

## **COURSE I**

### **RESEARCH METHODOLOGY**

#### **Course Objectives**

- To understand the types of research and thesis writing.
- To learn to use tools related to research in Computer Science.
- To learn to calculate the computing time of algorithms and ideas related to NP-Completeness.
- To learn Formal Language of Computer Science, its grammar and its applications
- To learn and use probability and applications of probability in areas such as System Reliability.
- To understand the concepts of Logic and Natural Deduction Systems.

#### **Unit I**

Thesis Writing: Research types – objectives and approaches – Literature collection, Web browsing – Software tools – Writing review and journal articles – manuscript publication.

Planning a thesis – general format – page and chapter format – footnotes – tables and figures – references and appendices.

Research Tools in Computer Science: LaTeX, R, WEKA, MATLAB, NS2.

#### **Unit II**

Analysis of algorithm: The role of algorithm in computing – Insertion sort – Analyzing and designing algorithms – growth of functions – Divide and Conquer: The Maximum Subarray Problem – Strassen's algorithm for Matrix multiplication – The substitution method and recursion tree methods of solving recurrences – Introduction to NP-completeness.

#### **Unit III**

Formal Languages and Finite Automata: Context free grammars – Derivation trees – Simplification of context free Grammars – Chomsky normal form – Greiback normal form – The pumping lemma for context free languages.

Finite state systems – Basic definitions – Non deterministic finite automata – Finite automata with epsilon moves – Regular expressions – Applications of finite Automata.

#### **Unit IV**

Probability and Statistical Analysis: Probability – Fail time data analysis – Hazard models – Conditional probability – Baye's rule – System reliability – Stochastic process.

#### **Unit V**

Logic – Relations and Functions: Propositions – Precedence rules for operators – Laws of equivalence – Natural deduction system – Developing natural deduction system proofs.

Relation properties – Matrix and Graph – Graph Notations for relations – Partition and covering – Equivalence relation – Compatibility relations – Partial ordering – Functions – Components – Composition of function – Inverse functions – Binary and n-ary operations

### **Text Books:**

1. Kothari C. R. Research Methodology – methods and techniques, 2<sup>nd</sup> Edition, Wishwa Prakashjan New Delhi 1999
2. For Research Tools in Computer Science: Official Websites of tools concerned.
3. Cormen, Leiserson, Rivest and Stein, “Introduction to Algorithms”, Third Edition, PHI LEARNING PVT. LTD-NEW DELHI, ISBN: 9788120340077, 8120340078, 3rd Edition, 2009.
4. John E. Hopcroft, Jeffery D. Ullman, ‘Introduction to Automata Theory Language and Computation’, narosa Publishing House, 1979
5. L.S. Srinath, ‘Reliability Engineering’, Third Edition, Affiliated East, West press pvt. Ltd, New Delhi, 2005
6. David Gries, ‘The Science of Programming’ Narosa Publishing House, 1981

### **Reference Books:**

1. Anderson, Durston and Poole, ‘Thesis and Assignment writing’, Wiley Eastern Ltd. ND 1970
2. Misra R.P. Research Methodology – A Hand Book, Concept publishing Company, New Delhi 1988
3. Ellis Horowitz and Sartaj Sahni, ‘Fundamentals of Computer algorithms’, Galgotia Publications, New Delhi 2000
4. E. Balagurusamy, ‘Reliability Engineering’, Tata McGraw Hill Publishing Ltd., New Delhi 2003
5. Leon S. Levy, ‘Discrete structures of Computer Science’, Wiley Eastern Ltd., 1980

### **Course Outcomes:**

Completion of this Course ensures the following.

- Understanding of what scholarly writing is and development of the skills to write the same.
- Learn to use tools related to research in Computer Science.
- Learn to analyze the algorithms and compute their computing time.
- Understanding of the basic concepts of NP-Complete and NP-Hard and problems of Computability.
- Understand the formal language, context free grammar and the applications of finite automata.
- Knowledge of Probability, Statistical Analysis and its application for System Reliability.
- Appreciation of logic, natural deduction systems and relations based on partial ordering.

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## COURSE II

### ADVANCED TOPICS IN COMPUTER SCIENCE

#### Course Objectives

- To understand the basic ideas of Data Science and to analyze big data sets.
- To understand the Cloud Computing as an emerging area of public and scientific use and to learn to apply Cloud Computing in the current social and research contexts.
- To learn and apply the ideas of Virtualization and its various uses.
- To appreciate IoT as a fast growing paradigm on Research in Computer Science and to use the same for research.
- To understand the basics of Machine Learning and its application in related areas such as Data Mining, ANN etc.
- To understand the use of Cryptography as a tool of security in the areas of Database, Program and Computer Networks.

