TITLE OF COURSE: MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE
COURSE CODE: CSC111
L-T-P: 4-0-0
CREDITS: 4

Pre-requisite: Basic concepts in mathematics and programming languages.

Introduction:
Discrete mathematics is mathematics that deals with discrete objects. Discrete objects are those which are separated from (not connected to/distinct from) each other. Integers (aka whole numbers), rational numbers (ones that can be expressed as the quotient of two integers), automobiles, houses, people etc. are all discrete objects. On the other hand real numbers which include irrational as well as rational numbers are not discrete. As you know between any two different real numbers there is another real number different from either of them. So they are packed without any gaps and cannot be separated from their immediate neighbours. In that sense, they are not discrete. In this course, we will be concerned with objects such as integers, propositions, sets, relations and functions, which are all discrete. We are going to learn concepts associated with them, their properties, and relationships among them among others.

Course Outcomes (CO):
CO1: Understand the notion of mathematical thinking, mathematical proofs, and algorithmic thinking, and be able to apply them in problem-solving.
CO2: Understand the basics of discrete probability and number theory, and be able to apply the methods from these subjects in problem-solving.
CO3: Be able to use effectively algebraic techniques to analyze basic discrete structures and algorithms.
CO4: Understand asymptotic notation, its significance, and be able to use it to analyze asymptotic performance for some basic algorithmic examples.
CO5: Understand some basic properties of graphs and related discrete structures, and be able to relate these to practical examples.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3	1	2
CO2	2			3								2		
CO3	3	3	2									3		2
CO4	2	3	3		3							2	3	2
CO5		3		2										

Course Contents:
Module I: Mathematical Logic: Statements and notations, Connectives, Well-formed formulas, Truth tables, tautology, equivalence implication, Normal forms.
Module II: Predicates: Predicative logic, Free & Bound variables, Rules of inference, Consistency, proof of contradiction, Automatic Theorem Proving.
Module III: Relations: Properties of Binary Relations, equivalence, compatibility and partial ordering relations, Hasse diagram. Functions: Inverse Function Comports of functions, Recursive Functions, Lattice and its Properties.
Module IV: Algebraic structures: Algebraic systems Examples and general properties, Semi groups and

monads, groups sub groups, homomorphism, Isomorphism.
Module V: Elementary Combinatorics: Basis of counting, Combinations & Permutations, with repetitions, Constrained repetitions, Binomial Coefficients, Binomial Multinomial theorems, the principles of Inclusion-Exclusion. Pigeon hole principles and its application
Module VI: Recurrence Relation: Generating Functions, Function of Sequences Calculating Coefficient of generating function, Recurrence relations, solving recurrence relation by substitution and Generating funds. Characteristics roots solution of in homogeneous Recurrence Relation.
Module VII: Graph Theory: Representation of Graph, DFS, BFS, Spanning Trees, Planar Graphs, Basic Concepts Isomorphism and Sub graphs, Multi graphs and Euler circuits, Hamiltonian graphs, Chromatic Numbers.

Text Books:

1. Elements of DISCRETE MATHEMATICS-A computer-oriented approach CL Liu, d p nohapatra, 3rd ed TMH
2. Discrete mathematics for computer scientists & mathematicians JL Mott, A Kandel, TP Baker PHI.

References:

1. Discrete Mathematics with Applications, Thomas Koshy, Elsevier
2. Discrete Mathematical Structures, Bernand Kolman, Roberty C. Busby, Sharn Cutter Ross, Pearson Education/PHI
3. Discrete Mathematical Structures Theory and application-Malik & Sen.
4. Discrete Mathematics for Computer science, Garry Haggard and others, Thomson.

TITLE OF COURSE: DISTRIBUTED SYSTEM
COURSE CODE: CSD111
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basic concepts in Network, Programming in Java and Operation System.

Introduction:

1. Understand foundations of Distributed Systems.
2. Introduce the idea of peer to peer services and file system.
3. Understand in detail the system level and support required for distributed system.
4. Understand the issues involved in studying process and resource management.

Course Outcomes (CO):
At the end of the course, the student should be able to:
CO1: Discuss trends in Distributed Systems.
CO2: Apply network virtualization.
CO3: Apply remote method invocation and objects.
CO4: Design process and resource management systems
Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3								3	2	2
CO2	3		3		3							3	2	2
CO3	3		3		3							3	3	2

CO4	3		3		3							3	3	2

Course Contents:

Module 1: INTRODUCTION

Examples of Distributed Systems–Trends in Distributed Systems – Focus on resource sharing – Challenges. Case study: World Wide Web.

Module 2: COMMUNICATION IN DISTRIBUTED SYSTEM

System Model – Inter process Communication – the API for internet protocols – External data representation and Multicast communication. Network virtualization: Overlay networks. Case study: MPI Remote Method Invocation and Objects: Remote Invocation – Introduction – Request-reply protocols – Remote procedure call – Remote method invocation. Case study: Java RMI – Group communication – Publish-subscribe systems – Message queues – Shared memory approaches – Distributed objects – Case study: Enterprise Java Beans -from objects to components.

Module 3: PEER TO PEER SERVICES AND FILE SYSTEM

Peer-to-peer Systems – Introduction – Napster and its legacy – Peer-to-peer – Middleware – Routing overlays. Overlay case studies: Pastry, Tapestry- Distributed File Systems –Introduction – File service architecture – Andrew File system. File System: Features-File model -File accessing models – File sharing semantics naming: Identifiers, Addresses, Name Resolution – Name Space Implementation – Name Caches – LDAP.

Module 4: SYNCHRONIZATION AND REPLICATION

Introduction – Clocks, events and process states – Synchronizing physical clocks- Logical time and logical clocks – Global states – Coordination and Agreement – Introduction – Distributed mutual exclusion – Elections – Transactions and Concurrency Control– Transactions -Nested transactions – Locks – Optimistic concurrency control – Timestamp ordering – Atomic Commit protocols -Distributed deadlocks – Replication – Case study – Coda.

Module 5: PROCESS & RESOURCE MANAGEMENT 9 Process Management: Process Migration: Features, Mechanism – Threads: Models, Issues, Implementation. Resource Management: Introduction- Features of Scheduling Algorithms –Task Assignment Approach – Load Balancing Approach – Load Sharing Approach.

Text Books

1. George Coulouris, Jean Dollimore and Tim Kindberg, “Distributed Systems Concepts and Design”, Fifth Edition, Pearson Education, 2012.

References

1. Pradeep K Sinha, “Distributed Operating Systems: Concepts and Design”, Prentice Hall of India, 2007.
2. Tanenbaum A.S., Van Steen M., “Distributed Systems: Principles and Paradigms”, Pearson Education, 2007.
3. Liu M.L., “Distributed Computing, Principles and Applications”, Pearson Education, 2004.
4. Nancy A Lynch, “Distributed Algorithms”, Morgan Kaufman Publishers, USA, 2003.
Detailed Syllabus of Computer Science & Engineering

TITLE OF COURSE: DISTRIBUTED SYSTEM
COURSE CODE: CSD191
L-T-P: 0-0-2
CREDITS: 1
Hands on experiment based on syllabus CSD111

TITLE OF COURSE: ADVANCED DATA STRUCTURES
COURSE CODE: CSD112
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basic concepts in data structure, algorithm and programming languages.

Introduction:
This course examines advanced data structures and algorithms basics. The Topics to be covered (tentatively) include:

- Dictionaries, Hashing, Skip Lists.
- Tree.
- Text Processing.
- Computational Geometry.

Course Outcomes (CO):
CO1: To learn about the data structures/ methods/algorithms mentioned in the course with a comparative perspective so as to make use of the most appropriate data structure/ method/algorithm in a program to enhance the efficiency (i.e., reduce the run-time) or for better memory utilization, based on the priority of the implementation.
CO2: To understand at least the efficiency aspects of the tree algorithms covered in this course.
CO3: To convert an inefficient program into an efficient one using the knowledge gathered from this course.
CO4: To identify suitable data structures and develop algorithms for computational geometry problems.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	2	2
CO2	2			3								2	2	2
CO3	3	2	3									3	2	2
CO4	2	3	2		3							2	2	2

Course Contents:
Module 1: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.
Module 2: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists**.**
Module 3: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees.
Module 4: String Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

Module 5: One Dimensional Range Searching, Two Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quad trees, k-D Trees.

Text Books

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.
3. Horowitz and Sahani: Fundamental of Data Structures in C,2nd Edn, 2008
4. Kruse, Tonso, Leung: Data Structures and Program Design in C, 2000

Reference:

1. Richard F. Gilberg & Behrouz Forouzan: Data Structures, A Pseudocode Approach withC, 2001.
2. Weiss: Data Structures and Algorithm Analysis in C/C++, 3rd Edn, 2006

TITLE OF COURSE: ADVANCED DATA STRUCTURES LAB
COURSE CODE: CSD192
L-T-P: 0-0-2
CREDITS: 1

Pre-requisite: Basic concepts in data structure, algorithm and programming languages

Introduction:

This course examines advanced data structures and algorithms basics. The Topics to be covered (tentatively) include:

- Dictionaries, Hashing, Skip Lists.
- Tree.
- Text Processing.
- Computational Geometry.

Course Outcomes (COs):

CO1: Will be able to learn about the data structures/ methods/algorithms mentioned in the course with a comparative perspective so as to make use of the most appropriate data structure/ method/algorithm in a program to enhance the efficiency (i.e. reduce the run-time) or for better memory utilization, based on the priority of the implementation.

CO2: Student will be able to understand at least the efficiency aspects of the tree algorithms covered in this course.

CO3: Able to convert an inefficient program into an efficient one using the knowledge gathered from this course.

CO4: Able to identify suitable data structures and develop algorithms for computational geometry problems.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	2	2
CO2	2			3								2	2	2
CO3	3	2	3									3	2	2

CO4	2	3	2		3							2	2	2

Course Contents:

Module 1: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing.

Module 2: Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists**.**

Module 3: Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, B-Trees.

Module 4: String Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS), Applying Dynamic Programming to the LCS Problem.

Module 5: One Dimensional Range Searching, Two-Dimensional Range Searching, Constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.

Exercises that must be done in this course are listed below:

Exercise No.1: Implementation of array operations

Exercise No. 2: Stacks and Queues: adding, deleting elements

Exercise No. 3: Circular Queue: Adding & deleting elements

Exercise No. 4: Merging Problem: Evaluation of expressions operations on multiple stacks & queues.

Exercise No. 5: Implementation of linked lists: inserting, deleting, and inverting a linked list.

Exercise No. 6: Implementation of stacks & queues using linked lists, Polynomial addition, and Polynomial multiplication

Exercise No. 7: Sparse Matrices: Multiplication, addition.

Exercise No. 8: Recursive and Non-recursive traversal of Trees

Exercise No. 9: Threaded binary tree traversal. AVL tree implementation

Exercise No. 10: Application of Trees. Application of sorting and searching algorithms.

References:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.
3. Horowitz and Sahani: Fundamental of Data Structures in C, 2nd Edition, 2008
4. Kruse, Tonso, Leung: Data Structures and Program Design in C, 2000
5. Richard F.Gilberg & Behrouz Forouzan: Data Structures, A Pseudo code Approach with C,2001.
6. Weiss: Data Structures and Algorithm Analysis in C/C++, 3rd Edition, 2006.

TITLE OF COURSE: RESEARCH METHODOLOGY AND IPR

COURSE CODE: RM111

L-T-P: 2-0-0

CREDITS: 2

Pre-requisite: Basic Core course, property rights

Introduction:

The overall aim of our postgraduate research training programs is to provide researchers with foundation-level competency in the research skills generic to their area of research studies. The overall objective of the postgraduate research degree programs is:

1. To equip and support our students, academics and other researchers (on campus and off-campus) in Research with the necessary information and skills and enhance their prospects for career advancement.
2. To equip researchers with the specialized research skills necessary for conducting empirical studies in academia and the public sector
3. To equip post-graduate students with transferable skills necessary for professional development either within (e.g., PhD) or outside of academia
4. To promote competent and ethical academic practice for future generations of academics

Course Outcomes (COs):

CO1: Understand research problem formulation.
CO2: Analyze research related information
CO3: Follow research ethics
CO4: Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO4: Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO5: Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			3	3							3	2	2
CO2		2											1	2
CO3			2			3		3				2	2	2
CO4						2	3		3				2	2
CO5					2				2	3	2	3	2	2

Course Contents:

Module 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
Module 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,
Module 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee
Module 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Module 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
Module 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 ndEdition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.

References:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

TITLE OF COURSE: CONSTITUTION OF INDIA
COURSE CODE: HSM111
L-T-P: 2-0-0
CREDITS: 2

Pre-requisite: Basic history of India

Introduction:
This course presents the Constitution of India to the technical students who are not always having proper knowledge of it and always unaware about their fundamental rights and fundamental duties as well. Even a brief introduction of the Constitution may create a lot of effect on the minds of the students and may help us to produce a good Engineers and future professors.

Course Outcomes (COs):
CO1: Students will be able to discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2: Increase the ability to discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO3: Able to build the mind set to discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4: Discuss the passage of the Hindu Code Bill of 1956.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2				3										

CO3				3		3	3						
CO4		3									3		

Course Contents:
Module-I: History of Making of the Indian Constitution: Brief history of the making of Constitution of India from 1773, drafting Committee (Composition & Working).
Module-II: Philosophy of the Indian Constitution: Preamble, Salient Features
Module-III: Contours of Constitutional Rights & Duties: Fundamental Rights - Right to Equality, Right to Freedom, Right against Exploitation, Right to freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
Module-IV: Organs of Governance: Parliament – Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.
Module-V: Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy
Module-VI: Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Text Books:
1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

Reference:
1. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

TITLE OF COURSE: ADVANCE ALGORITHMS
COURSE CODE: CSC212
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basic concepts in data structure, algorithm and programming languages

Introduction:
This course examines advanced data structures and algorithms basics. The Topics to be covered (tentatively) include:

- Sorting
- Graph
- Matroids
- Graph Matching
- Flow-Networks
- Matrix Computations

- Shortest Path in Graphs
- Modulo Representation of integers/polynomials
- NP-completeness
- Approximation Algorithms
- Randamized Algorithm

Course Outcomes:

At the end of this course, students will be able to:

CO1: Understand the different complexity analysis according different problem. You will examine the algorithms used for various operations on operating systems.

CO2: Visualize different types of algorithm techniques. Become aware of the issues in the management of resources like processor, memory and input-output.

CO3: Determine the appropriate data structure for solving a particular set of problems.

CO4: Understand the basic principle of different classes of problems like P, NP, and NP-complete.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	2	2
CO2	2			3								2	2	2
CO3	3	2	3									3	2	2
CO4	3	3	2		3							2	2	2

Course Contents:

Module-I: Bubble Sort, Insertion Sort, Merge sort, Quick sort, Topological sort with complexity. Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

Module-II: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. Algorithm to compute maximum bipartite matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

Module-III: Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm. Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, LUP decomposition.

Module-IV: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming. Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.

Module-V: Examples, proof of NP-hardness and NP-completeness. Necessity of approximation scheme, Approximation ratio, Vertex cover problem, travelling salesman problem. Monte carlo and Las Vegas algorithm.

Text Books:

1."Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.

References:

1. "Algorithm Design" by Kleinberg and Tardos.

TITLE OF COURSE: ADVANCE ALGORITHMS LAB
COURSE CODE: CSC292
L-T-P: 0-0-2
CREDITS: 1

Hands on experiment based on syllabus CSC212

TITLE OF COURSE: WASTE TO ENERGY
COURSE CODE: WE217
L-T-P: 2-0-0
CREDITS: 2

Pre-requisite: Basic knowledge in Environmental Science.

Introduction:
The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is designed to provide an understanding of the various aspects of Waste to Energy. The various sources of waste generation is analyzed with a focus on its potential for energy production. The need for characterization of wastes will be discussed along with the existing norms for waste utilization for alternate energy source. Various Technological options available for the production of energy form waste will delineated along with economics of using alternate sources. Case studies will be discussed to provide a better understanding of the concepts of "Waste to Energy" in the Indian context.

Course Outcomes (COs):
CO1: Apply the knowledge about the operations of Waste to Energy Plants.
CO2: Analyze the various aspects of Waste to Energy Management Systems.
CO3: Carry out Techno-economic feasibility for Waste to Energy Plants.
CO4: Apply the knowledge in planning and operations of Waste to Energy plants.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3		
CO2	2			2								3		
CO3	3	3	3									2		
CO4	2	3	3		2							3		

Course Contents:
Module-I: Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors
Module-II: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.
Module-III: Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal

heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Module-IV: Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Module-V: Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Text Books:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

References:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

TITLE OF COURSE: DISASTER MANAGEMENT
COURSE CODE: HSM215
L-T-P: 2-0-0
Credits: 2

Pre-requisite: Basic knowledge in Environmental Science.

Introduction:

Disasters are seen as the effect of hazards on vulnerable areas. Hazards that occur in areas with low vulnerability do not result in a disaster. Great damage, loss, destruction and devastation to life and property are the results of Disasters. The immeasurable damage caused by disaster varies with the geographical location. In the concerned areas disasters have the following effects: It completely upsets the normal day to day life. Harmfully persuade the emergency systems Depending on the intensity and severity of the disaster the normal needs and processes are badly affected and deteriorated. Disasters are the effect of hazard on vulnerable or defenseless areas. Hazards that occur in areas with low vulnerability do not result in a disaster.

Course Outcomes (CO):

CO1: Develop an understanding of the key concepts, definitions a key perspectives of All Hazards Emergency Management

CO2: Understand the Emergency/Disaster Management Cycle REVISED

CO3: Have a basic understanding for the history of Emergency management

CO4: Develop a basic under understanding of Prevention, Mitigation, Preparedness, Response and Recovery.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										3		

CO2	3	3		2							3		
CO3	2									2	2		
CO4	3	3							3	3	3		

Course Contents:

Module-I: Introduction

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

Module-II: Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Module-III: Disaster Prone Areas in India: Study Of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

Module-IV: Disaster Preparedness And Management: Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Module-V: Risk Assessment: Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co- Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Module-VI: Disaster Mitigation: Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs Of Disaster Mitigation in India.

Text Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies 'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

References:

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Specialization Elective Course:

Cloud Computing

TITLE OF COURSE: VISUALIZATION & NETWORK IN CLOUD COMPUTING
COURSE CODE: CC101
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Knowledge is also assumed of basic concepts of Virtualization utilization in big data handling.

Introduction:
The course enables students to understand the virtualization technology, Applications along with cloud computing concepts and services.

Course Outcomes (CO):
The students will be able to know the basics of virtualization technology, hypervisors and cloud computing concepts

CO1: Understand what Cloud Computing is.
CO2: Understand what Virtualization is.
CO3: Understand Cloud Types and Cloud Service Deployment Models (IaaS*, PaaS*, SaaS*).
CO4: Learn How to Create Virtual Machines (VM) using Hypervisors (type-2).
CO5: Understand Computer Networks and IP Addressing.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3	2	2
CO2	2			3	3							2	3	3
CO3	3	3	3		2							3	3	3
CO4	3	2	2		3							2	3	2
CO5			3					3				3	3	3

Course Contents:
Module-1: Overview: introduction to cloud computing, OS and Virtualization, VM, advantage of Virtualization, Virtualization and cloud and its overlapping, service driven model, advantage of cloud computing: marketing point of view, types of services, business value, business impact of cloud, technological value of cloud, end user benefits, change for provider and administrator, pros and cons of cloud model, anatomy of cloud, solution component, service catalog, user self-service portal, service request management, provisioning, optimized infrastructure, chargeback, benefit of cloud, delivery and deployment model, different cloud architecture: public, private and hybrid and its pros and cons, delivery models. Cloud transformation roadmap, history of cloud, Clint-server, cluster, grid models, cloud vs grid and their relationship, cluster and cloud, utility computing and evolution of cloud computing, cloud computing.
Module-2: Introduction to Virtualization. Overview of Virtualization: Need of Virtualization, traditional IT Infrastructure, shortcoming of physical infrastructure, benefit of Virtualization, comparison of traditional IT infrastructure with virtualized infrastructure.

Module-3: Virtualization: Implementing Virtualization, typical hardware / software server stack and its logical equivalence, pre/post virtualization server stack ,types of virtualization, area and technology based classification, history of virtualization, time sharing system, IBM mainframe and Power virtualization, Extending Virtualization to x86 and its hardware support, impact of Virtualization: cost and manageability impact.

Module-4: Server and Storage Virtualization. Types of Server Virtualization, simulation, Hardware Assisted Virtualization, Hypervisors, Ring levels on x86 processors, types of Hypervisors, IBM Power VM Hypervisors, common consideration in server Virtualization, Desktop Virtualization: Benefits Constraints and Types. Anatomy of server Virtualization, three major layers in Xen server, storage Virtualization overview: benefit and types, features of logical layers, Host level storage Virtualization, host based mirroring, storage level Virtualization, network based storage Virtualization.

Module-5: Network and Application Virtualization. Network Virtualization overview: VPN, VLAN, challenges in using application in traditional install, use and update model, solution for challenges, Architecture, benefits of Application Virtualization.

Module-6: Cloud Implementation, Deployment and Delivery Models. Cloud Deployment models: Public, Private, Hybrid, pros and cons of each architecture, cloud deployment decision factors, Business IT Control, Business critical application, data and transaction security, compliance and audit, balance of CAPEX and OPEX, workload characteristics, workload lifespan preferences, Industry segment- SME and Large enterprises, Data Freedom, software characteristics, time to deploy, Public Cloud: factor matrix, advantage, disadvantage, Public Cloud: Factor Matrix, advantage and disadvantage, Hybrid Cloud: factor matrix, advantage, disadvantage, Overview of Cloud delivery models, infrastructure, IT Layers, IaaS Overview, features, cloud bursting, multi tenancy, resource pooling, PaaS: overview, component, example, SaaS: advantage, example.

Module-7: Case Study on Virtualization and Cloud workloads. Case study overview, customer IT landscape, function of data center, trigger for virtualization, preparation for virtualization, server selection, server sizing, server criticality, provisioning, proximity and locality, transition tool for virtualization, cost savings, cloud workload overview, workload characterization, factor s, suitable workload for cloud, private cloud solution, types of workload, advantage, mission. critical workload, mixed workload, production only workload for hybrid cloud, industry specific workload, non suitable workload: public, private cloud, possible workload by cloud.

Text Books:

1. Introduction to Virtualization and Cloud Computing (IBM ICE Publication)

Reference Books:

1. " Distributed and Cloud Computing " By Kai Hawang , Geofrey C.Fox, Jack J. Dongarra Pub: Elservier
2. Cloud Computing, Principal and Paradigms, Edited By Rajkumar Buyya, JemesBroberg, A. Goscinski, Pub.- Wiley
3. Kumar Saurabh, "Cloud Computing", Wiley Pub
4. Krutz , Vines, "Cloud Security " , Wiley Pub
5. Velte, "Cloud Computing- A Practical Approach", TMH Pub

TITLE OF COURSE: VISUALIZATION & NETWORK IN CLOUD COMPUTING LAB
COURSE CODE: CC191
L-T-P: 3-0-2
CREDITS: 3

Hands-on experiments related to the course contents CC101

TITLE OF COURSE: CLOUD SECURITY
COURSE CODE: CC102
L-T-P: 3-0-0
CREDITS: 3

Pre requisites:

1. Knowledge of a programming language such as Python, Java or C/C++
2. Students are expected to have broad understanding of different aspects of how computer systems work.
3. It is strongly recommended that the student have a working knowledge of computer networks.
4. The students should also feel comfortable with algorithmic concepts and modular arithmetic.

Introduction:

Information is an important strategic and operational corporate asset. These days computers and computer networks, are increasingly being used for storing and retrieving information. Some of these information may be of a sensitive nature. Consequently, they need to have adequate security measures that can safeguard sensitive information. In this course, we will begin by investigating some of the security measures that can be employed to safeguard information. For the most part we will look into the theory that goes into designing these measures rather than studying security tools and techniques. This is because there are too many of those tools out there and they are changing frequently. The course examines how system designs, network protocols, and software engineering practices can result in vulnerabilities. The course explores how to better design and implement future systems in order to mitigate vulnerabilities. In addition, the course explores how to detect and mitigate vulnerabilities in existing systems

Course Outcomes (CO):

CO1: Understand the fundamental principles of access control models and techniques, authentication, and secure system design

CO2: Have a strong understanding of different cryptographic protocols and techniques and be able to use them

CO3: Apply methods for authentication, access control, intrusion detection and prevention

CO4: Identify and mitigate software security vulnerabilities in existing systems.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2			3				3	3	3
CO2	2			3								2	1	2
CO3	3	2	3									3	3	3
CO4	3	3	2		3						3	2	2	2

Course Contents:

Module-1: Introduction to Cloud Security. Introduction- Architectural and Technological Influences of Cloud Computing -the Cloud deployment models security concepts- Cloud Computing Roles- threats-risk modeling and security services-Proactive activity monitoring, Incident Response -Monitoring for unauthorized access, malicious traffic, abuse of system privileges, intrusion detection, events and alerts - Auditing – Record generation, Reporting and Management- Tamper-proofing audit logs - Quality of Services - Secure Management -Identity management - Security Information and Event Management.

