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S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Syllabus for: M.Sc. Computer Science

Program: M.Sc.

Course Code: Computer Science (RPSCS)

(Choice Based Credit System (CBCS) with effect from academic year 2019-20)

M.Sc Computer Science SYLLABUS

CREDIT BASED SYSTEM AND GRADING SYSTEM

ACADEMIC YEAR 2019-2020

Semester -I: Practical Lab courses

The syllabus proposes four laboratory courses of 2 credits each. The practical have equal weightage similar to that of theory courses that 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 (THEORY & PRACTICAL)					
COURSE CODE	**COURSE TITLE**	**CREDITS**	**PRACTICAL COURSE**	**CREDITS**	**TOTAL CREDITS**
RPSCS101	Analysis of Algorithms	4	RPSCSP101	2	6
RPSCS102	Advanced Computer and Enterprise Networking	4	RPSCSP102	2	6
RPSCS103	Advanced Database Management Systems	4	RPSCSP103	2	6
RPSCS104	Robot Computing	4	RPSCSP104	2	6

Semester -II

The syllabus proposes four subjects in semester-II same 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,a 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 & PRACTICAL)					
COURSE CODE	**COURSE TITLE**	**CREDITS**	**PRACTICAL COURSE**	**CREDITS**	**TOTAL CREDITS**
RPSCS201	Advanced Operating Systems	4	RPSCSP201	2	6
RPSCS202	Design and implementation of Modern Compilers Networking	4	RPSCSP202	2	6
RPSCS203A	Elective I- Track A: Cloud Computing (Concepts and Design of Web services)	4	RPSCSP203A	2	6
RPSCS203B	Elective I- Track B: Cyber and Information Security (Network Security)	4	RPSCSP203B	2	6
RPSCS204A	Elective II - Track C:Business Intelligence and BigData Analytics	4	RPSCSP204A	2	6
RPSCS204B	Elective II - Track D: Machine Intelligence (Fundamentals of Machine Intelligence)	4	RPSCSP204B	2	6

Semester-III

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

Semester-III: Theory courses

The four theory courses offered in semester-III are:

i) Social Network Analysis

ii) Elective - I

(a) Track A: Cloud Computing - II (Cloud Computing Technologies)

(b) Track B: Cyber and Information Security - II (Cyber Forensics)

iii) Elective - II

(a) Track C: Business Intelligence and Big Data Analytics - II (Mining Massive Data sets)

(b) Track D: Machine Learning - II (Advanced Machine Learning)

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

SEMESTER – III (THEORY & PRACTICAL)					
COURSE CODE	**COURSE TITLE**	**CREDITS**	**PRACTICAL COURSE**	**CREDITS**	**TOTAL CREDITS**
RPSCS301	Social Network Analysis	4	RPSCSP301	2	6
RPSCS302A	Elective I - Cloud Computing -II(Cloud Computing Technologies)	4	RPSCSP302A	2	6
RPSCS302B	Elective I - Cyber andInformation Security- II (Cyber Forensics)	4	RPSCSP302B	2	6
RPSCS303A	Elective II - Business Intelligence and Big Data Analytics -II(Mining Massive	4	RPSCSP303A	2	6
RPSCS303B	Elective II - Machine Learning - II(Advanced Machine Learning)	4	RPSCSP303B	2	6
--	PROJECT	-	RPSCSP304	-	6

Project: The syllabus introduces a project to be done in the semester-III. 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. The project will be based on a topic related to the elective the student has been pursuing in semester -II and should finish in Semester III along with the implementation and dissertation of the project.The experimental set up, analysis of results, comparison with results of related works, conclusion and prospects will be part of the project implementation. Thestudent is expected to make a project implementation report and appear for a project viva.

He or she needs to spend around 300 hours for the project implementation, which fetches 6 credits.

Semester -IV

The syllabus proposes three subjects in semester-IV, each with theory and practical components. In addition, there will be internship with industry. 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 three 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 & PRACTICAL)					
COURSE CODE	**COURSE TITLE**	**CREDITS**	**PRACTICAL COURSE**	**CREDITS**	**TOTAL CREDITS**
RPSCS401	Simulation and Modeling	4	RPSCSP401	2	6
RPSCS402A	Elective I - Cloud Computing -III (Building Clouds and Services)	4	RPSCSP402A	2	6
RPSCS402B	Elective II - Cyber and Information Security- II (Cryptography and Crypt Analysis)	4	RPSCSP402B	2	6
RPSCS402C	Elective III - Business Intelligence and Big Data Analytics -III (Intelligent Data Analysis)Massive Data sets)	4	RPSCSP402C	2	6

RPSCS402D	Elective IV - Machine Learning -III (Computational Intelligence)	4	RPSCSP402D	2	6
---	Internship	-	RPSCSP403	-	12

Semester-IV: Internship with industry

The syllabus proposes an internship for about 600 hours to be done by a student. It is expected that a student chooses an IT or IT-related industry and formally works as a fulltime 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 by the person, to whom the student was reporting, with Organization's seal should be attached as part of the documentation.

SEMESTER I

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS101	**Analysis of Algorithms**	**4**	**4**

Course Objective:

- Understanding and computing algorithm complexity
- Designing and analyzing various algorithmic models for searching and problem solving.
- Solving traditional problems with new application and approaches..

Expected Learning Outcome:

Students completing this course will be able to:

- Working and analysis of Algorithms

UNITS	COURSE CONTENTS	NO. OF LECTURES
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, thesubstitution method for solving recurrences. Probabilistic Analysis and RandomizedAlgorithms: The hiring problem, Indicator random variables, Randomized algorithms.	15 L
II	**Advanced Design and Analysis Techniques:** Dynamic Programming: Rod cutting, Elements of dynamic programming, longestcommon subsequence. Greedy Algorithms: An activity-selection problem, Elements ofthe greedy strategy, Huffman codes. Elementary Graph Algorithms: Representations ofgraphs, Breadth-first search, Depth-first search. Minimum Spanning Trees: Growing aminimum 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.	15 L
III	**Number-Theoretic Algorithms:** Elementary number-theoretic notions, Greatest common divisor, Modular arithmetic,Solving modular linear equations, The Chinese remainder theorem, Powers of anelement, The RSA public-key cryptosystem	15 L
IV	**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.	15 L

Text book:

1.Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charles E.Leiserson, Ronald L. Rivest, Clifford Stein, PHI Learning Pvt. Ltd-New Delhi(2009).

2.Researching Information Systems and Computing, Brinoy J Oates, Sage Publications India Pvt Ltd (2006).