#### Unit I : Data Science

Big Data and Data Science Hype – Datafication - The Current Landscape -Thought Experiment. Statistical Inference, Exploratory Data Analysis, and the Data Science Process: Statistical Thinking in the Age of Big Data - Exploratory Data Analysis – The Data Science Process.

**Big Data :** Understanding Big Data: Concepts and Terminology - Big Data Characteristics - Source of Big Data – Big Data Types (Formats) – Big Data Classification – Big Data processing technologies/tools/platforms. Types of Analytics: Analytics- Data Analytics – Big Data Analytics – Health Big Data Analytics – Importance of Analytics – Types: Predictive – Descriptive – Diagnosis – Prescriptive.

#### UNIT II : Cloud Architecture And Model

Technologies for Network-Based UNIT System – System Models for Distributed and Cloud Computing – NIST Cloud Computing Reference Architecture. Cloud Models:- Characteristics – Cloud Services – Cloud models (IaaS, PaaS, SaaS) – Public VS Private Cloud –Cloud Solutions - Cloud ecosystem – Service management – Computing on demand.

**Virtualization:** Basics of Virtualization - Types of Virtualization - Implementation Levels of Virtualization - Virtualization Structures - Tools and Mechanisms - Virtualization of CPU, Memory, I/O Devices - Virtual Clusters and Resource management – Virtualization for Data-center Automation.

#### UNIT III : Internet of Things

IoT architecture M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model – IoT reference architecture.

## **Unit IV : Machine Learning**

Types of learning, hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, over fitting- Instance based learning, Feature reduction, Collaborative filtering based recommendation - Probability and Bayes learning - Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM - Neural network: Perceptron, multilayer network, back-propagation, introduction to deep neural network - Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning - Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model - Concept learning – general to specific ordering – Decision tree learning – ANN.

## **Unit V : Security problems in Computing**

Cryptography – program security – Database security – Security in Networks

### **Recommended Text books:**

1. “Doing Data Science: Straight Talk from the Frontline”, by Rachel Schutt and Cathy O’Neil, O’Reilly Media publications, 2013.
2. Big Data Fundamentals: Concepts, Drivers & Techniques”, by Paul Buhler, Wajid Khattak, Thomas Erl, Prentice Hall Publications, January 2016,ISBN: 9780134291185
3. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud” O’Reilly
4. Gautam Shroff, Enterprise Cloud Computing, Cambridge University Press,2011
5. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
6. Machine Learning. Tom M. Mitchell. First Edition, McGraw- Hill, 1997.
7. Charles P. Pfleeger & Shani Lawrence Pfeeger, “Security in Computing”, Pearson Education, ISBN: 9789352866533, 9352866533, Fifth Edition, 2018.

### **Course Outcomes :**

Completion of this Course ensures the following.

- Understanding of basic ideas of Data Science and capacity to analyze big data sets.
- Understanding the Cloud Computing as an emerging area of public and scientific use and applications of Cloud Computing in the current social and research contexts.
- Knowledge of Virtualization and its various uses for practical applications.
- Appreciation of IoT as a fast growing paradigm of Computer Science and its uses in research.
- Understanding of the basics of Machine Learning and its application in related areas such as Data Mining, ANN etc.
- Appreciation of Cryptography as a tool of security in the areas of Database, Program and Computer Networks and to pursue further learning of the same.

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## **COURSE III**

### **Teaching and Learning Skills**

#### **Course Objectives :**

- Acquaint different parts of computer system and their functions.
- Understand the operations and use of computers and common Accessories.
- Develop skills of ICT and apply them in teaching learning context and Research.
- Appreciate the role of ICT in teaching, learning and Research.
- Acquire the knowledge of communication skill with special reference to its elements, types, development and styles.
- Understand the terms communication Technology and Computer mediated teaching and develop multimedia /e- content in their respective subject.
- Understand the communication process through the web.
- Acquire the knowledge of Instructional Technology and its Applications.
- Develop different teaching skills for putting the content across to targeted audience.

#### **Unit I : Computer Application Skills**

Information and Communication Technology (ICT): Definition, Meaning, Features, Trends – Integration of ICT in teaching and learning – ICT applications: Using word processors, Spread sheets, Power point slides in the classroom – ICT for Research: On-line journals, e-books, Courseware, Tutorials, Technical reports, Theses and Dissertations - **ICT for Professional Development** : Concept of professional development; institutional efforts for competency building; individual learning for professional development using professional networks, OERs, technology for action research, etc.

#### **Unit II : Communications Skills**

Communication: Definitions – Elements of Communication: Sender, Message, Channel, Receiver, Feedback and Noise – Types of Communication: Spoken and Written; Non-verbal communication – Intrapersonal, interpersonal, Group and Mass communication – Barriers to communication: Mechanical, Physical, Linguistic & Cultural – Skills of communication: Listening, Speaking, Reading and Writing – Methods of developing fluency in oral and written communication – Style, Diction and Vocabulary – Classroom communication and dynamics.