Module-2: Access control models: Policy, Compliance and Risk Management in Cloud Computing-Discretionary and mandatory access control- Covert channels and Chinese Wall-Clark-Wilson, RBAC, ABAC.

Module-3: Introduction to cryptography, Secret key cryptosystems- Key Escrow-Modular Arithmetic and Public key cryptosystems-Public key cryptosystems- Diffie-Hellman, RSA, El-Gammal- Pairing based cryptosystems, IBE and attribute-based encryption.
Module-4: Message digests, Merkle hashes, digital signatures-Identification and authentication, Passwords, Biometrics- One-time passwords and challenge response schemes, Kerberos- SSL, SSH
Module-5: Wireless Security. Wireless Security- Privacy- Cloud Compliance Assessment and Reporting - Case Study- PCI DSS 3.0 Compliant Cloud Tenant- Protecting PHI in Cloud.

Text Books:
1. Charles P. Pfleeger, "Security in Computing", Prentice Hall.
2. William Stallings, "Cryptography and Network Security: Principles and Practice.", Prentice-Hall.

Reference Books:
1. William R. Cheswick and Steven M. Bellovin, "Firewalls and Internet Security: Repelling the Wily Hacker", Addison-Wesley.
2. Charlie Kaufman, Radia Perlman and Mike Spencer, "Network Security: Private Communication in a Public World", Prentice Hall.
3. Marshall D. Adams, Sushil Jajodia and Harold J. Podell, eds., "Information Security: An Integrated Collection of Essays". IEEE Computer Society Press.
4. Edward Amoroso, "Fundamentals of Computer Security Technology", Prentice-Hall.

TITLE OF COURSE: CLOUD ADAPTATION AND MIGRATION
COURSE CODE: CC203
L-T-P SCHEME: 3-0-2
COURSE CREDITS: 4

Pre requisites: For this course it's assumed that you have a working knowledge of Cloud Computing and Cloud principles

Introduction:
In this course we will study the important terminology and familiar with cloud adaptation, cloud migrations, some of the constraints that cloud avoid cloud migration, legacy hardware and software architecture.

Course Outcomes (CO):
From this course students will be able to learn about intra cloud data adaptation and inter cloud data migration. Students will also get some sense to implement data migration techniques from this course.
CO1: Have a greater visibility of some of the key points of a Cloud Migration.
CO2: Be able to confidently assess the requirements for your migration.
CO3: Get Knowledge about data migration techniques
CO4: Understand about Intra cloud data adaptation.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	2	2
CO2	2	3	3	3								2	1	3

CO3	3	3	3					3				3	3	2
CO4	2	1	3								3	3	2	2

Course Contents:

Module-1(Cloud computing definition and use cases): Introduction – Component of CC – Comparing CC with Virtualization, Grids, Utility Computing, client- server model, P-to-P Computing - Key Drivers for Cloud Computing - Cloud computing Service delivery model, Cloud Types – Private, Public and Hybrid. Introduction to cloud computing &it's application. Goal of cloud adaptation and migration. Various use cases of cloud computing.

Module-2 (Adopting the cloud): Instantaneous provisioning of computing resources, tapping into an infinite storage capacity, cost-effective pay-as-you-use billing models. Handling sensitive data, aspects of cloud security, assessing governance solutions. Adoption of Public cloud by SMBs- Public Cloud Adoption phase for SMBs- Vendor liability and Management Adoption process of Public clouds by Enterprises – Managed Private clouds Migrating Application to the cloud – Impact of Shared Resources and Multi-Tenancy on cloud Applications – Phases during Migration an Application to An IaaS Cloud

Module-3: Introduction, definition, cloud adaptation architecture, adaptation techniques, decision engine architecture, adaptation in cloud resource configuration, VM- adaptation

Module-4 (Migration Framework): Re-architecting applications for the cloud, integrating the cloud with existing applications, avoiding vendor lock-in, planning the migration and selecting a vendor.

Module-5 (Migration Planning & Discovery): Identifying and mitigating risk, The 6 R's of cloud migration, asset and application discovery, licensing, data sovereignty, and governance.

Module-6 (Mobile Cloud computing): Introduction, Definition, Architecture, Benefits, challenges in mobile and at cloud shield.

Text Books

1. Cloud Migration from on-premise data center to AWS by Charista Keiko
2. Cloud Computing: Concepts, Technology & Architecture by RichardoPuttini, Thomas Erl, and Zaigham Mahmood

TITLE OF COURSE: CLOUD ADAPTATION AND MIGRATION LAB
COURSE CODE: CC293
L-T-P SCHEME: 0-0-2
COURSE CREDITS: 1

Hands-on experiments related to the course contents CC203

TITLE OF COURSE: CLOUD ARCHITECTURE & DEVELOPMENT MODEL
COURSE CODE: CC204
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Knowledge is also assumed of basic concepts of grid computing and cloud computing introduction.

Introduction:

The objective is to study the architecture and deployment models to develop a private cloud using the open standards tools such as open stack. Cloud is the future of computing. It is about outsourcing of IT services

and infrastructure to make them accessible remotely via the Internet. Utilizing cloud-computing models boosts not only productivity but also provide a competitive edge to organizations. The growing popularity of cloud computing has given rise to different types of cloud service deployment models and strategies. Therefore, today there exists a variety of enterprise cloud solutions depending on the degree of desired outsourcing needs.

Course Outcomes (CO):

After successful completion of this course, the students will be able to:

CO1: Understand the architecture and deployment model of cloud computing.

CO2: Understand the architecture and components related to open stack.

CO3: Understand other open standards tools for deploying a private cloud such as Eucalyptus.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	2	2
CO2	2	3	3	3								2	1	3
CO3	3	3	3					3				3	3	2

Course Contents:

Module-1: Definition of cloud computing, Delivery Models, Conceptual reference model, Cloud Computing solution components.

Module-2: Cloud computing Architecture: The conceptual reference model, Service Deployment, Cloud service management, cloud taxonomy, IBM CC RA, Common cloud management platform.

Case Study: IBM Smart Cloud Entry, VMware vCloud director.

Module-3: Cloud vendor selection: SLA, Security and privacy, periodic update and maintenance, data location and Jurisdiction, Measurability, Pricing, Interoperability and lock in, Exit process, track record.

Module-4: Open Stack: Definition, Advantages, Releases, Architectural overview, Different components of Open Stack, Open stack- Hypervisors, Network Services, Storage- Block Storage, Object Storage, Choosing Storage Backends , Commodity Storage Backend Technologies: swift, Ceph, Gluster, LVM, ZFS.

Module-5: Advance concepts in Open stack: Multi server Openstack, Tenant model architecture, Cloud orchestration using OpenStack using OpenStack Heat and Ubuntu Juju. Eucalyptus: Introduction, Features and Functionality, Architecture, Basic and Advanced Components. Eucalyptus vs Openstack. OpenNebula: Introduction, Features and Functionality, Architecture, Basic and Advanced Components. OpenNebula vs Open stack

Text Books:

1. Raj Kumar Buyya, James Broberg, Andrezei M. Goscinski (2011), Cloud Computing: Principles and paradigms.
2. Rittinghouse, John, W, Cloud computing: Implementation, management and security

Reference Book:

1. Barrie Sosinsky (2011), Cloud Computing Bible, Wiley.
2. Bumgardner, V. C. (2016). OpenStack in action. Manning Publications Company.

TITLE OF COURSE: CLOUD ARCHITECTURE & DEVELOPMENT MODEL LAB
COURSE CODE: CC294
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents CC204

TITLE OF COURSE: GOOGLE CLOUD - ORGANIZATION & IAM
COURSE CODE: CC205
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Understand the basic concepts of Cloud IAM, in particular the Google Cloud resource hierarchy.

Introduction:
This course introduces you to important concepts and terminology for working with Google Cloud Platform (GCP). You learn about, and compare, many of the computing and storage services available in Google Cloud Platform, including Google App Engine, Google Compute Engine, Google Kubernetes Engine, Google Cloud Storage, Google Cloud SQL, and BigQuery. You learn about important resource and policy management tools, such as the Google Cloud Resource Manager Hierarchy and Google Cloud Identity and Access Management. Hands-on labs give you foundational skills for working with GCP.

Course Outcomes (CO):
CO1: Understand how cloud security differs from on-premises security
CO2: Configure identities and access levels in Google Cloud Platform using Cloud IAM
CO3: Create, manage, and assign service accounts to GCP VMs
CO4: View audit logs in the GCP console

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2									3	2	3
CO2	2	3	2									2	3	2
CO3	2	2	3		3							3	2	3
CO4	3	3	3	3				3				3	2	2

Course Contents:
Module-1: Introducing Google Cloud Platform. Advantages of Google Cloud Platform. Components of Google's network infrastructure, including: Points of presence, data centers, regions, and zones. Understand the difference between Infrastructure-as-a- Service (IaaS) and Platform-as-a-Service (PaaS).
Module-2: Getting Started with Google Cloud Platform. Identify the purpose of projects on Google Cloud Platform. Understand the purpose of and use cases for Identity and Access Management. List the methods of interacting with Google Cloud Platform. Getting Started with Google Cloud Platform.

Module-3: Virtual Machines and Networks in the Cloud. Identify the purpose of and use cases for Google Compute Engine. Understand the various Google Cloud Platform networking and operational tools and services.
Module-4: Storage in the Cloud. Understand the purpose of and use cases for: Google Cloud Storage, Google Cloud SQL, Google Cloud Bigtable, and Google Cloud Datastore. Learn how to choose between. Various storage options on Google Cloud Platform. Cloud Storage and Cloud SQL.
Module-5: Containers in the Cloud. Concept of a container and identify uses for containers. Identify the purpose of and use cases for Google Kubernetes Engine and Kubernetes. Kubernetes Engine
Module-6: Applications in the Cloud. Understand the purpose of and use cases for Google App Engine. Contrast the App Engine Standard environment with the App Engine Flexible environment. Understand the purpose of and use cases for Google Cloud Endpoints. App Engine.
Module-7: Developing, Deploying, and Monitoring in the Cloud. Understand options for software developers to host their source code. Understand the purpose of template-based creation and management of resources. Understand the purpose of integrated monitoring, alerting, and debugging. Deployment Manager and Stack driver.
Module-8: Big Data and Machine Learning in the Cloud, Understand the purpose of and use cases for the products and services in the Google Cloud big data and machine learning platforms.

Text Books:
1. Google Cloud Platform for Developers by Steven Porter
2. Google Cloud Platform in Action 1st Edition by JJ Geewax
3. Google Professional Cloud Architect Study Guide 1st Edition by Dan Sullivan

Reference Book:
1. Professional Cloud Architect- Google Cloud Certification Guide: A complete GCP Cloud Architect certification guide filled with exam objectives and mock tests Kindle Edition by Konrad Clapa (Author), Brian Gerrard
2. Google Cloud Platform Cookbook: Implement, deploy, maintain, and migrate applications on Google Cloud Platform Kindle Edition by Legorie Rajan PS
3. Introducing Google Cloud Platform: Enabling a whole new possibilities Kindle Edition by Soumen Chatterjee

TITLE OF COURSE: MICROSOFT AZURE AND ITS SERVICES
COURSE CODE: CC306
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Knowledge is also assumed of basic concepts of grid computing and cloud computing introduction.

Introduction:
The objective is to study the architecture and deployment models to develop a private cloud using the open standards tools such as open stack. Cloud is the future of computing. It is about outsourcing of IT services and infrastructure to make them accessible remotely via the Internet. Utilizing cloud-computing models boosts not only productivity but also provide a competitive edge to organizations. The growing popularity of cloud computing has given rise to different types of cloud service deployment models and strategies. Therefore, today there exists a variety of enterprise cloud solutions depending on the degree of desired outsourcing needs.