References:

1.Algorithms, Sanjoy Dasgupta , Christos H. Papadimitriou, UmeshVazirani,McGraw-Hill Higher Education (2006)

2. Grokking Algorithms: An illustrated guide for programmers and other curious people, MEAP, Aditya Bhargava, http://www.manning.com/bhargava

3.Research Methodology, Methods and Techniques, Kothari, C.R.,1985, third edition, New Age International (2014) .4. Basic of Qualitative Research (3rd Edition), Juliet Corbin & Anselm Strauss:,
Sage Publications (2008).

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP101	**PRACTICAL OF Algorithms and analysis**	**2**	**4**
	1.Write a program on Strassen's algorithm for matrix multiplication and analyze its complexity. 2. Give a solution for hiring problem analyze its complexity. 3. Write a dynamic program for rod cutting analyze its complexity. 4. Perform graph search algorithm using Breath First, Depth first analyze its complexity. 5. Give best cost optimization using a) Dijkstra's algorithm b) Bellman-Ford algorithm Kruskal and Prim 6. Apply Chinese reminder theorem to a constrain satisfaction problem analyze its complexity. 7. AKS primality test program for run time polynomial testing analyze its complexity. 8. Write a problem on travelling Salesman problem analyze its complexity.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS102	**Advanced Computer and Enterprise Network Architecture**	**4**	**4**

Course Objective:

- Understanding advance routing techniques
- Looking head to new age networking using virtual network.
- Exploring new techniques in Adhoc networks
- Understanding Enterprise network management.

Expected Learning Outcome:

Students completing this course will be able to:

- Understand architecture of Advanced computer Networks

UNITS	COURSE CONTENTS	NO. OF LECTURES

I	**TCP-Suite and Routing** Introduction to TCP, Network Layer, Transport Layer, Application Layer Network Layer, IPV4, ARP, Mobile IP, Routing Algorithms, Routing in the Internet.	15 L
II	**Network Virtualization:** Need for Virtualization, Introducing VMware NSX –The Platform for Network Virtualization, Compelling Technical Features and Characteristics, Compelling Capabilities and Business Value	15 L
III	**Wireless and 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.	15 L
IV	**Enterprise Networking Architecture:** Enterprise Campus Architecture and Design Introduction, Campus Architecture and Design Principles, Modularity, Campus Services, Virtualization Services, Security Services	15 L

Text book:

1) TCP/IP Protocol Suite 4 edition, Behrouz Forouzan, McGraw-Hill Science (2009)
2) Network Virtualization, Victor Moreno, Kumar Reddy, Cisco Press (2006).
3) Ad Hoc and Sensor Networks: Theory and Applications 2nd edition; Carlos de MoraisCordeiro, Dharma Prakash Agrawal, World Scientific Publishing Company; 2 edition (2011)
4) VMware NSX Network Essentials by C. Sreejith
5) Enterprise Campus 3.0 Architecture: Overview and Framework

References:

1) Computer Networking: A Top-Down Approach 6th edition, James F. Kurose, Keith W. Ross, Pearson (2012)
2) Mobile Ad Hoc Networks: Current Status and Future Trends, Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz, CRC Press(2011)

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP102	**PRACTICAL OF Advanced computer and Networking Concepts**	**2**	**2**

	1 Implementation of Routing Algorithms a) RIP2 b) OSPF c) EIGRIP d) BGP 2 Implement virtual network in VMware and demonstrate the same. 3 Demonstrate load Balancing in Virtual network 4. Perform fail over configurations in VMware 5. Create a Manet 6. Create a wireless sensor network 7. Create and demonstrate an enterprise network 8. Enable and configure security services in enterprise networking		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS103	**Advanced Database Management Systems**	**4**	**4**

Course Objective:

- Effective implementation of database
- Understanding use and implementation of DDBMS
- Understanding use and implementation of OODBMS
- To lay down bases for advance Mining and Big Data analytics

Expected Learning Outcome:

Students completing this course will be able to:

- Design dtabase schema with the use of appropriate data types
- To create ,manupulate query and back up database.

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Advance Databases:** Introduction of Advanced Databases Systems: The rudiments and basic principles of database administration and design- data and information, fundamental structures, normalisation, homogeneous structures, database administration, the designing of the database.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.	15 L
II	**Distributed Database Concepts** Definition of Distributed databases and Distributed Database Management System	15 L

	(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. Transaction Management: Definition and examples, formalization of a transaction, ACID properties, classification of transaction. Concurrency Control: definition, executionschedules, examples, locking based algorithms, timestamp ordering algorithms,deadlock management.	
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: ODMGModel, Object Definition Languages (ODL), Object Query Languages (OQL). Temporal	15 L
IV	**Semi- Structured Databases** 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. Introduction NoSQL.	15 L

Text book:

- Sadalage, Pramod; Fowler, Martin (2012). NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. Addison-Wesley. ISBN 0-321-82662-0
- Distributed Database; Principles & Systems By Publications, Stefano Ceri andGiuseppoPelagatti,, McGraw-Hill International Editions (1984)
- Database Management Systems, 3rd edition, Raghu Ramakrishnan andJohannesGehrke, 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. ElsevierPublishers, 2013

References:

- Principles of Distributed Database Systems; 2nd Editied By M. Tamer Ozsu and Patrick Valduriez, Person Education Asia.
- Database System Concepts, 5th edition, AviSilberschatz , 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 NAME	CREDITS	LECTURE/ WEEK
RPSCSP103	**PRACTICAL OF Advanced Database Management Systems**	**2**	**2**
	1. Demonstrate the use of XML and Multimedia Databases is a case study. 2. Demonstrate the use of Active databases using triggers and cursors in a case study. 3. Demonstrate the application of distributed databases in a scenario 4. Implement and demonstrate the use of parallel database and transactions 5. Develop an object-oriented database for a scenario 6. Implement deductive databases for a scenario. 7. Create a NoSQL database for an application. 8. Implement spatial database for a scenario		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS104	**Robot Computing**	**4**	**4**
Course Objective: To Learning the working of Robot			

How Computing inn Roboting

Expected Learning Outcome:

- Understanding implementation of Robot
- Simulating actuators and working with the same.
- Designing A.I. strategy and Heuristics.

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	Introduction to Robotics:What is a Robot? Definition, History of Robots: Control Theory, Cybernetics, GreyWalter Tortoise, Analog Electronic Circuit, Reactive Theory, Braitenberg's Vehicle,Artificial Intelligence, Vision Based Navigation, Types of Robot Control. RobotComponents: 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 offreedom Locomotion: Stability, Moving and Gaits, Wheels and Steering, Staying on thepath. Manipulators: Endeffectors, Teleoperation, Why is manipulation hard? Sensors:Types of Sensors, Levels of Processing, Passive and Active sensors, Switches, Lightsensors, Resistive position sensor.	15 L
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 forRobots, Feedback or Closed Loop Control: Example of Feedback Control Robot, Typesof feedback control, Feed forward or Open loop control.	15 L
III	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.	15 L
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.	15 L

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, PeterNorvig, 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).