#### **Unit III : Pedagogy**

Instructional Technology: Definition, Objectives and Types – Difference between Teaching and Instruction – Lecture Technique: Steps, Planning of a Lecture, Delivery of a Lecture – Narration in tune with the nature of different disciplines – Lecture with power point presentation - Versatility of Lecture technique – Demonstration: Characteristics, Principles, planning Implementation and Evaluation – Teaching-learning Techniques: Team Teaching, Group discussion, Seminar, Workshop, Symposium and Panel Discussion.

## **Unit IV : E- Learning, Technology Integration and Academic Resources in India**

Concept and types of e-learning (synchronous and asynchronous instructional delivery and means), m-learning (mobile apps); blended learning; flipped learning; E-learning tools (like LMS; software's for word processing, making presentations, online editing, etc.); subject specific tools for e-learning; awareness of e-learning standards- Concept of technology integration in teaching- learning processes; frameworks guiding technology integration (like TPACK; SAMR); Technology Integration Matrix- Academic Resources in India: MOOC, NMEICT; NPTEL; e-pathshala; SWAYAM, SWAYAM Prabha, National academic depository, National Digital Library; e-Sodh Sindhu; virtual labs; eYantra, Talk to a teacher, MOODLE, mobile apps, etc.

## **Unit V : Skills of Teaching and Technology based assessment**

Teaching skills: Definition, Meaning and Nature- Types of Teaching Skills: Skill of Set Induction, Skill of Stimulus Variation, Skill of Explaining, Skill of Probing Questions, Skill of Black Board Writing and Skill of Closure – Integration of Teaching Skills – Evaluation of Teaching Skills- **Technology for Assessment:** Concept of assessment and paradigm shift in assessment; role of technology in assessment 'for' learning; tools for self & peer assessment (recording devices; e-rubrics, etc.); online assessment (open source software's; e-portfolio; quiz makers; e- rubrics; survey tools); technology for assessment of collaborative learning like blogs, discussion forums; learning analytics.

## **References**

1. Bela Rani Sharma (2007), Curriculum Reforms and Teaching Methods, Sarup and sons, New Delhi
2. Brandon Hall , E-learning, A research note by Namahn, found in: [www.namahn.com/resources/ .../note-e-learning.pdf](http://www.namahn.com/resources/.../note-e-learning.pdf), Retrieved on 05/08/2011
3. Don Skinner (2005), Teacher Training, Edinburgh University Press Ltd., Edinburgh
4. Information and Communication Technology in Education: A Curriculum for schools and programmed of Teacher Development, Jonathan Anderson and Tom Van Weart, UNESCO, 2002.
5. Jereb, E., & Šmitek, B. (2006). Applying multimedia instruction in e-learning. Innovations in Education & Teaching International, 43(1), 15-27.
6. Kumar, K.L. (2008) Educational Technology, New Age International Publishers, New Delhi.
7. Learning Management system : [https://en.wikipedia.org/wiki/Learning\\_management\\_system](https://en.wikipedia.org/wiki/Learning_management_system) , Retrieved on 05/01/2016
8. Mangal, S.K (2002) Essential of Teaching – Learning and Information Technology, Tandon Publications, Ludhiana.
9. Michael, D and William (2000), Integrating Technology into Teaching and Learning: Concepts and Applications, Prentice Hall, New york.

10. Pandey, S.K (2005) Teaching communication, Commonwealth Publishers, New Delhi.
11. Ram Babu, A abd Dandapani, S (2006), Microteaching (Vol.1 & 2), Neelkamal Publications, Hyderabad.
12. Singh, V.K and Sudarshan K.N. (1996), Computer Education, Discovery Publishing Company, New York.
13. Sharma, R.A., (2006) Fundamentals of Educational Technology, Surya Publications, Meerut
14. Vanaja, M and Rajasekar, S (2006), Computer Education, Neelkamal Publications, Hyderabad.

### **Course Outcomes :**

After completing the course, the students will:

- Develop skills of ICT and apply them in Teaching Learning context and Research.
- Be able to use ICT for their professional development.
- Leverage OERs for their teaching and research.
- Appreciate the role of ICT in teaching, learning and Research.
- Develop communication skills with special reference to Listening, Speaking, Reading and Writing.
- Learn how to use instructional technology effectively in a classroom.
- Master the preparation and implementation of teaching techniques.
- Develop adequate skills and competencies to organize seminar / conference / workshop / symposium / panel discussion.
- Develop skills in e-learning and technology integration.
- Have the ability to utilize Academic resources in India for their teaching.
- Have the mastery over communication process through the web.
- Develop different teaching skills for putting the content across to targeted audience.
- Have the ability to use technology for assessment in a classroom.