Course Outcomes (CO):

After successful completion of this course, the students will be able to:

CO1: Understand the architecture and deployment model of cloud computing

CO2: Understand the architecture and components related to open stack.

CO3: Understand other open standards tools for deploying a private cloud such as Eucalyptus.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3							3	2	2
CO2	2	3	3	3								2	3	3
CO3	3	2	3								3	3	3	2

Course Contents:

Module-1: Introduction to Microsoft Azure and Its Services-Azure Subscriptions, Azure Resources, Azure Free Tier Account, Azure Resource Manager, Azure Resource Manager Template, Azure Storage, Types of Azure Storage

Module-2: Azure Virtual Machines and Networking-Azure Resource Manager Virtual Machine, Virtual Machines in ARM Template, Overview of Azure Virtual Machine, Azure Managed Disks, Azure Blob Storage, Networking in Azure, Subnets, NIC, NSG, IP Addresses, DNS

Module-3: Azure VMSS and Availability Zones-Resiliency, Azure Availability Sets, Azure Availability Zone, Autoscaling, Virtual Machine Scale Set, Fault Domain, Update Domain, Load Balancer, Application Gateway, Azure Disk Encryption

Module-4: Azure App Services and Its Features-Azure App Service Web Apps, App Service Security, Serverless Computing Concepts, Function Apps, Azure Event Grid, Azure Service Bus, Azure App Service Logic App, Using Shell Commands to create Web App, Background Tasks, Swagger tool-

Module-5: Advanced Azure Hybrid Connectivity and Site Recovery-Hybrid Connectivity, VNet S2S VPN, VNet Peering, Service Chaining, Azure VPN Gateway, Policy Based Gateway, Route Based Gateway, Swagger tool, Gateway Connections, Express Route, VNet Routing, User Defined Route, Border Gateway Protocol

Module-6: Azure Storage Solution and Design Patterns-Azure Architecture Center, Cloud design patterns, Cache-aside pattern, Sharding Pattern, Azure SQL DB, Azure Elastic Pool, Azure Data Lakes, Azure Data Factory, Azure Cosmos DB

Module-7: Azure Kubernetes Service-Application Environment Components, Docker, DockerFile, Docker Image, Azure Container Registry, Azure Container Instance, Orchestration, Azure Kubernetes Service, Diagnostics Logs

Module-8: Azure Active Directory and Role Based Access Control-Access Control, Role Based Access Control, Authentication in applications (certificates, Azure AD, Azure AD Connect, token-based), Multi-factor authentication (MFA), Claims-based authorization, Role-based access control (RBAC) authorization, End-to-end encryption, Azure confidential computing, SSL and TLS communications, Azure Key Vault, Configure Fraud alerts, Bypass option, trusted IPs, Managed Service Identity, Service Principal authentication

Module-9: Azure Messaging Service (Events, Hubs, Queue and Bus)-Azure Messaging Service, Azure Service Bus, Azure Events Hub, Azure Events Grid, Azure Notifications Hub, Auto Scale Ruling in Azure, Transient Fault Handling

Module-10: Azure Monitoring and Insights Service-Azure Monitoring, Azure Analytics, Azure Alerts, Azure Resource Metrics, Azure Activity Log, Service Health, Azure Log Analytics, Azure App Insights

Text Books:

1. Azure for Architects: Implementing Cloud Design, DevOps, IoT, and Serverless Solutions on Your Public Cloud, by Ritesh Modi
2. Microsoft Azure Tutorial the Ultimate Beginners Guide, by Dennis Hutten
3. Introducing Windows Azure for IT Professionals, by Mitch Tulloch

Reference:

1. Azure: Microsoft Azure Tutorial for Beginners, by Kennan Bismar
2. Implementing Microsoft Azure Infrastructure, by Michael Washam and Rick Rainey
3. Mastering Microsoft Azure Infrastructure Services, by John Savill
4. Azure for Architects: Implementing Cloud Design, DevOps, Containers, IoT, and Serverless Solutions on Your Public Cloud, 2nd Edition, by Ritesh Modi

TITLE OF COURSE: AWS FUNDAMENTAL
COURSE CODE: CC307
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Knowledge is also assumed of basic concepts of how the AWS cloud infrastructure is built, walk you through Amazon Elastic Compute Cloud (Amazon EC2) and Amazon Lightsail compute services.

Introduction:

This course gives current or aspiring IT professionals an overview of the features, benefits, and capabilities of Amazon Web Services (AWS). As you proceed through these Module interconnected courses, you will gain a more vivid understanding of core AWS services, key AWS security concepts, strategies for migrating from on-premises to AWS, and basics of building server less applications with AWS.

Course Outcomes (CO):

After successful completion of this course, the students will be able to:

CO1: Understand the core AWS services
CO2: Understand the key AWS security concepts
CO3: Understand the strategies for migrating from on-premises to AWS.
CO4: Understand basics building serverless applications with AWS.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			2							3	2	3
CO2	2	3		3				3				2	3	2
CO3	3	2						2				3	2	3
CO4	3	3	3								3	3	2	2

Course Contents:

Module-1: Aws Fundamentals: Going Cloud-Native, Introduced To The Course And Learn About Aws Services, Infrastructure, And Compute Services, Networking And Storage On Aws, Databases On Aws, Monitoring And Scaling.

Module-2: AWS Fundamentals: Addressing Security Risk, basic concepts such as "least privilege" and the "Shared Responsibility Model, network isolation and endpoint security, Detective controls such as Amazon CloudTrail as well as AWS Security Hub, Amazon GuardDuty and AWS Config, encryption of data at rest, in motion, store data within and between various AWS services, Amazon EC2 and AWS Lambda, AWS Well-Architected Framework.

Module-3: AWS Fundamentals: Migrating to the Cloud, Defining what we mean by Migration, Migration Preparation and Business Planning, Portfolio Discovery and Planning ,Design, Migration and Application Validation ,Operate, Cloud Adoption Framework - Hybrid Environments, Scaling Considerations, High Availability, Considerations with Migrating DB vs Applications, AWS Server Migration Services, VM Import and VM on AWS (Server Migration Service),Introduce AWS Migration Hub, AWS Application Discovery Service, Amazon EFS, Amazon EBS, & Amazon S3,

Module-4: Storage - AWS Snowball & AWS Snowmobile, AWS Storage Gateway Now with AWS DataSync, Storage - AWS DMS Overview, Storage - AWS DMS Core Features, Storage Schema Conversion, Storage - Amazon Aurora (Serverless), AWS Direct Connect & Amazon Route 53, Automation - AWS API Centricity, AWS System Manager & AWS Cloud Formation, Overview and TSO Logic, Migration Tools - Cloud Endure.

Module-5: AWS Fundamentals: Building Serverless Applications, Amazon Lex, Amazon Lex Walkthrough, Introduction to Amazon CloudFront, AWS Identity Access Management (IAM), Introduction to Serverless Computing with AWS Lambda

Text Books:

1. Amazon web services in action, written by andreas witting and michael wittig
2. Mastering AWS Development, written by Uchit Vyas

Reference Books:

1. Implementing cloud design patterns for aws, written by marcus young.
2. Aws administration – the definitive guide, written by yohan wadia.

Specialization Elective Course:
Blockchain Technology

TITLE OF COURSE: BLOCKCHAIN BASICS
COURSE CODE: BC101
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basic concepts in networking.

Introduction:
This course describes basic blockchain technology in networking system. The Topics to be covered (tentatively) include: an introduction to blockchain, Crypto asset or Digital asset, Ethereum Blockchain, Bitcoin & Blockchain, Decentralized Systems and Ethereum Blockchain.

Course Outcomes (CO):
In this course we will study the basic components of blockchain. Students are expected to be capable of understanding the cryptocurrency, their advantages and drawbacks, how to implement them in blockchain, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:
CO1: Students would be able to design & implement any blockchain properly.
CO2: Students would be able to implement any problem by writing their own algorithm in blockchain.
CO3: By analyzing, students would be able to implement public private key combination in security.
CO4: To become an efficient blockchain developer.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	3	2
CO2	2			3				3				2	2	3
CO3	3	2	3									3	3	3
CO4	3	3	2		3							2	3	2

Course Contents:
Module-1: Basic introduction about blockchain in digital world, Crypto asset or Digital asset, Self Sovereign Identity, Smart Contract, Decentralized Business Model, Device to device communication in blockchain
Module-2: Network Security, Different type of network attack, Warm hole attack, byzantine attack, network-based attack etc, Trust based Secure routing schemes.
Module-3: Bitcoin & Blockchain: Blockchain Structure, Basic Operations, Beyond Bitcoin, Gas, minor's role in blockchain.
Module-4: Ethereum Blockchain: Smart Contracts, Ethereum Structure, Ethereum Operations, Incentive Model in blockchain.
Module-5: Cryptography and cryptocurrency: Algorithms & Techniques Public-Key Cryptography, Public key and private key combinations in Blockchain security, Hashing, Transaction Integrity, Securing

Blockchain.
Module-6: Decentralized Systems: Consensus Protocol, Practitioner's Perspective Decentralized Governance, Robustness, Forks.

Text Books
1. The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects, by Elad Elrom, ISBN-13: 978-1484248461, ISBN-10: 1484248465

References
1. Blockchain Technology Explained: The Ultimate Beginner's Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA and Smart Contracts, by Alan T. Norman

TITLE OF COURSE: BLOCKCHAIN BASICS LAB
COURSE CODE: BC191
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents BC101

TITLE OF COURSE: BLOCKCHAIN COMPONENTS & ARCHITECTURE
COURSE CODE: BC102
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Basic concepts in blockchain and networking.
Introduction:
This course described implementation and architecture of blockchain. The Topics to be covered (tentatively) include: an introduction to Blockchain history, Digital Money, Hash, Signature, Blockchains design goals, Blockchain for Government: Digital identity and records.

Course Outcomes (CO):
In this course we will study the basic components of blockchain in digital asset. Students are expected to be capable of understanding the blockchain architecture, their advantages and drawbacks, how to implement them in network, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:
CO1: Students would be able to design & implement blockchain as a digital asset properly.
CO2: Students would be able to implement different security algorithm in blockchain.
CO3: By analyzing the logic of any algorithm, students would be able to implement Blockchain in Financial Software and Systems.
CO4: To become an efficient blockchain developer.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	2	3		2							3	2	3
CO2	2			3								2	3	3
CO3	3	3	2								3	3	3	3
CO4	2	3	3		3							2	3	2

Course Contents:

Module-1: Introduction to Blockchain history: Digital Money to Distributed Ledgers Design Primitives: Protocols, Security, Consensus, Permissions, Privacy

Module-2: Blockchain Architecture and Design. Basic crypto primitives: Hash, Signature, Hash chain to Blockchain, Basic consensus mechanisms

Module-3: Consensus, Requirements for the consensus protocols, Proof of Work (PoW) Scalability aspects of Blockchain consensus protocols

Module-4: Permissioned Blockchains, Design goals, Consensus protocols for Permissioned Blockchains Hyperledger, Decomposing the consensus process Hyperledger fabric components Chain code Design and Implementation Hyperledger Fabric beyond Chain code fabric SDK and Front End, Hyperledger composer tool

Module-5: Blockchain in Financial Software and Systems (FSS): Settlements, KYC, Capital markets, Insurance

Use case II: Blockchain in trade supply chain: Provenance of goods, visibility, trade supply chain finance, invoice management discounting, etc

Module-6: Blockchain for Government: Digital identity, and records and other kinds of record keeping between government entities, public distribution system social
welfare systems

Module-7: Blockchain Cryptography Privacy and Security on Blockchain, Blockchain consensus protocols, Various recent works on scalability

Module-8: Secure cryptographic protocols on Blockchain Secured, Multi-party Computation, Blockchain, for science: making better use of the data-mining network, Case Studies:
Comparing Ecosystems - Bitcoin, Hyperledger, Ethereum and more

Text Books

1. Blockchain Technology Explained, by Alan T. Norman

References

1. Blockchain: Ultimate guide to understanding blockchain, bitcoin, cryptocurrencies, smart contracts and the future of money.
2. The Bitcoin Standard: The Decentralized Alternative to Central Banking by Saifedean Ammous

TITLE OF COURSE: TRANSACTION ON BLOCKCHAIN
COURSE CODE: BC203
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basic concepts in blockchain technology.