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP104	**PRACTICAL OF Robot Computing**	**2**	**2**
	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 A* search algorithm for a given standard problem.		

SEMESTER II

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS201	**Advanced Operating Systems**	**4**	**4**

Course Objective:

- Understanding advanced Operating System concepts
- Working with real time operating Systems
- Understanding working of multiprocessor operating systems
- Understanding working of current Operating systems and other trends in Operating Systems

Expected Learning Outcome:

Students completing this course will be able to:

- Understanding various types of ooperating systems
- Working with real time & cluster

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	Process Synchronization: Overview, Synchronization Mechanisms, Process Deadlocks.Distributed Operating Systems: Architectures of Distributed Systems, Theoretical Foundations, Distributed Mutual Exclusion, Distributed Deadlock Detection, Agreement ProtocolsDistributed Resource Management: Distributed File Systems, Distributed Share Memory, Distributed Scheduling	15 L
II	Failure Recovery Failure Recovery and Fault Tolerance, Recovery, Fault Tolerance. Protection and Security, Resource Security and Protection Access and Flow Control ,Data Security Cryptography	15 L
III	Multiprocessor and Database Operating System. Multiprocessor Operating Systems: Multiprocessor System Architectures, Multiprocessor Operating SystemsDatabase Operating Systems :Introduction to Database Operating Systems, Concurrency Control Theoretical Aspects	15 L
IV	System Recovery, Real Time and Multimedia Operating system Lightweight Recoverable Virtual Memory, Rio Vista, Quicksilver, Internet Scale Computing, Giant Scale Services, MapReduce, Content Delivery Networks. Real-Time and Multimedia, Time sensitive Linux, Persistent temporal streams	15 L

Text book:

- Multiprocessor Operating Systems: Multiprocessor System Architectures, Multiprocessor Operating Systems Singhal, Mukesh.
- Database Operating Systems :Introduction to Database Operating Systems, Concurrency Control Theoretical Aspects, Concurrency Control
- 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, PeterBaerGalvin,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, EviNemet, Garth Snyder, Tren Hein, Ben Whaley, Pearson Education, Inc, 2011,

References:

- Operating Systems: Design and Implementation, Third Edition, Andrew S. Tanenbaum, Albert S. Woodhull, Prentice Hall, 2006

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP201	**PRACTICAL OF Advanced Operating Systems**	**2**	**2**
	1. Demonstrate synchronization mechanism in process management using threads 2. Implement mutual exclusion based algorithms a) Decker's algorithm b) Lamport algorithm c) Perterson's algorithm 3. Implementation of failure recovery by method of graceful degradation 4. Create a network on nodes to demonstrate fault tolerance using Ring management protocol. 5. Working with database operating system to demonstrate concurrency management. 6. Create a multimedia server using Linux to stream multimedia files over the clients on request. 7. Demonstrate internet scale computing using any network operating system. 8. Demonstrate cluster computing system.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS202	**Design and implementation of Modern Compilers**	**4**	**4**

Course Objective:

- Understanding working of System Software
- Implementation of Compliers (Toy Compiler)
- Understanding new techniques in compliers and design.

Expected Learning Outcome:

Students completing this course will be able to:

- Working with system softwares
- Developing Toy compilers

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	System Software: Introduction to System Software, Introduction to Compiling, A simple one passcompiler	15 L
II	Lexical Analysis, Syntax Analysis	15 L
III	Syntax directed translation , Type Checking Run, Time Environments	15 L
IV	Intermediate Code generations , Code generation , Code Optimization	15 L

Text book:

- Compilers: Principles, Techniques and Tools 2nd edition, Alfred V. Aho , MonicaS. Lam , Ravi Sethi , Jeffrey D. Ullman , Pearson (2011)
- Modern Compiler Implementation in Java, Second Edition, Andrew Appel andJens 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 NAME	CREDITS	LECTURE/ WEEK
RPSCSP202	**PRACTICAL OF Design and implementation of Modern Compilers**	**2**	**2**
	1. Write a program to implement shift reduce parser and to display the configuration using the a given grammar. 2. Write a program to implement the conversion of DFA using the given regular expression. 3. Write a c program to implement the conversion of NFA from regular expression 4. To check the syntax of looping statements in 'C' language 5. To check the syntax of input and output statements in 'C++' language 6. Implement SPM also use warshall's algorithm, SPF 7. Implement OPM, OPF 8. Implement LALR parser given the action table.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS203A	**Elective I- Track A: Cloud Computing (Concepts and Design of Web services)**	**4**	**4**

Course Objective:

- Working cloud architecture and designing solutions
- Understaing the SOA
- Working SOAP

Expected Learning Outcome:

Students completing this course will be able to:

- Launching web services on cloud
- Understand and implement of SOA

UNITS	COURSE CONTENTS	NO. OF LECTURES
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 differentplatform, SOAP, Message transport, Service contract, Web Services returning RicherData types, WSDL structure.	15 L
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 BinaryData.	15 L
III	REST-style Web Services: What is REST? HTTP methods, Java API for RESTful Web Services (JAX-RS), JAX-RSwith 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.	15 L
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, Architectsolutions with multiple regions, Employ Auto Scaling design patterns, AmazonCloudFront for caching, Big data services including AWS Data Pipeline, AmazonRedshift and Amazon Elastic MapReduce. AWS OpsWorks.	15 L

References:

- 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 NAME	CREDITS	LECTURE/ WEEK
RPSCP203A	**PRACTICAL OF Elective I- Track A: Cloud Computing (Concepts and Design of Web services)**	**2**	**2**
	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.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS203B	**Elective I - Track B: Cyber and Information Security (Network and Communication Security)**	**4**	**4**

Course Objective:

- Computer Security protocols
- Understanding networking security
- Understanding cloud security

Expected Learning Outcome:

- Working with mobile and cloud security
- Developing application to understand computer and network security

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	Computer Security Principles of Security, Different Attacks: malicious and non-malicious program, Types of Computer Criminals. Operating System Security: Protected objects	15 L

	and methods ofprotection. Memory address protection: Fence, Relocation, Base/Bound Registers, Tagged Architecture, Segmentation, Paging, Directory, access control list. DatabaseSecurity: Security requirements, Integrity, Confidentiality, Availability, Reliability of Database, Sensitive data, Multilevel database, Proposals for multilevel security. .	
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, Policybased, 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.	15 L
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 andESXi 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.	15 L
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 802.11Networks, Attacking 802.11 Networks, Bluetooth Scanning and Reconnaissance,Bluetooth Eavesdropping, Attacking & Exploiting Bluetooth, Zigbee Security & Attacks.	15 L

Text book:

- Security in Computing4th 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).