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## **Core Course IV**

## **BIG DATA ANALYSIS**

### **Course Outcomes:**

1. Acquired knowledge on the basics of Big Data
2. Knowing the role and use of Big Data in various relevant industries
3. Having a clear idea on the various tools and techniques used with big data
4. Acquired the techniques of Big Data Analytics
5. Learnt to cutting edge tools and technologies to analyze Big Data.
6. Ability to appreciate the Big Data Storage concepts and technologies

### **Unit-I**

Overview of Big Data: Big Data - History of Data Management – Evolution of Big Data - Structuring Big Data - Types of Data - Elements of Big Data – Volume – Velocity – Variety – Veracity - Big Data Analytics - Advantages of Big Data Analytics - Careers in Big Data. Use of Big Data in Business Context: Use of Big Data in Social Networking - Business Intelligence – Marketing - Product Design and Development -Use of Big Data in Preventing Fraudulent Activities - Preventing Fraud Using Big Data Analytics - Use of Big Data in Detecting Fraudulent Activities in Insurance Sector - Fraud Detection Methods - Use of Big Data in Retail Industry - Use of RFID Data in Retail.

### **Unit-II**

Understanding Hadoop Ecosystem: Hadoop Ecosystem - Hadoop Distributed File System - HDFS Architecture - Features of HDFS – MapReduce – Features of MapReduce -Hadoop YARN – Hbase - Features of HBase – Hive – Pig and Pig Latin – Sqoop – ZooKeeper – Flume – Oozie. Understanding Analytics and Big Data: Analysis - The Analytic Process - Types of Analytics -Basic Analytics - Advanced Analytics – Operationalized Analytics - Monetized Analytics -Characteristics of Big Data Analysis - Points to Consider during Analysis - Frame the Problem Correctly – Making Inferences versus Computing Statistics - Skills Required for an Analyst -Convergence of IT and Analytics - Understanding Text Analytics.

### **Unit-III**

Analytical Approaches and Tools to Analyze Data: Analytical Approaches- Ensemble Methods - Text Data Analysis - History of Analytical Tools -Graphical User Interfaces - Point Solutions - Data Visualization Tools -Introducing Popular Analytical Tools - The R Project for Statistical Computing- IBM SPSS – SAS - Comparing Various Analytical Tools.NoSQL Data Management: Introduction to NoSQL - Characteristics of NoSQL - Evolution of Databases - Aggregate Data Models - Key Value Data Model - Document Databases –Relationships - Graph Databases - Schema- Less Databases - Materialized Views - Distribution Models - CAP Theorem – Sharding - MapReduce Partitioning and Combining – Composing MapReduce Calculations.

### **Unit-IV**

Social Media Analytics and Text Mining: Introducing Social Media - Introducing Key Elements of Social Media - Introducing Text Mining - Understanding Text Mining Process - Sentiment Analysis - Performing Social Media Analytics and Opinion Mining on Tweets - Online Social Media Analysis. Mobile Analytics: Introducing Mobile Analytics - Define Mobile Analytics -



Mobile Analytics and Web Analytics - Types of Results from Mobile Analytics - Types of Applications for Mobile Analytics - Introducing Mobile Analytics Tools - Location-based Tracking Tools - Real-time Analytics Tools - User Behavior Tracking Tools - Performing Mobile Analytics – Challenges of Mobile Analytics.

### **Unit-V**

Data Visualization: Introducing Data Visualization - Techniques Used for Visual Data Representation - Types of Data Visualization - Applications of Data Visualization - Visualizing Big Data - Deriving Business Solutions - Turning Data into Information - Tools Used in Data Visualization – Proprietary Data Visualization Tools - Open-Source Data Visualization Tools – Analytical Techniques Used in Big Data Visualization. Data Visualization with Tableau: Introduction to Tableau Software – Tableau Desktop Workspace - Operations on Data - Data Analytics in Tableau Public - Using Visual Controls in Tableau Public.

### **Book for Study:**

1. Big Data (Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization) Black Book, published by Dreamtech Press, 2016. Book(s) for Reference:
1. Paul Buhler, WajidKhattak and Thomas Erl, “Big Data Fundamentals: Concepts, Drivers & Techniques”, Prentice Hall Publications, January 2016, ISBN: 9780134291185.
2. SoumendraMohanty, MadhuJagadeesh, and HarshaSrivatsa, “Big Data Imperatives: Enterprise Big Data Warehouse, BI Implementations and Analytics”, Published by Apress Media, 2013.
3. Tom White, “Hadoop: The Definitive Guide”, Third Edition, O’reilly Media, 2012. 52 53