Introduction:

This course examines basic block chain. The Topics to be covered (tentatively) include: an introduction to Cryptoassets, Smart Contracts, Digital Signatures, and Financial Services etc.

Course Outcomes (CO):

In this course we will study the basic components of cryptoasset and transaction of blockchain. Students are expected to be capable of understanding the smart contract, their advantages and drawbacks, how to implement them in blockchain, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:

CO1: Students would be able to design & implement any transaction at blockchain properly.

CO2: Students would be able to implement any problem by writing their own business idea.

CO3: By analyzing the logic of transaction, students would be able to write efficient business proposal in blockchain.

CO4: To become an efficient blockchain developer.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2							3	2	2
CO2	2			3								2	3	2
CO3	3	2	3									3	3	3
CO4	3	3	3		3							3	2	2

Course Contents:

Module-1: Cryptoassets, Cryptocurrencies, Protocol Tokens, Utility Tokens (App Coins),Security Tokens, Natural Asset & Commodity Tokens, Crypto-collectibles, Crypto-fiat Currencies and Stable coins, Practitioner Perspective – Tokenomics, Practitioner Perspective - Cristina Dolan: Cryptoassets, Initial Coin Offerings: A New Breed of Meta-Asset, Practitioner Perspective - Rolf Hoefer: ICOs, Recap of Cryptoassets Protocol Tokens, Utility Tokens (App Coins), Security Tokens, Natural Asset & Commodity Tokens.

Module-2: Smart Contracts, Practitioner Perspective - Rolf Hoefer: Smart Contracts, Smart Contract Phases, Smart vs. Traditional Contracts, Smart Contracts and Law, Practitioner Perspective - Smart Contracts, Smart Contract Application Areas, Practitioner Perspective - Rob Carter: Smart Contracts, Smart Contract Strategies & Best Practices for the Organization, Smart vs. Traditional Contracts, Smart Contract Application Areas

Module-3: Identity, Introduction to Identity and Identifiers, Five Problems with Identifiers, Distributed, Self-sovereign Identity Systems, Practitioner Perspective - Carlos Augier: Identity,
Blockchain Identity Applications, Practitioner Perspective - Stephen Tse & Li Jiang: Personal Data, Managing Health Data on a Blockchain, Polyalphabetic Ciphers, Symmetric Digital Signatures, RSA, ECC, ECDS

Module-4: Rethinking Finance, Six Inefficiencies in Financial Services, The Golden Eight Part, The Golden Eight Part, Problems with Modern Accounting, The World-Wide Ledger, Rethinking Financial Services, The Golden Eight, New Frameworks for Accounting, The Golden Eight

Text Books

1. A Practical Guide to Blockchain and its applications by Parikshit Jain, Publisher: Bloomsbury India

References

1. Blockchain Enabled Applications: Understand the Blockchain Ecosystem and How to Make it Work for You, by Vikram Dhillon & David Metcalf & Max Hooper

TITLE OF COURSE: TRANSACTION ON BLOCKCHAIN LAB
COURSE CODE: BC293
L-T-P: 0-0-2
CREDITS: 4

Hands-on experiments related to the course contents BC203

TITLE OF COURSE: BLOCKCHAIN OPPORTUNITY ANALYSIS
COURSE CODE: BC204
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basic concepts in blockchain.

Introduction: This course examines Blockchain Transformations for Every Industry. The Topics to be covered (tentatively) include: Industry Transformations, Introduction to the Blockchain Case Commons, Problem Solving with Blockchain, Decision Matrix, and Statement of Benefit.

Course Outcomes (CO):
In this course we will study the business are of blockchain. Students are expected to be capable of understanding the implementation blockchain in industry, their advantages and drawbacks, how to implement them in network, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:
CO1: Students would be able to analyses opportunity in blockchain properly.
CO2: Students would be able to implement any problem by writing their own business idea.
CO3: By analyzing the logic of transaction, students would be able to write efficient business proposal in blockchain.
CO4: To become an efficient blockchain administrator.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2							3	2	2
CO2	2			3								2	3	2
CO3	3	2	3									3	3	3
CO4	3	3	3		3							3	2	2

Course Contents:
Module-1: Blockchain Transformations for Every Industry, Practitioner Perspective: Rob Carter, CIO at FedEx, How to Use the Blockchain Case Commons, Decentralizing the Enterprise, Blockchain & ConsenSys, Transaction Costs and the Structure of the Firm, Opportunity Search, Opportunity Contracting, Opportunity Coordination, Opportunity, Building Trust, Determining Corporate Boundaries, Hacking Your Future: Boundary Decisions, Decentralizing the Enterprise, Transaction Costs and the Structure of the Firm
Module-2: Industry Transformations, Introduction to the Blockchain Case Commons, Exploratory Market Research, Conducting Preliminary Market Research, How to Perform a Competitive Analysis,

Intellectual Property, Payments, Attribution, and Licensing, Distributed Ownership
Module-3: APAC Business Development & Strategic Relations, Use a Decision Matrix, Problems That Blockchain Can and Cannot Solve, Blockchain Opportunity Brainstorm, Problem Solving With Blockchain, Decision Matrix, Statement of Benefit,
Module-4: Keyless Technologies, Strategic Positioning of Your Organization, Regulatory Principles, Regulation, Regulation vs. Governance, Regulation & Governance, The Blockchain Stack, Multiple Layers of Blockchain Governance, A New Framework for Blockchain Governance, Practitioner Perspective - Rob Carter: Governance, Profile of a Blockchain Hotbed

Text Books
1. Blockchain: Blueprint for a New Economy Kindle Edition, by Melanie Swan

References
1. The Internet of Money Kindle Edition, by Andreas M. Antonopoulos
2. Bitcoin Billionaires: A True Story of Genius, Betrayal, and Redemption, by Ben Mezrich

TITLE OF COURSE: BLOCKCHAIN OPPORTUNITY ANALYSIS LAB
COURSE CODE: BC294
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents BC204

TITLE OF COURSE: BITCOIN AND CRYPTO CURRENCY
COURSE CODE: BC205
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Basic concepts in blockchain architecture.

Introduction:
This course examines bit coin as a crypto currency. The Topics to be covered (tentatively) include: an introduction to crypto currency, Hash Functions, Hash Pointers, Bitcoin Transactions, Bitcoin Scripts, Applications, payment service in bit coin.

Course Outcomes (CO):
In this course we will study the bit coin as a crypto currency. Students are expected to be capable of understanding the crypto currency, their advantages and drawbacks, how to implement them in python, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:
CO1: Students would be able to design & implement bit coin as a crypto currency properly.
CO2: Students would be able to implement Ethereum under the hood.
CO3: By analyzing the logic of any hash function, students would be able to implement crypto asset.
CO4: To become an efficient blockchain developer.
Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2							3	2	2

CO2	2			3								2	3	2
CO3	3	2	3									3	3	3
CO4	3	3	3		3							3	2	2

Course Contents:

Module-1: Cryptographic Hash Functions, Hash Pointers and Data Structures, Digital Signatures, Public Keys as Identities, A Simple Cryptocurrency, Transacting in Bitcoin, Why Cryptocurrency.

Module-2: Centralization vs. Decentralization, Distributed Consensus, Consensus without Identity, the Block Chain, Incentives and Proof of Work, Putting It All Together, The Digital Signature, A Tamper Proof Ledger, Examples, Distributed Consensus, Proof of Work, Mining and Currency Supply.

Module-3: Bitcoin Transactions, Bitcoin Scripts, Applications of Bitcoin Scripts, Bitcoin Blocks, The Bitcoin Network, Limitations & Improvements, Cryptocurrency as an Asset Class, Risk and Return to Cryptocurrency, Review of Portfolio Theory, Asset Allocation with Cryptocurrency, Mining, Crypto Classifications, The Crypto Vision, Ethereum Overview, Ethereum Under the Hood, The DAO, Private Blockchains.

Module-4: How to Store and Use Bitcoins, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets, Building the Blockchain, Crypto Finance, Business Use Cases, Blockchain in Gaming, Investing in Blockchain, Government and Regulation, Media and Advocacy1m, Creating the New Frontier of FinTech.

Text Books

1. Bitcoin and Cryptocurrency Technologies, by Arvind Narayanan, Joseph Bonneau, Edward Felten
2. Understanding Bitcoin: Cryptography, Engineering and Economics, By Pedro Franco, Wiley

References

1. The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects, by Elad Elrom, ISBN-13: 978-1484248461, ISBN-10: 1484248465

TITLE OF COURSE: BLOCK CHAIN BUSINESS APPLICATION & IMPLICATION
COURSE CODE: BC306
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Basic concepts in block chain.

Introduction:

This course examines different type of business application through block chain. The Topics to be covered (tentatively) include: opportunities for blockchain, blockchain changes the deep structures and architecture of the firm, application of block chain in civil society, private sector, Trust and Vulnerability in block chain.

Course Outcomes (CO):

In this course we will study the block chain in business application. Students are expected to be capable of understanding the implementation of block chain, their advantages and drawbacks, how to implement them in industry, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:

CO1: Students would be able to analyses opportunity in blockchain properly.

CO2: Students would be able to implement any problem by writing their own business idea.

CO3: By analyzing the core idea of efficient business proposal in blockchain.
CO4: To become an efficient blockchain business administrator.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2							3	2	2
CO2	2			3								2	3	2
CO3	3	2	3									3	3	3
CO4	3	3	3		3							3	2	2

Course Contents:

Module-1: New Business Models, opportunities for blockchain to disrupt or displace traditional centralized business models. blockchain technology can support "open networked enterprise" business models through the inclusion of native payment systems, reputation systems, uncensorable content, trustless transactions, smart contracts, and autonomous agents.

Module-2: Blockchain and the C-Suite, blockchain changes the deep structures and architecture of the firm, it will consequently transform our models of management and the roles of the C-Suite. Navigating the balance between blockchain's hype and its true potential is a key responsibility of an organization's management team, decisions and changes that business leaders can anticipate when considering how the future of blockchain will unfold within their business.

Module-3: Leadership for the Next Era, Blockchain alone is just a tool, fulfill its long-term promise, humans must lead. Rather than relying on state-based institutions, blockchain must be primarily self-governed through collaborations of civil society, private sector, government, and stakeholders in non-state networks, the idea of blockchain governance networks and explain how they can support blockchain stewardship at three levels: The platform level, the application level, and the ecosystem level. As well, you will learn about the conditions that are necessary for a blockchain-based hub of innovation to succeed.

Module-4: Blueprint for a New Social Contract, digital revolution unfolds, global economy, labor markets, old institutions, and society as a whole. To realize the potential of the blockchain revolution, we need business leaders to come to the table as responsible and active participants in a new social contract for both their own long-term interests as well as in the interest of a healthy society and economy, possible directions for a new social contract—i.e. the agreements, laws, and behaviors that people, companies, civil society, and their governments adhere, catalyze investigation, debate, and action, Trust and Vulnerability Short history of the scaling out of human trust. High and Low trust societies, Types of Trust model: Peer-to-Peer, Leviathan, and Intermediary

Text Books

1 Blockchain Basics: A Non-Technical Introduction in 25 Steps Kindle Edition, by Daniel Drescher

References

1. Bitcoin and Cryptocurrency Technologies, by Arvind Narayanan, Joseph Bonneau, Edward Felten.

TITLE OF COURSE: Emerging Areas, The Merkle Tree and Cryptocurrencies
COURSE CODE: BC307
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Basic concepts in mathematics and programming languages.

Introduction:

This course examines Merkle Tree. The Topics to be covered (tentatively) include: an introduction to Merkle Tree and Immutability, hash values and hash sequences, hash functions and hash puzzles, basic principle of proof-of-work and proof-of-stake.

Course Outcomes (CO):

In this course we will study the Merkle Tree and Immutability. Students are expected to be capable of understanding the Merkle Tree, their advantages and drawbacks, how to implement them in block chain as crypto currency, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:

CO1: Students would be able to implement Markel Tree properly.
CO2: Students would be able to implement hash function and solve hash puzzles.
CO3: By analyzing the logic, students would be able to write proper algorithm.
CO4: To become an efficient developer.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2							3	2	2
CO2	2			3								2	3	2
CO3	3	2	3									3	3	3
CO4	3	3	3		3							3	2	2

Course Contents:

Module-1: Data blocks are assembled as well as how hash values and encryption are used to ensure the proper sequencing and integrity of data blocks that are added to a blockchain. Round Table Discussion - The Merkle Tree and Immutability

Module-2: Hashing and an Introduction to Cryptocurrencies, hash values and hash sequences. Assembling block header hash values for a specified hash puzzle difficulty level. Blockchain Basics, Round Table Discussion - Proof of Work and Proof of Stake

Module-3: Investigated hash functions and hash puzzles, we will focus on proof-of-work, which is an approach to modifying the blockchain that can be difficult and time-consuming to compute. We will also focus on proof-of-stake, an alternative to updating the blockchain in which larger nodes are modified that already represent a large portion of the blockchain.