References:

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

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP203B	**PRACTICAL OF Track B: Cyber and Information Security (Network and Communication Security)**	**2**	**2**
	1. Demonstrate techniques for file and data integrity 2. Demonstrate techniques to create multi-level access control in databases 3. Create a honey pot and demonstrate the following a)Penetration b)Phishing 4. Configure and implement SSL/TSL for any webpages to maintain secure session communication. 5. Write a program to send an encrypted email which allows the user to choose the type of encryption. Implement any 3 techniques. 6. Implement ESX file system security in cloud. 7. Develop application to implement Zigbee security. 8. Demonstrate and implement Bluetooth security.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS204A	**Elective II - Track C: Business Intelligence and Big Data Analytics (Business Intelligence)**	**4**	**4**

Course Objective:

- Understanding Business Intelligence
- Understanding OLTP and OLAP
- Understanding Datawarehousing and mining

Expected Learning Outcome:

Students completing this course will be able to:

- Developing and understaning business intelliegence systems
- Working data warehousing and mining for DSS

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	Introduction to Business Intelligence, Business View of Information Technology Applications, Types of Digital Data	15 L
II	Introduction to OLTP and OLAP, Getting Started with Business Intelligence,BI Definitions and Concepts	15 L
III	Basics of Data Integration, Need for Data Warehouse, Definition of Data Warehouse, Multidimensional Data Modeling, Measures, Metrics, KPIs and Performance Management, Basics of Enterprise Reporting	15 L
IV	Understanding Statistics, Application of Analytics, Data Mining Algorithms, BI Road Ahead	15 L

Text book:

- Fundamentals of Business Analytics, 2ed R N Prasad, Seema Acharya

- Business Intelligence (2nd Edition), Efraim Turban, Ramesh Sharda, DursunDelen, 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, PrenticeHall (2006)
- Data Mining: Practical Machine Learning Tools and Techniques, Second Edition,Witten, Ian and Eibe Frank, Morgan Kaufmann (2011)

References:

- 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 Zhao Hui andCrivat Bogdan, Wiley India Edition (2009).

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP204A	**PRACTICAL OF Elective II - Track C: Business Intelligence and Big Data Analytics (Business Intelligence)**	**2**	**2**
	1) Create a database application that takes • Structure data • Unstructured data • Semi-Structured data 2) Create an application that works on operational system and generated data to be implemented for OLTP. 3) Develop an OLAP service to incorporate data from an OLTP system and generate appropriate results. 4) Demonstrate business intelligence using appropriate OLAP reports and queries. 5) Create data-marts for a thus demonstrate data integration techniques to create data-warehouse using bottom up approach. 6) Demonstrate various data modelling techniques 7) Develop application to apply time series analysis 8) 8. Demonstrate mining techniques		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS204B	**Elective II - Track D: Machine Learning (Fundamentals of Machine Learning)**	**4**	**4**
Course Objective: • Understanding various learning startegies			

- Mathematical represetation of Machine learning problems and solutions

Expected Learning Outcome:

Students completing this course will be able to:

- Machine learning using linear methods and non linear methods
- Developing machine learning architectures for clustering

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Learning-Standard Linear methods:**Statistical Learning: What Is Statistical Learning, Assessing Model Accuracy. Linear Regression: Simple Linear Regression, Multiple Linear Regressions, OtherConsiderations 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.	15 L
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.	15 L
III	**Non-Linear Learning methods:** Polynomial Regression, Step Functions, Basis Functions, Regression Splines, Smoothing Splines, Local Regression, Generalized Additive Models, Tree-BasedMethods: The Basics of Decision Trees. Bagging, Random Forests, Boosting.	15 L
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 LogisticRegression. Unsupervised Learning: The Challenge of Unsupervised Learning, Principal Components Analysis, Clustering Methods: K-Means Clustering, Hierarchical Clustering, Practical Issues in Clustering.	15 L

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).

References:

- Introduction to Machine Learning (Second Edition): EthemAlpaydın, 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.

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP204B	**PRACTICAL OF Elective II - Track D: Machine Learning (Fundamentals of Machine Learning)**	**2**	**2**
	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: • Perform the polynomial regression and make a plot of the resulting polynomial fit to the data. • 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 Car seats, Boston etc for the purpose].		

SEMESTER III

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS301	**Social Network Analysis**	**4**	**4**

Course Objective:

- Understanding the working of Social Networks
- Working with Social networking
- Understanding statistically the working of Social Networks

Expected Learning Outcome:

- Statistical results for analyzing Social Networking
- Understanding the behavior for Social Networking

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Introduction to social network analysis (SNA)** Introduction to networks and relations- analyzing relationships to understand people and groups, binary and valued relationships, symmetric and asymmetric relationships, multimode relationships, Using graph theory for social networks analysis- adjacency matrices, edge-lists, adjacency lists, graph traversals and distances, depth-first traversal, breadth-first traversal paths and walks, Dijkstra's algorithm, graph distance and graph diameter, social networks vs. link analysis, ego-centric and socio-centric density.	15 L
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 between nesscentrality, local and global centrality, centralization and graph centers, notion of importance within network, Google pagerank algorithm, Analyzing network structure-bottom-up approaches using cliques, N-cliques, N-clans, K-plexes, K-cores, F-groups and top-down approaches using components, blocks and cut-points, lambda sets and bridges, and factions.	15 L
III	**Measures of similarity and structural equivalence in SNA** Approaches to network positions and social roles- defining equivalence r similarity, structural equivalence, automorphic equivalence, finding equivalence sets, brute forceand Tabu search, regular equivalence, equivalence of distances: Maxsim, regularequivalence, Measuring	15 L

	similarity/dissimilarity- valued relations, Pearson correlationscovariance and cross-products, Understanding clustering- agglomerative and divisiveclusters, Euclidean, Manhattan, and squared distances, binaryrelations, matches:exact, Jaccard, Hamming,	
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 usingtwo-mode core periphery analysis, two-mode factions analysis, affiliation and attributenetworks.	15 L

Text book:

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

References:

