4 credits each. The laboratory experiments from first two theory courses (PSCS101 and PSCS102) are combined together and are proposed as the first practical course (PSCSP101). Similarly, the laboratory experiments from the last two theory courses (PSCS103 and PSCS104) are combined together and called as the second practical course (PSCSP102). As far as the practical are concerned, equal weightage similar to that of theory courses has been given in terms of the number of hours. The following table summarizes the details of the practical courses in the semester I.

Semester I – Practical Laboratory courses

Course code	Course Title	No of hours	Credits
PSCSP101	Analysis of Algorithms & Researching Computing and Advanced Networking Concepts	60+60= 120	04
PSCSP102	Advanced Database Systems and Robotics & Artificial Intelligence	60+60= 120	04
Total Credits for Practical Laboratory courses in Semester –I			08

Semester –II

The syllabus proposes four subjects in semester –II also. As in the case of semester –I, each subject has theory and practical components.

Semester II- Theory courses

The four theory courses offered in semester II are

(i) Advanced Operating Systems

(ii) Design and implementation of Modern Compilers

(iii) Elective - I

(a) Track A: Cloud Computing – I (Concepts and Design of Web services)

(b) Track B: Cyber and Information Security – I (Network Security)

(iv) Elective – II

(a) Track C: Business Intelligence and Big Data Analytics – I (Business Intelligence)

(b) Track D: Machine Intelligence – I (Fundamentals of Machine Intelligence)

A student can take either track A or track B from Elective – I. Similarly one can take either track C or track D from Elective – II. Each of these courses (compulsory as well as elective) is of four credits each and is expected to complete in 60 hours. The details are shown in the following table.

Semester II – Theory courses

Course code	**Course Title**	**No of hours**	**Credits**
PSCS201	Advanced Operating Systems	60	04
PSCS202	Design and implementation of Modern Compilers	60	04
PSCS2031	Elective I- Track A: Cloud Computing (Concepts and Design of Web services)	60	04
PSCS2032	Elective I- Track B: Cyber and Information Security (Network Security)		
PSCS2041	Elective II - Track C:Business Intelligence and Big Data Analytics (Business Intelligence)	60	04
PSCS2042	Elective II - Track D: Machine Intelligence (Fundamentals of Machine Intelligence)		
Total Credits for Theory courses in Semester II			16

Semester –II: Practical Laboratory courses

The syllabus proposes two laboratory courses of 4 credits each. The laboratory experiments from the first two theory courses (PSCS201 and PSCS202) are combined together and are proposed as the first practical course (PSCSP201). Similarly, the laboratory experiments from the elective courses are combined together and taken as the second practical course (PSCSP202). The following table summarizes the details of the practical courses in the semester –II.

Semester II – Practical Laboratory courses

Course code	Course Title	No of hours	Credits
PSCSP201	Analysis of Algorithms &Researching Computing and Advanced Networking Concepts	60+60= 120	04
PSCSP202	Elective I and Elective II	60+60= 120	04
Total Credits for Practical Laboratory courses in Semester –II			08

Case study: The syllabus proposes a case study under the lab course on Elective -I and Elective - II (PSCSP202). A student is expected to select a topic related to his or her chosen track belonging to either Elective -I or Elective- II and make a case study report. It is expected that the student refers at least five research papers in the process of making the case study. By introducing the case study in the second semester, the syllabus prepares a student to take up a research project in the semester III and semester IV.

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

2		**PSCSP2**	Journal	-	10	10
3			Viva	-	10	10
		Total Marks		100		
Sr No	**Semester**	**Course Code**	**Particular**	**No of questions**	**Marks/ question**	**Total Marks**
1	II	**PSCSP3**	Laboratory experiment question with internal choice	2	40	80
2			Journal	-	10	10
3			Viva	-	10	10
		Total Marks		100		
1	II	**PSCSP4**	Laboratory experiment question with internal choice	2	25	50
2			Journal	-	10	10
3			Viva	-	10	10
4			Evaluation of Case Study	1	30	30
		Total Marks		100		

Guidelines for Case Study in the Semester –II

The syllabus proposes introduction of a case study to be done by students in the semester –II. The objective of this step is to make learning more student-centric and to create a sense of involvement. Student can choose any topic related to one of the elective courses chosen by him or her. It is expected that the student refers to at least FIVE research papers as part of the case study. Working on a case study is expected to help the student to appreciate the coverage of the topics discussed in the 'Analysis of algorithms and researching computing' course studied in the semester I. This would also help the student to choose a good project topic and undertake a rigorous literature review needed for the project to be undertaken in the semester III and semester IV.

- The case study can be taken by students individually or as a group of two.
- The efforts for the case study should be spread over a period of at least 8 weeks.
- The case study should cover a topic related to one of the electives chosen by the student.
- Student should make a case study report of around 10-15 pages and submit during the practical examination.
- A presentation and viva based on the case study will be undertaken during the practical examination.

The following are some examples of case studies for each track. The list is only for illustration purpose and students are advised to choose a topic of their interest.

Elective – I: Track A: Cloud Computing

- Consumption of REST services in heterogeneous environment by an Android client.
- Service Oriented Architecture (SOA) approach to support heterogeneity, decentralization and fault tolerance in large distributed systems.
- Cloud security measures adopted in Elastic Compute Cloud (EC2) of Amazon Web Services (AWS).

Elective – I: Track B: Cyber and Information Security

- Game theoretic approach to shield collaborative wireless network.
- Application of emoticons in the area of cryptography.
- Digital Watermarking techniques for encryption and decryption

Elective – II: Track C: Business Intelligence and Big Data Analytics

- Assuming that you have been engaged to submit a blue print for the development of a data warehouse for an e-commerce company, make a project report detailing different steps to be taken for the purpose.
- Effectiveness of Hadoop as an open source companion to standard data warehouses.
- Emerging trends on cloud based business intelligence and analytics.

Elective – II: Track D: Machine Intelligence

- Machine intelligence approaches in stock market prediction.
- Recognizing Devnagri scripts using different machine intelligence techniques.
- Identify an area where support vector machines are used and discuss different approaches applied.

Guidelines for maintenance of journals:

A student should maintain a journal with at least ten practical experiments reported for each of the practical course. Related theory/algorithm need to be explained in journal. Certified journals need to be submitted at the time of the practical examination.

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