Module-4: The pros and cons of each approach and prepare to apply the principles of proof-of-work and proof-of-stake Comparing proof-of-work and proof-of-stake, alternative approaches that combine the best features of proof-of-work and proof-of-stake.

Text Books

1. Understanding Bitcoin: Cryptography, Engineering and Economics, By Pedro Franco, Wiley.
2. Cryptocurrency Investing For Dummies 1st Edition, by Kiana Danial, ISBN-13: 978-1119533030, ISBN-10: 1119533031

References

1. The Crypto Book: How to Invest Safely in Bitcoin and Other Cryptocurrencies by Siam Kidd

Specialization Elective Course:
Big Data Analytics

TITLE OF COURSE: BIG DATA ANALYTICS
COURSE CODE: BDA101
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Should have knowledge of one Programming Language (Java preferably), Practice of SQL (queries and sub queries), exposure to Linux Environment.

Introduction:
The course enables students to Understand the Big Data Platform and its Use cases, Provide an overview of Apache Hadoop, Provide HDFS Concepts and Interfacing with HDFS, Understand Map Reduce Jobs, Provide hands on Hadoop Eco System, Apply analytics on Structured, Unstructured Data, Exposure to Data Analytics with R.

Course Outcomes (CO):
The students will be able to:
CO1: Identify Big Data and its Business Implications
CO2: List the components of Hadoop and Hadoop Eco-System
CO3: Access and Process Data on Distributed File System
CO4: Manage Job Execution in Hadoop Environment
CO5: Develop Big Data Solutions using Hadoop Eco System

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3								3	3	2
CO2	3		3		3							3	3	3
CO3	3		3						3			3	3	3
CO4	3		3		3				3	3		3	3	2
CO5	3		3								3	3	2	3

Course Contents:
Module-1: Introduction To Big Data And Hadoop: Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets.
Module-2: HDFS (Hadoop Distributed File System) The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.
Module-3: Map Reduce Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

Module-4: Hadoop Eco System Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive: Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. HBase: HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. Big SQL: Introduction

Module-5: Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR.

Textbooks:

1. Tom White "Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference Books:

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
2. Jay Liebowitz, "Big Data and Business Analytics" Auerbach Publications, CRC press (2013)
3. Tom Plunkett, Mark Hornick, "Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle Enterprise and Oracle R Connector for Hadoop", McGraw-Hill/Osborne Media (2013), Oracle press

TITLE OF COURSE: BIG DATA ANALYTICS LAB
COURSE CODE: BDA191
L-T-P: 0-0-2
CREDITS: 1

Pre-requisite: Should have knowledge of one Programming Language (Java preferably), Practice of SQL (queries and sub queries), exposure to Linux Environment.

Introduction:

The course enables students to Understand the Big Data Platform and its Use cases, Provide an overview of Apache Hadoop, Provide HDFS Concepts and Interfacing with HDFS, Understand Map Reduce Jobs, Provide hands on Hadoop Eco System, Apply analytics on Structured, Unstructured Data, Exposure to Data Analytics with R.

Course Outcomes (CO):

The students will be able to:

CO1: Set up single and multi-node Hadoop Clusters

CO2: Apply Map Reduce technique for various algorithms

CO3: Design algorithms that uses Map Reduce to apply on Unstructured and structured data

CO4: Develop Scalable machine learning algorithms for various Big data applications using R

CO5: Represent NoSQL data

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3								3	3	2

CO2	3		3		3						3	3	3
CO3	3		3						3		3	3	3
CO4	3		3		3				3	3	3	3	2
CO5	3		3								3	3	2	3

LIST OF EXPERIMENTS

1. Set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop Distributed File System, running on Ubuntu Linux. After successful installation on one node, configuration of a multi-node Hadoop cluster (one master and multiple slaves).
2. MapReduce application for word counting on Hadoop cluster
3. Unstructured data into NoSQL data and do all operations such as NoSQL query with API.
4. K-means clustering using map reduce
5. Page Rank Computation
6. Mahout machine learning library to facilitate the knowledge build up in big data analysis.
7. Application of Recommendation Systems using Hadoop/mahout libraries

TITLE OF COURSE: BIG DATA MODELING & MANAGEMENT
COURSE CODE: BDA102
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Introduction about Big data and Hadoop.

Introduction:
In this course, you will experience various data genres and management tools appropriate for each. You will be able to describe the reasons behind the evolving plethora of new big data platforms from the perspective of big data management systems and analytical tools.

Course Outcomes (CO):
The students will be able to:
CO1: Recognize different data elements in your own work and in everyday life problems.
CO2: Explain why your team needs to design a Big Data Infrastructure Plan and Information System Design.
CO3: Identify the frequent data operations required for various types of data.
CO4: Select a data model to suit the characteristics of your data.
CO5: Apply techniques to handle streaming data.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3								3	3	2
CO2	3		3		3							3	3	3

CO3	3		3						3			3	3	3
CO4	3		3		3				3	3		3	3	2
CO5	3		3								3	3	2	3

Course Contents:

Module-1: Introduction to Big Data Modeling and Management, Data Ingestion, Data Storage, Data Quality, Data Operations, Data Scalability and Security, Energy Data Management Challenges at ConEd

Module-2: Big Data Modeling, Introduction to Data Models, Data Model Structures, Data Model Operations, Data Model Constraints, Introduction to CSV Data, What is a Relational Data Model?, What is a Semi-structured Data Model?, Exploring the Relational Data Model of CSV Files, Exploring the Semi-structured Data Model of JSON data, Exploring the Array Data Model of an Image, Exploring Sensor Data.

Module-3: Vector Space Model, Graph Data Model, Other Data Models, Exploring the Lucene Search Engine's Vector Data Model, Exploring Graph Data Models with Gephi.

Module-4: Data Model vs. Data Format, What is a Data Stream?, Why is Streaming Data different?, Understanding Data Lakes, Exploring Streaming Sensor Data.

Module-5: DBMS-based and non-DBMS-based Approaches to Big Data, From DBMS to BDMS, Redis: An Enhanced Key-Value Store, Aerospike: a New Generation KV Store, Semi structured Data – AsterixDB, Solr: Managing Text, Relational Data – Vertica.

Textbooks:

1. Hands-On Big Data Modeling, By James Lee , Tao Wei & Suresh Kumar Mukhiya
2. Data Management: Databases And Organizations 6th Editionby Richard T. Watson

Reference:

1. Big Data Principles and best practices of scalable realtime data systems, Nathan Marz and James Warren

TITLE OF COURSE: BIG DATA INTEGRATION & MODELING
COURSE CODE: BDA203
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Completion of Intro to Big Data is recommended.

Introduction: Nowadays, huge volume of data is collected from many heterogeneous data sources which are generating data in real-time with different qualities — which is called Big Data. The big data integration is very challenging especially after the traditional data integration techniques failed to handle it.

Course Outcomes (CO):

The students will be able to:

CO1: Retrieve data from example database and big data management systems.

CO2: Describe the connections between data management operations and the big data processing patterns needed to utilize them in large-scale analytical applications.

CO3: Identify when a big data problem needs data integration

CO4: Execute simple big data integration and processing on Hadoop and Spark platforms

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3								3	3	2
CO2	3		3		3							3	3	3
CO3	3		3						3			3	3	3
CO4	3		3		3				3	3		3	3	2

Course Contents:

Module-1: introduction to big data integration and processing, big data modeling and management, why is big data processing different? What is data retrieval?, querying two relations, subqueries, querying relational data with postgres.

Module-2: Retrieving Big Data: Querying JSON Data with MongoDB, Aggregation Functions, Querying Aerospike, Querying Documents is MongoDB, Exploring Pandas Data Frames.

Module-3: Big Data Integration: Overview of information integration, A Data integration Scenario, Integration for Multichannel Customer Analytics, Big Data Management and Processing Using Splunk and Datameer, why splunk?, Connected Cars with ford's OpenXC and Splunk, Big Data Management and Processing using Datameer, Installing splunk Enterprise on Windows, Installing splunk enterprise on Linux, Exploring Splunk Queries.

Module-4: Processing Big Data: Big Data Processing Pipelines, Some High-Level Processing Operations in Big Data Pipelines, Aggregation Operations in Big Data Pipelines, Typical Analytical Operations in Big Data Pipelines, Overview of Big Data Processing Systems, The Integration and Processing Layer, Introduction to Apache Spark, Getting Started with Spark, WordCount in Spark.

Module-5: Big Data Analytics using Spark: Spark Core: Programming In Spark using RDDs in Pipelines, Spark Core: Transformations, Spark Core: Actions, Spark SQL, Spark Streaming, Spark MLLib, Spark GraphX, Exploring SparkSQL and Spark DataFrames, Analyzing Sensor Data with Spark Streaming.

Textbooks:

1. Data Integration Blueprint And Modeling: Techniques For A Scalable And Sustainable Architecture (Paperback) (Ibm Press) 1st Edition By Anthony David Giordano

2. Managing Data In Motion: Data Integration Best Practice Techniques And Technologies (The Morgan Kaufmann Series On Business Intelligence) 1st Edition By April Reeve

Reference:

1. Principles of Data Integration 1st Edition by AnHai Doan, Alon Halevy , Zachary Ives

TITLE OF COURSE: BIG DATA INTEGRATION & MODELING LAB
COURSE CODE: BDA293
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents BDA203

TITLE OF COURSE: MACHINE LEARNING WITH BIG DATA
COURSE CODE: BDA204
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Completion of Intro to Big Data is recommended.

Introduction:
This course provides an overview of machine learning techniques to explore, analyze, and leverage data. You will be introduced to tools and algorithms you can use to create machine learning models that learn from data, and to scale those models up to big data problems.

Course Outcomes (CO):
The students will be able to:
CO1: Design an approach to leverage data using the steps in the machine learning process.
CO2: Apply machine learning techniques to explore and prepare data for modeling.
CO3: Identify the type of machine learning problem to apply the appropriate set of techniques.
CO4: Construct models that learn from data using widely available open source tools.
CO5: Analyze big data problems using scalable machine learning algorithms on Spark.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2		3							3	3	2
CO2	3			3	3						3	3	3	3
CO3	2	3	3								3	2	3	3
CO4	3	3	3		2							3	3	2
CO5	3			3								2	2	3

Course Contents:
Module-1: Introduction to Machine Learning With Big Data, Summary of Big Data Integration and Processing, Machine Learning Overview, Categories Of Machine Learning Techniques, Machine Learning Process, Goals and Activities in the Machine Learning Process, CRISP-DM, Scaling Up Machine Learning Algorithms
Module-2: Data Exploration: Data Terminology, Data Exploration, Data Exploration through Summary Statistics, Data Exploration through Plots, Exploring Data with KNIME Plots, Data Exploration in Spark.
Module-3: Data Preparation: Data Preparation, Data Quality, Addressing Data Quality Issues, Feature Selection, Feature Transformation, Dimensionality Reduction, Handling Missing Values in KNIME, Handling Missing Values in Spark.
Module-4: Classification: introduction to Classification, Building and Applying a Classification Model, Classification Algorithms, k-Nearest Neighbors, Decision Trees, Naïve Bayes, Classification using Decision Tree in KNIME, Classification in Spark.
Module-5: Evaluation of Machine Learning Models: Generalization and Overfitting, Overfitting in Decision Trees, Using a Validation Set, Metrics to Evaluate Model Performance, Confusion Matrix, Evaluation of Decision Tree in KNIME, Evaluation of Decision Tree in Spark.

Module 6: Regression, Cluster Analysis, and Association Analysis: Regression Overview, Linear Regression, Cluster Analysis, k-Means Clustering, Association Analysis, Association Analysis in Detail, Machine Learning With Big Data - Final Remarks, Cluster Analysis in Spark.