1. Exploratory Social Network Analysis with Pajek, Second edition: WouterdeNooy, Andrej Mrvar, Vladimir Batagelj, Cambridge University Press, 2011.
2. Analyzing Social Networks, Stephen P Borgatti, Martin G. Everett, JeffreyC.Johnson, SAGE Publications, 2013.
3. Statistical Analysis of Network Data with R: Eric D. Kolaczyk, GáborCsárdi,Springer, 2014.
4. Network Analysis: Methodological Foundations, (Editors) UlrikBrandes, ThomasErlebach. Springer, 2005.
5. Models and Methods in Social Network Analysis: (Editors) Peter J. Carrington,JohnScott,Stanley Wasserman, Cambridge University Press, 2005

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP301	**PRACTICAL OF Social Network Analysis**	**2**	**4**
	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.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS302A	**Elective I- Track A: Cloud Computing -II (Cloud Computing Technologies)**	**4**	**4**

Course Objective:

- Understanding various technologies in Cloud
- Developing and creating cloud infrastructure

Expected Learning Outcome:

- Creating and executing cloud services
- Understanding enterprise application services in cloud

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Parallel and Distributed Computing** Elements of parallel computing, elements of distributed computing, Technologies fordistributed computing: RPC, Distributed object frameworks, Service oriented computing. Virtualization - Characteristics, taxonomy, virtualization and cloud computing.	15 L
II	**Computing Platforms** Cloud Computing definition and characteristics, Enterprise Computing, The internet as aplatform, Cloud computing services: SaaS, PaaS, IaaS, Enterprise architecture, Typesof clouds.	15 L
III	**Cloud Technologies** Cloud computing platforms, Web services, AJAX, mashups, multi-tenant software,Concurrent computing: Thread programming, High-throughput computing:Taskprogramming, Data intensive computing: Map-Reduce programming	15 L
IV	**Software Architecture** Dev 2.0 platforms, Enterprise software: ERP, SCM, CRMCustom enterprise applications and Dev 2.0, Cloud applications.	15 L

Textbook:

1. Enterprise Cloud Computing Technology, Architecture, Applications, GautamShroff, Cambridge University Press, 2010
2. Mastering In Cloud Computing, RajkumarBuyya, Christian Vecchiola AndThamariSelvi S, Tata Mcgraw-Hill Education, 2013
3. Cloud Computing: A Practical Approach, Anthony T Velte, Tata Mcgraw Hill,2009

References:

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

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP302A	**PRACTICAL OF Elective I - Track A: Cloud Computing -II (Cloud Computing Technologies)**	**2**	**2**
	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)		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS302B	**Elective I- Track B: Cyber and Information Security- II (Cyber Forensics)**	**4**	**4**

Course Objective:

- Understanding vulnerabilities in computer
- Computer forensics
- Understand security protocols

Expected Learning Outcome:

- Students completing this course will be able to:
- Develop strategies to analyze security loop holes
- Develop and understand security protocols in computer and networking

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Computer Forensic Fundamentals:** Introduction to Computer Forensics andobjective, the Computer Forensics Specialist, Use of Computer Forensic in LawEnforcement, Users of	15 L

	Computer Forensic Evidence, Case Studies, InformationSecurity Investigations. Types of Computer Forensics Technology: Types of Military Computer Forensic Technology, Types of Law Enforcement Computer ForensicTechnology, Types of Business Computer Forensic Technology, Specialized ForensicsTechniques, Hidden Data, Spyware and Adware, Encryption Methods andVulnerabilities, Protecting Data from Being Compromised, Internet Tracing Methods, Security and Wireless Technologies. Types of Computer Forensics Systems: Studydifferent 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.	
II	**Data Recovery:** Data Recovery and Backup, Role of Data Recovery, Hidingand Recovering Hidden Data. Evidence Collection: Need to Collect the Evidence, Typesof Evidences, The Rules of Evidence, Collection Steps. Computer Image Verificationand Authentication: Special Needs of Evidence Authentication. Identification of Data: Timekeeping, Forensic Identification and Analysis of Technical Surveillance Devices,Reconstructing Past Events: How to Become a Digital Detective, Useable File Formats,Unusable File Formats, Converting Files.	15 L
III	**Network Forensics:** Sources of Network Based Evidence, Principles ofInternetworking, 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 andAnalysis, Common Attacks, Locating Wireless Devices. Network Intrusion Detection andAnalysis: NIDS/NIPS Functionality, Modes of Detection, Types of NIDS/NIPS,NIDS/NIPS Evidence Acquisition	15 L
IV	**Network Devices and Mobile Phone Forensics:** Sources of Logs, NetworkArchitecture, Collecting and Analyzing Evidence, switches, routers, firewalls, interfaces Web Proxies: Need to Investigate Web Proxies, Functionality, Evidence, Squid, WebProxy Analysis, Encrypted Web Traffic. Mobile Phone Forensics: Crime and Mobile Phones, Voice, SMS and Identification of Data Interception in GSM, Mobile PhoneTricks, SMS Security, Mobile Forensic.	15 L

Text book:

1. Computer Forensics Computer Crime Scene Investigation, John R. Vacca,Second Edition, 2005.
2. Network Forensics, Sherri Davidoff, Jonathan HAM, Prentice Hall, 2012.

3. Mobile Phone Security and Forensic: A Practical Approach, Second Edition, IosifI. Androulidkis, Springer, 2012.

References:

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

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP302B	**PRACTICAL OF Elective I-Track B: Cyber and Information Security- II (Cyber Forensics)**	**2**	**2**
	1. Write a program to take backup of mysql database 2. Write a program to restore mysql database 3. Use Drive Image 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		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS303A	**Elective II- Track C: Business Intelligence and Big DataAnalytics -II (Mining Massive Data sets)**	**4**	**4**

Course Objective:

- Understanding overview of BIG data
- Analyzing Big Data
- Understanding working with Business intelligences

Expected Learning Outcome:

Students completing this course will be able to:

- Big data using Hadoop
- Map Reduce using Hadoop

• Shingling using hadoop		
UNITS	**COURSE CONTENTS**	**NO. OF LECTURES**
I	**Introduction To Big Data** Big data: Introduction to Big data Platform, Traits of big data, Challenges ofconventional systems, Web data, Analytic processes and tools, Analysis vsReporting,Modern data analytic tools, Statistical concepts: Sampling distributions, Re-sampling,Statistical Inference, Prediction error. Data Analysis: Regression modeling, Analysis oftime Series: Linear systems analysis, Nonlinear dynamics, Rule induction, Neuralnetworks: Learning and Generalization, Competitive Learning, Principal Component Analysis and Neural Networks, Fuzzy Logic: Extracting Fuzzy Models from Data, FuzzyDecision Trees, Stochastic Search Methods.	15 L
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 andProjections,Union, Intersection, and Difference, Natural Join. Extensions to MapReduce: WorkflowSystems, Recursive extensions to MapReduce, Common map reduce algorithms.	15 L
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. TheTheory of Locality-Sensitive functions. Methods for high degrees of similarity.	15 L
IV	**MINING DATA STREAMS** Introduction to streams concepts - Stream data model and architecture, Streamcomputing, Sampling data in a stream, Filtering streams, Counting distinct elements in astream, Estimating moments, Counting oneness in a Window, Decaying window, Realtime analytics Platform(RTAP).	15 L