Textbooks:

1. Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners Book by Jared Dean
2. Machine Learning Models and Algorithms for Big Data Classification: Thinking with Examples for Effective Learning Book by Shan Suthaharan.

Reference:

1. Big Data and Machine Learning in Quantitative Investment Book by Tony Guida
2. Machine Learning For Big Data Analysis, Edited By Siddhartha Bhattacharyya, Hrishikesh Bhaumik, Anirban Mukherjee, Sourav De

TITLE OF COURSE: MACHINE LEARNING WITH BIG DATA LAB
COURSE CODE: BDA294
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents BDA204

TITLE OF COURSE: STATISTICS FOR DATA ANALYTICS
COURSE CODE: BDA205
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Pre-requisite: Basic concepts of Mathematics and Statistics like Linear Algebra, Calculus, and Probability.

Introduction:

This statistics and data analysis course will pave the statistical foundation for our discussion on data science. You will learn how data scientists exercise statistical thinking in designing data collection, derive insights from visualizing data, obtain supporting evidence for data-based decisions and construct models for predicting future trends from data.

Course Outcomes (CO):

The students will be able to:

CO1: Data collection, analysis, and inference.
CO2: Data classification to identify key traits and customers.
CO3: Conditional Probability-How to judge the probability of an event, based on certain conditions.
CO4: How to use Bayesian modeling and inference for forecasting and studying public opinion.
CO5: Basics of Linear Regression.
CO6: Data Visualization: How to create use data to create compelling graphics.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3			3				3	3	2

CO2	3			3								3	3	3
CO3	3		3									3	3	3
CO4	3	3							3			3	3	2
CO5	3	3	3									3	2	3
CO6	3				3						3	3	3	2

Course Contents:

Module-1: Statistics and Big Data: What are Statistics and what is Big Data. How are Big Data problems being tackled? Why is it important for statistics to be one of the key disciplines for Big Data? What does statistics bring to Big Data and where are the opportunities?

Module-2: Introduction Statistical Thinking, Examples of Statistical Thinking, Numerical Data, Summary Statistics, From Population to Sampled Data, Different Types of Biases, Introduction to Probability, Introduction to Statistical Inference.

Module-3: Association and Dependence, Association and Causation, Conditional Probability and Bayes Rule, Simpsons Paradox, Confounding, Introduction to Linear Regression, Special Regression Models.

Module-4: Exploratory Data Analysis and Visualization, Goals of statistical graphics and data visualization, Graphs of Data, Graphs of Fitted Models, Graphs to Check Fitted Models, what makes a good graph, Principles of graphics.

Module-5: Introduction to Bayesian Modeling, Bayesian inference: combining models and data in a forecasting problem, Bayesian hierarchical modeling for studying public opinion, Bayesian modeling for Big Data.

Text books:

1. Statistics for Data Science, James D. Miller
2. Statistical Techniques for Data Analysis, By John K. Taylor, Cheryl Cihon

Reference:

1. An Introduction to Statistical Learning: with Applications in R By Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani
2. Statistical Models for Data Analysis, edited by Paolo Giudici, Salvatore Ingrassia, Maurizio Vichi

TITLE OF COURSE: GRAPH ANALYTICS FOR BIG DATA

COURSE CODE: BDA306

L-T-P: 3-0-0

CREDITS: 3

Pre-requisite: Basic concepts of Data structure and Data base management system.

Introduction:

Graph analytics is an emerging form of data analysis, one that works particularly well with complex relationships. It involves moving data points and relationships between data points into a graph format (also known as nodes and links, or vertices and edges). When querying complex relationships or distant

connections between data, graph analytics offers a solution that codes queries more efficiently and can output results in an easy-to-digest visual format.

Course Outcomes (CO):
The students will be able to:
CO1: Model A Problem into A Graph Database
CO2: Perform Analytical Tasks Over the Graph in A Scalable Manner.
CO3: Apply These Techniques to Understand the Significance of Your Data Sets for Your Own Projects.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3				3		3	3	3	2
CO2	2	3	3		3						2	3	3	3
CO3	3	3	3		3				3		3	2	3	3

Course Contents:
Module-1: Graphs: What is a Graph?, Why Graphs? Why Graphs? Example 1: Social Networking, Why Graphs? Example 2: Biological Networks, Why Graphs? Example 3: Human Information Network Analytics, Why Graphs? Example 4: Smart Cities, The Purpose of Analytics, What are the impact of Big Data's V's on Graphs?
Module-2: Graph Analytics: Focusing On Graph Analytics Techniques, Path Analytics, The Basic Path Analytics Question: What is the Best Path?, Applying Dijkstra's Algorithm, Inclusion and Exclusion Constraints, Connectivity Analytics, Disconnecting a Graph, Connectedness: Indegree and Outdegree, Community Analytics and Local Properties, Global Property: Modularity, Centrality Analytics.
Module-3: Bi-directional Dijkstra Algorithm, Goal-directed Dijkstra Algorithm, Power Law Graphs, Measuring Graph Evolution, Eigenvector Centrality, Key Player Problems.
Module-4: Graph Analytics Techniques: Hands-On: Downloading, Installing, and Running Neo4j, Hands-On: Getting Started With Neo4j, Hands-On: Modifying a Graph With Neo4j, Hands-On: Importing Data Into Neo4j, Hands-On: Basic Queries in Neo4j With Cypher, Hands-On: Path Analytics in Neo4j Using Cypher ,Hands-On: Connectivity Analytics in Neo4j With Cypher.
Module-5: Introduction: Large Scale Graph Processing, A Parallel Programming Model for Graphs, Pregel: The System That Changed Graph Processing, Giraph and GraphX, Beyond Single Vertex Computation, Introduction to GraphX: Hands-On Demonstrations, Hands On: Building a Graph, Hands On: Building a Degree Histogram, Hands On: Plot the Degree Histogram, Hands On: Network Connectedness and Clustering Components, Hands On: Joining Graph Datasets.

Textbooks:
1. Graph Analytics Using Big Data,By Rajat Mehta

Reference:
1. Graph Algorithms: Practical Examples in Apache Spark And Neo4j, By Mark Needham And Amy E. Hodler

TITLE OF COURSE: MANAGING BIG DATA WITH SQL
COURSE CODE: BDA307
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Basic concepts Data base management system and SQL Query Language.

Introduction:

This course is an introduction to how to use relational databases in business analysis. You will learn how relational databases work, and how to use entity-relationship diagrams to display the structure of the data held within them. This knowledge will help you understand how data needs to be collected in business contexts, and help you identify features you want to consider if you are involved in implementing new data collection efforts.

Course Outcomes (CO):

The students will be able to:

CO1: Understand How Data Needs to Be Collected in Business Contexts.

CO2: Identify Features You Want to Consider If You Are Involved in Implementing New Data Collection Efforts

CO3: Understand How to Execute the Most Useful Query and Table Aggregation Statements For Business Analysts

CO4: Understand Query Practice Using Them with Real Databases.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			3		3						2	3	2
CO2	2			2		2						3	3	3
CO3	3			3		3						3	2	3
CO4	3	3	3			2					3	3	3	2

Course Contents:

Module-1: Problems with Having a Lot of Data Used by a Lot of People, How Relational Databases Help Solve Those Problems, Database Design Tools That Will Help You Learn SQL Faster.

Module-2: How Entity-Relationship Diagrams Work, Database Structures Illustrated by Entity-Relationship Diagrams, Relational Schemas, How to Make Entity-Relationship Diagrams using ERDPlus, How to Make Relational Schemas using ERDPlus.

Module-3: Queries to Extract Data from Single Tables: Introduction to Query Syntax, How to Use Jupyter Notebooks, How to Use Your Jupyter Account, How to Use Teradata Viewpoint and SQL Scratchpad.

Module-4: Queries to Summarize Groups of Data from Multiple Tables: What are Joins? Joins with Many to Many Relationships and Duplicates, A Note about Our Join Examples, Retrieve Your Data.

Module-5: Queries to Address More Detailed Business Questions: Design and execute subqueries, Introduce logical conditions into your queries using IF and CASE statements, Implement analyses that accommodate missing data or data mistakes, and Write complex queries that incorporate many tables and clauses.

Textbooks:

1. Sql on big data, technology, architecture, and innovation, authors: pal, sumit.

Reference Books:

1. Oracle database 11g pl/sql programming by mclaughlin, mcgraw hill**,** by mclaughlin.

Specialization Elective Course:

Data Science

TITLE OF COURSE: DATA SCIENCE WITH PYTHON
COURSE CODE: DS101
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: This course is intended for learners who have a basic knowledge of programming in any language (Java, C, C++, Pascal, Fortran, Javascript, PHP, python, etc.).

Introduction:
This course will introduce the learner to the basics of the python programming environment, including fundamental python programming techniques such as lambdas, reading and manipulating csv files, and the numpy library. The course will introduce data manipulation and cleaning techniques using the popular python pandas data science library and introduce the abstraction of the Series and DataFrame as the central data structures for data analysis, along with tutorials on how to use functions such as groupby, merge, and pivot tables effectively. By the end of this course, students will be able to take tabular data, clean it, manipulate it, and run basic inferential statistical analyses.

Course Outcomes (CO):
After Completion of this course student able to understand:
CO1: Basic process of data science
CO2: Python and Jupyter notebooks
CO3: An applied understanding of how to manipulate and analyze unsaturated datasets
CO4: Basic statistical analysis and machine learning methods
CO5: How to effectively visualize results.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				2							3	2	3
CO2	3			3	3							2	3	3
CO3	2	3	2						3			3	3	3
CO4	3	3	3		3							3	2	2
CO5	2			3							3	2	3	3

Course Contents:
Module 1: Data Science, Jupyter Notebook System, Python Functions, Python Types and Sequences, Python More on Strings
Module 2: Python Demonstration: Reading and Writing CSV files, Python Dates and Times, Advanced Python Objects, map (), Advanced Python Lambda and List Comprehensions, Advanced Python Demonstration: The Numerical Python Library (NumPy).
Module 3: The Series Data Structure, querying a Series, The Data Frame Data Structure, Data Frame Indexing and Loading, querying a Data Frame, Indexing Data frames, Missing Values.
Module 4: Merging Data frames, Pandas Idioms, Group by, Scales, Pivot Tables, Date Functionality.

Module 5: introduced to a variety of statistical techniques such a distributions, sampling and t-tests, Distributions, More Distributions, Hypothesis Testing in Python.

Text Books

1. Learning Python, 5th Edition by Mark Lutz, O'Reilly Media, 2013. ISBN 978-1-4493-5573-9
2. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython by Wes McKinny, O'Reilly Media, 2012. ISBN 978-1-4493-1979-3

Reference Books:

1. Clean Code: A Handbook of Agile Software Craftsmanship by Robert C. Martin, Prentice Hall, 2008. ISBN 000-0-1323-5088-2
2. The Linux Command Line: A Complete Introduction by William E. Shotts, Jr., No Starch Press, 2012. ISBN 978-1-5932-7389-7

TITLE OF COURSE: DATA SCIENCE WITH PYTHON LAB
COURSE CODE: DS191
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents DS101

TITLE OF COURSE: DATA MINING & DATA WARE HOUSING
COURSE CODE: DS102
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Knowledge is also assumed of basic concepts in data base management system, and mathematics.

Introduction:

The recent years have generated explosive expansion of digital data stored in computer databases as well as increased pressure on companies to keep competitive advantage. This has put Data Mining (DM) as a key method for extracting meaningful information from the flood of digital data collected by businesses, government, and scientific agencies.

Course Outcomes (CO):

This course will serve to broaden the student's understanding of the issues and latest developments in the area of data mining. To reach this goal, the following objectives need to be met:

CO1: To understand the basic principles, concepts and applications of data warehousing and data mining

CO2: To introduce the task of data mining as an important phase of knowledge recovery process.

CO3: Ability to do Conceptual, Logical, and Physical design of Data Warehouses OLAP applications and OLAP deployment.

CO4: Have a good knowledge of the fundamental concepts that provide the foundation of data mining.

CO5: Design a data warehouse or data mart to present information needed by management in a form that issuable for management client.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			3								3	2	3
CO2	3	3		2							3	2	3	3
CO3	2	3	3		3				3		3	3	3	3
CO4	3											3	2	2
CO5	3				3					3		3	3	3

Course Contents:

Module 1:

Overview of Data warehousing, Strategic information and the need for Data warehousing, Defining a Data warehouse, Evolution of Data warehousing, Data warehousing and Business Intelligence.