Text book:

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

References:

1. Big Data for Dummies, J. Hurwitz, et al., Wiley, 2013
2. 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.

3. 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.
4. Big Data Glossary, Pete Warden, O'Reilly, 2011.
5. Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph, David Loshin, Morgan Kaufmann Publishers, 2013

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP303A	**PRACTICAL OF Elective II - Track C: Business Intelligence and Big Data Analytics -II (Mining Massive Data sets)**	**2**	**2**
	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.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS303B	**Elective II- Track D: Machine Intelligence - II (Advanced Machine Learning Techniques)**	**4**	**4**
Course Objective:			

- Machine learning algorithms
- Working with realtime machine learning problems
- Mathematics of machine learning

Expected Learning Outcome:

Students completing this course will be able to:

- Solving problems involved in machine learning
- Developing strategies for machine learning

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Probability** A brief review of probability theory, Some common discrete distributions, Somecommon continuous distributions, Joint probability distributions, Transformations ofrandom 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, TheEM algorithm.	15 L
II	**Kernels** Introduction, kernel function, Using Kernel inside GLMs, kernel trick, Support vectormachines, 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 randomfields): Conditional independence properties of UGMs, Parameterization of MRFs, Learning, Conditional random fields (CRFs), applications of CRFs.	15 L
III	**Monte Carlo inference** Introduction, Sampling from standard distributions, Rejection sampling, Importancesampling, Particle filtering, Applications: visual object tracking, time series forecasting, Rao-Blackwellised ParticleFiltering(RBPF).Markov chain Monte Carlo (MCMC) inference: Gibbs sampling, Metropolis Hastingsalgorithm, Speed and accuracy of MCMC.	15 L
IV	**Graphical model structure learning** Structure learning for knowledge discovery, Learning tree structures, Learning DAGstructure with latent variables, Learning causal DAGs, Learning undirected Gaussian graphical models, Learning undirected discrete graphical models. Deep learning: Deepgenerative models, Deep neural networks, Applications of deep networks.	15 L

Text book:

1. Machine Learning: A Probabilistic Perspective: Kevin P Murphy, The MIT PressCambridge (2012). Network Forensics, Sherri Davidoff, Jonathan HAM,

References:

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

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP303B	**PRACTICAL OF Elective II- Track D: Machine Intelligence - II (Advanced Machine Learning Techniques)**	**2**	**2**
	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.		

SEMESTER IV

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS401	**Simulation and Modeling**	**4**	**4**

Course Objective:

- Simulate and model computer applications
- Understanding various models in simulations
- Working with strategies to simulate

Expected Learning Outcome:

Students completing this course will be able to:

- Developing simulation system to simulate real life scenarios
- Exploring scenarios using 3D visualizations

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Introduction** Introduction to Simulation, Need of Simulation, Time to simulate, Inside simulationsoftware: Modeling the progress of Time, Modeling Variability, Conceptual Modeling: Introduction to Conceptual modeling, Defining conceptual model, Requirements of theconceptual model, Communicating the conceptual model, Developing the Conceptual Model: Introduction, A framework for conceptual modeling, methods of modelsimplification.	15 L
II	**Model Verification and Validation** Data Collection and Analysis: Introduction, Data requirements, Obtaining data,Representing unpredictable variability, Selecting statistical distributions. ObtainingAccurate Results: Introduction, The nature of simulation models and simulation output,Issues in obtaining accurate simulation results, example model, dealing withinitialization bias: warm-up and initial conditions, Selecting the number of replicationsand run-length. Searching the Solution Space: Introduction, The nature of	15 L

	simulationexperimentation, Analysis of results from a single scenario, Comparing alternatives,Search experimentation, and Sensitive analysis. Verification, Validation andConfidence: Introduction, Defining Verification and Validation, The difficulties ofverification and validation, Methods of verification and validation, Independent verification and validation.	
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 EventModeling, Agent Based modeling:Introduction to Agent, Agent-based modeling, Time inagent based models, Space in agent based models, Discrete space, Continuous spacemovement in continuous space, Communication between agents, Dynamic creation anddestruction of agents, Statics on agent population, Condition triggered events andtransition in agents. Building agents based models:The problem statement, Phases ofmodeling, Assumptions, 3 D animation. Dynamics Systems: Stock and flow diagrams,examples of stock and flow diagrams. Multi-method modeling: Architecture, Technicalaspects of combining modeling methods, Examples.	15 L
IV	**Design and behavior of models** Designing state-based behavior: Statecharts, State transitions, Viewing and debuggingStatecharts at runtime, Statecharts for dynamic objects. Discrete events and Eventmodel object: Discrete event, Event-the simplest low level model object, Dynamicevents, and Exchanging data with external world. Presentation and animation: Workingwith shapes, groups and colors, Designing interactive models: using controls, Dynamicproperties of controls, 3D Animation. Randomness in Models: Probability distributions,sources of randomness in the model, randomness in system dynamics model, randomnumber generators, Model time, date and calendar: Virtual and real time: The modeltime, date and calendar, Virtual and real-time execution modes.	15 L

Textbook:

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

References:

1. Agent Based Modeling and Simulation, Taylor S, 2014.
2. Simulation Modeling Handbook: A Practical Approach, Christopher A. Chung,2003.
3. Object Oriented Simulation: A Modeling and Programming Perspective, Garrido,José M, 2009.
4. Simulation, Modeling and Analysis, Averill M Law and W. David Kelton, "TataMcGraw Hill, Third Edition, 2003.
5. Process Control: Modeling, Design and Simulation, Wayne Bequette W, PrenticeHall of India, 2003.

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP401	**PRACTICAL OF Simulation and Modeling**	**2**	**2**

	1. 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] 2. 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] 3. 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]. 4. 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] 5. 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] 6. 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]. 7. 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. 8. Verify and validate a model developed like bank model or manufacturing model 9. Create defense model to stimulate aircraft behavior		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS402A	**Specialization: Cloud Computing -III (Building Clouds and Services)**	**4**	**4**

Course Objective:
- Cloud services and architecture
- Working with various technologies

Expected Learning Outcome:
- Students completing this course will be able to:
- Explaining the working or various technologies

UNITS	COURSE CONTENTS	NO. OF LECTURES
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 SecurityMechanisms, Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO), Cloud-Based SecurityGroups, Hardened Virtual Server Images.	15 L
II	**Cloud Computing Mechanisms**	15 L

	Cloud Infrastructure Mechanisms, Logical Network Perimeter, Virtual Server, CloudStorage Device, Cloud Usage Monitor, Resource Replication Ready-MadeEnvironment. Specialized Cloud Mechanisms, Automated Scaling Listener, LoadBalancer, 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, ResourceManagement System, SLA Management System, Billing Management System.	
III	**Cloud Computing Architecture** Fundamental Cloud Architectures, Workload Distribution Architecture, Resource PoolingArchitecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture,Service Load Balancing Architecture, Cloud Bursting Architecture, Elastic DiskProvisioning Architecture, Redundant Storage Architecture. Advanced CloudArchitectures, Hypervisor Clustering Architecture, Load Balanced Virtual ServerInstances Architecture, Non-Disruptive Service Relocation Architecture, Zero DowntimeArchitecture, Cloud Balancing Architecture, Resource Reservation Architecture,Dynamic Failure Detection and Recovery Architecture, Bare-Metal ProvisioningArchitecture, Rapid Provisioning Architecture, Storage Workload ManagementArchitecture.	15 L
IV	**Working with Clouds** Cloud Delivery Model Considerations, Cloud Delivery Models: The Cloud ProviderPerspective, Building IaaS Environments, Equipping PaaS Environments, OptimizingSaaS Environments, Cloud Delivery Models: The Cloud Consumer Perspective. CostMetrics and Pricing Models, Business Cost Metrics, Cloud Usage Cost Metrics, Cost Management Considerations. Service Quality Metrics and SLAs, Service QualityMetrics, Service Availability Metrics, Service Reliability Metrics, Service PerformanceMetrics, Service Scalability Metrics, Service Resiliency Metrics.	15 L

Text book:

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

References:

1. Tom Fifield, Diane Fleming, Anne Gentle, Lorin Hochstein, Jonathan Proulx,Everett Toews, and Joe, Topjian,OpenStack Operations Guide, O'Reilly Media,Inc, 2014.
2. 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
3. https://www.openstack.org
4. http://cloudstack.apache.org

5. http://www.foss-cloud.org/en/wiki/FOSS-Cloud
6. http://www.ubuntu.com/cloud/openstack/autopilot

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP402A	**PRACTICAL OF Track A: Cloud Computing - III (Building Clouds and Services)**	**2**	**2**
	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		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS402B	**Specialization: Cyber and Information Security (Cryptography and Crypt Analysis)**	**4**	**4**

Course Objective:
- How to work with cryptography
- Explain the working of crypt analysis

Expected Learning Outcome:
Students completing this course will be able to:
- cyber security
- working with various crypto logical algorithms

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Introduction to Number Theory**	15 L

	Topics in Elementary Number Theory: O and notations, time estimates for doingarithmetic-divisibility and the Euclidean algorithm, Congruence: Definitions andproperties, linear congruence, residue classes, Euler's phi function, Fermat's LittleTheorem, Chinese Reminder Theorem, Applications to factoring, finite fields, quadraticresidues and reciprocity: Quadratic residues, Legendre symbol, Jacobi Symbol. (proofsof the theorems are not expected to cover).	
II	**Simple Cryptosystems** Shift Cipher, Substitution Cipher, Affine Cipher, Vigenère Cipher, Vermin Cipher, HillCipher, Permutation Cipher, Stream Cipher, Cryptanalysis of Affine Cipher, SubstitutionCipher, Vigenère Cipher and Hill Cipher, Block Ciphers, Algorithm Modes, DES, DoubleDES, Triple DES, Meet-in-Middle Attack, AES, IDEA algorithm. Cryptographic HashFunctions: Hash Functions and Data Integrity, Security of Hash Functions, Secure HashAlgorithm, Message Authentication Code, Nested MACs, HMAC.	15 L
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-1Algorithm, Dixon's Random Squares Algorithm, Attacks on RSA, The RabinCryptosystem. Public Key Cryptosystems: The idea of public key Cryptography, TheDiffie-Hellman Key Agreement, ElGamal Cryptosystem, The Pollard Rho DiscreteLogarithm Algorithm, Elliptic Curves, Knapsack problem.	15 L
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 Agreementscheme. Public-Key Infrastructure:What is PKI?, Secure Socket Layer, Certificates,Certificate Life cycle, Trust Models: Strict Hierarchy Model, Networked PKIs, The webbrowser Model, Pretty Good Privacy.	15 L

Text book:

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

References:

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

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK

RPSCSP402B	**PRACTICAL OF Track B: Cyber and Information Security-III (Cryptography and Cryptanalysis)**	**2**	**2**
	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.		

COURSE CODE	**COURSE NAME**	**CREDITS**	**LECTURE /WEEK**
RPSCS402C	**Specialization: Business Intelligence and Big Data Analytics (Intelligent Data Analysis)**	**4**	**4**

Course Objective:

- Understanding various strategies in data mining
- Understand techniques for classification, clustering etc.

Expected Learning Outcome:

Students completing this course will be able to:

- Develop application to perform real life data mining staregies
- Working to data warehousing and big data analytics for the same

UNITS	**COURSE CONTENTS**	**NO. OF LECTURES**
I	**Clustering** Distance/Similarity, Partitioning Algorithm: K-Means; K-Medoids, Partitioning Algorithmfor large data set: CLARA; CLARANS, Hierarchical Algorithms: Agglomerative(AGNES); Divisive (DIANA), Density based clustering: DBSCAN, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism.	15 L
II	**Classification** Challenges, Distance based Algorithm: K nearest Neighbors and kD-Trees, Rules andTrees based Classifiers, Information gain theory, Statistical based classifiers: Bayesianclassification, Document classification, Bayesian	15 L

	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).	
III	**Dimensionality Reduction** Introduction to Eigen values and Eigen vectors of Symmetric Matrices, Principal-Component Analysis, Singular-Value Decomposition, CUR Decomposition	15 L
IV	**Link Analysis And Recommendation Systems** Link analysis: PageRank, Efficient Computation of PageRank, Topic-SensitivePageRank, Link Spam. Recommendation Systems: A Model for RecommendationSystems, Content-Based Recommendations, Collaborative Filtering, DimensionalityReduction.	15 L

Text book:

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

References:

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

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP402C	**PRACTICAL OF Track C: Business Intelligence and Big Data Analytics - III (Intelligent Data Analysis)**	**2**	**2**

	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.		

COURSE CODE	COURSE NAME	CREDITS	LECTURE /WEEK
RPSCS402D	**Specialization: Machine Learning -III (Computational Intelligence)**	**4**	**4**

Course Objective:

- Developing computation models for ANNs
- Understanding and representing intelligence
- Working computer intelligence

Expected Learning Outcome:

Students completing this course will be able to:

- Develop strategies and heuristics for working with ANNs
- Develop evolutionary strategies to working on real world problems and solve the same.

UNITS	COURSE CONTENTS	NO. OF LECTURES
I	**Artificial Neural Networks** The Artificial Neuron, Supervised Learning Neural Networks, Unsupervised LearningNeural Networks, Radial Basis Function Networks, Reinforcement Learning, Performance Issues.	15 L
II	**Evolutionary Computation** Introduction to Evolutionary Computation, Genetic Algorithms, Genetic Programming,Evolutionary Programming, Evolution Strategies, Differential Evolution, CulturalAlgorithms, Co-evolution.	15 L
III	**Computational Swarm Intelligence** Particle Swarm Optimization(PSO) - Basic Particle Swarm Optimization, Social NetworkStructures, Basic Variations and parameters, Single-Solution PSO. Advanced Topics	15 L

	and applications. Ant Algorithms- Ant Colony Optimization Meta-Heuristic, CemeteryOrganization and Brood Care, Division of Labor, Advanced Topics and applications.	
IV	**Artificial Immune systems, Fuzzy Systems and Rough Sets** Natural Immune System, Artificial Immune Models, Fuzzy Sets, Fuzzy Logic andReasoning, Fuzzy Controllers, Rough Sets.	15 L

Text book:

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

References:

1. Computational Intelligence And Feature Selection: Rough And FuzzyApproaches, Richard Jensen Qiang Shen, IEEE Press Series On ComputationalIntelligence, A John Wiley & Sons, Inc., Publication, 2008.
2. Computational Intelligence And Pattern Analysis In Biological Informatics,(Editors). Ujjwal Maulik, Sanghamitra Bandyopadhyay, Jason T. L.Wang, JohnWiley& Sons, Inc, 2010.
3. Neural Networks for Applied Sciences and Engineering: From Fundamentals to Complex Pattern Recognition 1st Edition, Sandhya Samarasinghe, Auerbach Publications, 2006.
4. Introduction to Evolutionary Computing (Natural Computing Series) 2nd ed, A.E. Eiben , James E Smith, Springer; 2015.
5. Swarm Intelligence, 1st Edition, Russell C. Eberhart, Yuhui Shi, James Kennedy, Morgan Kaufmann, 2001
6. Artificial Immune System: Applications in Computer Security, Ying Tan, Wiley-IEEE Computer Society, 2016.
7. Computational Intelligence and Feature Selection: Rough and Fuzzy Approaches 1st Edition, Richard Jensen, Qiang Shen, Wiley-IEEE Press, 2008

COURSE CODE	COURSE NAME	CREDITS	LECTURE/ WEEK
RPSCSP402D	**PRACTICAL OF Track D: Machine Learning - III (Computational Intelligence)**	**2**	**2**
	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.		

MSc EVALUATION SCHEME

THEORY (100 Marks)

Internal Exam-40 Marks

i. **20 Marks Test:**

It will be conducted either using any open source learning management system such as Moodle (Modular object-oriented dynamic learning environment)

ii. **20 Marks-**

Develop a project in the group(maximum five students) and presentation.

Or

Tutorial of around 10 problems to be solved in class

Or

Quizzes consisting of at least 20 questions based on current trends.

Or

Complete MOOC courses assigned by teachers

External Examination- 60 Marks Duration 2½Hrs

Theory Question Paper Pattern (COMPUTER SCIENCE):-

All Questions are Compulsory		
Questions	**Based On**	**Marks**
Q.1	Unit I	12
Q.2	Unit II	12
Q.3	Unit III	12
Q.4	Unit IV	12
Q.5	Based on all units	12

- All questions shall be compulsory with internal choice within the questions.
- Each Question will have 4 sub-questions carrying 6 marks each, out of which student has to answer only 2.

PRACTICAL (50 Marks)

Internal Practical - 20 Marks

10 Marks- Individual Practical Implementation & Performance

- Each student will maintain an e-journal. After every practical student will upload his practical in the form of documents along with the screenshots of output on the online portal (Moodle/Google site/any LMS).
- Students should show their regular practical completion chart duly signed by faculty with dates.

10 Marks–Design and implement the innovative application of the technology

External Practical Component - 30 Marks

30 Marks Practical Question -

- The student must acquire at least 40% marks in each paper individually.

PROJECT (150 Marks)

INTERNAL COMPONENT - 50 Marks

- Abstract submission & literature Survey / sample data collection - 10 Marks
- Technology Implementation - 20 marks
- Mid-Term Presentation - 20 Marks
- Project Documentation- 10 marks

EXTERNAL COMPONENT - 100 Marks

- Project Quality - 20 Marks.
- Project Implementation - 30 Marks.
- Presentation - 40 Marks.

A Student should submit a project implementation report with the following details:

1) **Title:** Title of the project.
2) **Implementation details:** A description of how the project has been implemented. It shall be of 2 to 4 pages.
3) **Experimental setup and results:** A detailed explanation of how experiments were conducted, what software used, and the results obtained. Details like screenshots, tables and graphs can come here. It shall be of 6 to 10 pages.
4) **Analysis of the results:** A description of what the results mean and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this. It shall be of 4 to 6 pages.
5) **Conclusion:** A conclusion of the project performed in terms of its outcome (Maybe half a page).
6) **Future enhancement:** A small description on what enhancement can be done when more time and resources are available (Maybe half a page).
7) **Program code:** The program code may be given as an appendix.

INTERNSHIP (300 Marks)

INTERNAL COMPONENT - 120 Marks

Assessment will be done by the Employer and Internship Coordinator jointly. Following are the guidelines:

- Job description (20 Marks)

- Technical knowledge/skills (20 Marks)
- Innovation & creativity (20 Marks)
- Adherence to Schedule (weekly activity report) (20 Marks)
- Soft Skills (Communication, Individual & Team work, Resource Management, Leadership qualities) (20 Marks)
- Discipline & behavior (20 Marks)

EXTERNAL COMPONENT - (180) Marks

On the basis of the detailed internship report submitted by the student duly signed by the employer and the internal faculty. A presentation is expected from the student for sharing his/her learning experience and work done at the internship.

- Internship Report (20 Marks))
- Innovation and creativity (30 Marks)
- Experience based learning (30 Marks)
- Viva (40 Marks)
- Internship Genuineness (30 Marks)
- Soft Skills (30 Marks)

PASSING CRITERIA 40%: - Student must acquire a minimum of 40% marks each course (Theory, Practical, Project& Internship).

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