Module 2:

The Building Blocks of Data warehouse, Defining features – Subject-oriented data, Integrated data, Time-variant data, Nonvolatile data, Data granularity, Data warehouses and Data marts, Architectural Types – Centralized, Independent data marts, Federated, Hub-and-Spoke, Data mart bus, Overview of components - Source Data, Data Staging, Data Storage, Information Delivery, Metadata, and Management and Control components. Definition and architecture in the areas of Data acquisition, Data storage, and Information delivery Distinguishing characteristics – Different objectives and scope, Data content, Complex analysis for faster response, Flexible and Dynamic, Metadata-driven etc Architectural Framework – supporting flow of data, and the Management and Control module Technical architecture – Data acquisition, Data storage, and Information delivery.

Module 3:

Business Requirements and Data warehouse: Dimensional nature of Business data and Dimensional Analysis, Dimension hierarchies and categories, Key Business. Metrics (Facts), Requirement Gathering methods and Requirements Definition Document (contents). Distinction between architecture and infrastructure, understanding of how data warehouse infrastructure supports its architecture Components of physical infrastructure, Hardware and Operating systems for data warehouse, Database Software, Collection of Tools, Data warehouse Appliances – evolution and benefits. Business Requirements and Data Design – Structure for Business Dimensions and Key Measurements, Levels of detail. Business Requirements and the Architecture plan, Business Requirements and Data Storage Specifications, Business Requirements and Information Delivery Strategy.

Module 4:

Understanding the importance of Metadata, Metadata types by functional areas – Data acquisition, Data storage, and Information delivery, Business Metadata – overview of content and examples, Technical Metadata – overview of content and examples, Metadata Requirements, Sources of Metadata, Metadata management – challenges, Metadata Repository, Metadata, integration and standards.

Module 5:

Concepts of Data warehouse architecture – Definition and architecture in the areas of Data acquisition, Data storage, and Information delivery, Distinguishing characteristics – Different objectives and scope, Data content, Complex analysis for faster response, Flexible and Dynamic, Metadata-driven etc

Architectural Framework – supporting flow of data, and the Management and Control module. Technical architecture – Data acquisition, Data storage, and Information delivery. Design decisions, Basics of Dimensional modeling, E-R modeling versus Dimensional modeling, The STAR schema – illustration, Dimension Table, Fact Table, Factless Fact Table, Data granularity, STAR schema keys – Primary, Surrogate, and Foreign, Advantages of the STAR schema, STAR schema examples. Overview of ETL, Requirements of ETL and steps Data extraction – identification of sources and techniques Data transformation – Basic tasks, Transformation types, Data integration and consolidation, Transformation for dimension attributes, Data loading – Techniques and processes, Data refresh versus update, Procedures for Dimension tables, Fact tables: History and incremental loads ETL Tool options.

Module 6:

Distinction between architecture and infrastructure, Understanding of how data warehouse infrastructure supports its architecture Components of physical infrastructure, Hardware and Operating systems for data warehouse, Database Software, Collection of Tools, Overall concept of Online Analytical Processing (OLAP), OLAP definitions and rules, OLAP characteristics Major features and functions of OLAP – General features, Dimensional analysis, Hypercubes, Drill Down and Roll Up, Slice and Dice, Rotation, Uses and Benefits Familiarity with OLAP models – Overview of variations, MOLAP, ROLAP, HOLAP, DOLAP, Database OLAP, Web OLAP. Web-enabled Data Warehouse – adapting data warehouse for the web Web-based information delivery – Browser technology for data warehouse and Security issues OLAP and Web – Enterprise OLAP, Web-OLAP approaches, OLAP Engine design. Data warehouse Appliances – evolution and benefits

Module 7:

Overview of Data mining – Definition, Knowledge Discovery Process (Relationships, Patterns, Phases of the process), OLAP versus Data mining, Some aspects of Data mining – Association rules, Outlier analysis, Predictive analytics etc), Concepts of Data mining in a Data warehouse environment, Major Data Mining techniques – Cluster Detection using R Language, Decision Trees, Memory-based Reasoning, Link Analysis, Neural, Networks, Genetic Algorithms etc, Data Mining Applications in industry – Benefits of Data mining using R Language, Discussion on applications in Customer Relationship, Management (CRM), Retail, Telecommunication, Biotechnology, Banking and Finance etc.

Textbooks:

1. Data Mining Technology, Third Edition by Arun K Pujari, Universities Press, India
2. Data Warehousing Fundamentals for IT Professionals, Second Edition by Paulraj Ponniah, Wiley India
3. Alex Berson, Stephen J. Smith, “Data Warehousing Data Mining & OLAP”, Tata McGrow- Hill References

References:

1. Data Warehousing, Data Mining, & OLAP – Second Edition by Alex Berson and Stephen J. Smith, Tata McGraw Hill
2. Data warehouse Toolkit by Ralph Kimball, Wiley India
3. Gajendra Sharma, “Data Mining Data Warehousing and OLAP”, S.K. KATARIA & SONS

TITLE OF COURSE: STATISTICS DATA ANALYSIS
COURSE CODE: DS203
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: This course requires that you are familiar with high-school level linear algebra, and calculus. Knowledge of probability theory, statistics, and programming is desirable.

Introduction:

This course will expose you to the data analytics practices executed in the business world. We will explore such key areas as the analytical process, how data is created, stored, accessed, and how the organization works with data and creates the environment in which analytics can flourish.

Course Outcomes (CO):
After Completion of this course student able to understand:
CO1: Strong foundation in all the areas that support analytics
CO2: Basis for going deeper into advanced investigative and computational methods
CO3: Use a simple but powerful language called SQL to extract analytical data sets
CO4: Machine learning utilization in Data Analysis.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3	2	3
CO2	2			3								2	3	3
CO3	3				2						3	3	3	3
CO4	3	3	2		3						3	2	2	2

Course Contents:

Module 1: Introduction to Data & Analysis in Real World, Thinking about Analytical Problems, Conceptual Business Models, The Information-Action Value Chain, Real World Events and Characteristics, Data Capture by Source Systems.

Module 2: Introduction - Analytical Technologies, Data Storage and Databases, Big Data & the Cloud, Virtualization, Federation, and In-Memory Computing, The Relational Database, Data Tools Landscape, The Tools of the Data Analyst.

Module 3: 1. Introduction to SQL, Aggregating and Sorting Data in SQL, Extracting Data from Multiple Tables, Stacking Data with UNION Command, Extending SQL Queries Using Operators, Using SQL Subqueries.

Module 4: Introduction to Real World Analytical Orgs, Analytical Organizations – Roles, Analytical Organizations – Structures, Data Governance ,Data Privacy, Data Quality.

Module 5: Descriptive Statistics, Inferential Statistics through hypothesis tests Permutation & Randomization Test, Regression & ANOVA, Machine Learning: Introduction and Concepts, Supervised and Unsupervised Learning Technique.

Textbooks:

1. Montgomery, Douglas C., and George C. Runger., Applied statistics and probability for engineers. John Wiley & Sons, 2010

TITLE OF COURSE: STATISTICS DATA ANALYSIS LAB
COURSE CODE: DS293
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents DS203

TITLE OF COURSE: STATISTICAL METHODS FOR DECISION MAKING
COURSE CODE: DS204
L-T-P: 3-0-2
CREDITS: 4

Prerequisites: The students are expected to have knowledge of basic mathematics at the plus two level.

Introduction:
Introduction to probabilistic and statistical techniques for decision making, including inferential statistics, hypothesis tests, analysis of variance, regression analysis, and statistical quality control. Using computer software and data in statistical analysis. Emphasis on formal modeling and the use of data for managerial decision making and problem solving.

Course Outcome:
CO1: Understand and appreciate the most widely used tools of business statistics which form the basis for rational and sound business decisions
CO2: Focus on problem recognition and test hypothesis/model in the context of managerial decision-making.
CO3: Develop skills in analysis and interpretation of data
CO4: Handle challenging problems using appropriate analysis tool

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3	2	3
CO2	2			3								2	3	3
CO3	3	2	3									3	3	3
CO4	3	3	2		3						3	2	2	2

Course Content:
Module 1: Introduction to Descriptive Statistics, Descriptive and Inferential Statistics, Types of measurements, Descriptive Statistics (Using Graphs), Descriptive Statistics (Using Numbers), Measures of location, variability, and relative standing

Module 2: probability and sampling applications, and rules, conditional probability, discrete distributions (binomial, poisson, hypergeometric, geometric), continuous distribution, normal and standard normal distribution, sampling distributions, sampling distribution parameters, central limit theorem, applying sampling distribution theory
Module 3: Confidence Intervals & Hypothesis Testing: Estimation and Hypothesis Testing, point estimators, interval estimation, t-distribution, Hypothesis testing, p-values, Estimation of Population Proportion.
Module 4: Statistical Process/Quality Control: Common Causes And Special Causes Of Variation, X-Bar Chart, R Chart, P Chart, Comparing Two Population Means (Confidence Intervals)
Module 5: Regression Analysis: Simple And Multiple Linear Regression, Relationship Between Two(Simple), Three Or More(Multiple) Variables, Model Estimation, Model Inference

Text books:

1. Anderson, Sweeney, and Williams, Statistics for Business and Economics, Seventh Edition, West Publishing Co., available at Hammes Bookstore.
2. Statistical Techniques for Data Analysis, By John K. Taylor, Cheryl Cihon

Reference:

1. An Introduction to Statistical Learning: with Applications in R By Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani
2. Statistical Models for Data Analysis, edited by Paolo Giudici, Salvatore Ingrassia, Maurizio Vichi

TITLE OF COURSE: STATISTICAL METHODS FOR DECISION MAKING LAB
COURSE CODE: DS294
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents DS204

TITLE OF COURSE: DATA VISUALIZATION
COURSE CODE: DS205
L-T-P: 3-0-0
CREDITS: 3

Prerequisites

Students should have taken a course in algorithms and data mining. While the computer graphics is not required, it is useful background. Familiarity with Web technologies and JavaScript is also useful.

Introduction:

Visualization is increasingly important in this era where the use of data is growing in many different fields. Data visualization techniques allow people to use their perception to better understand this data. The goal of this course is to introduce students to data visualization including both the principles and techniques. Students will learn the value of visualization, specific techniques in information visualization and scientific visualization, and how understand how to best leverage visualization methods.

Course Outcome:

CO1: Students will be able to prepare data for visualization.
CO2: Students will be able to design visualizations.
CO3: Students will be able to use web technology to create visualizations.
CO4: Understand the type of data impacts the type of visualization.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											2	2	3
CO2	2		3									3	3	3
CO3	3	3	2								3	3	3	3
CO4	3			3								2	2	2

Course Content:

Module 1: The Computer and the Human: Overview of Visualization, 2-D Graphics, SVG-example, 2-D Drawing, 3-D Graphics, Photorealism, Non-Photorealism, The Human, Memory, Reasoning, The Human Retina, Perceiving Two Dimensions, Perceiving Perspective.

Module 2: Visualization of Numerical Data Introduction, Data, Mapping, Charts, Glyphs, Parallel Coordinates, Stacked Graphs, Tufte's Design Rules, Using Color.

Module 3: Visualization of Non-Numerical Data Introduction, Graphs and Networks, Embedding Planar Graphs, Graph Visualization, Tree Maps, Principal Component Analysis, Multidimensional Scaling, Packing.

Module 4: Introduction to Visualization Systems, The Information Visualization Mantra, Database Visualization Part, Visualization System Design

Textbooks:

1. Data Visualization: A Practical Introduction By Kieran Healy
2. Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures By Claus O. Wilke

Reference Books:

1. Data Visualization: A Handbook for Data Driven Design, By Andy Kirk
2. Effective Data Visualization: The Right Chart for the Right Data, Book by Stephanie Evergreen

TITLE OF COURSE: EXPLORATORY DATA ANALYSIS
COURSE CODE: DS306
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Calculus, Probability and Statistics for Computer Science

Introduction:

Learn how to use graphical and numerical techniques to begin uncovering the structure of your data. When your dataset is represented as a table or a database, it's difficult to observe much about it beyond its size and the types of variables it contains. In this course, you'll learn how to use graphical and numerical techniques to begin uncovering the structure of your data. Which variables suggest interesting relationships? Which observations are unusual? By the end of the course, you'll be able to answer these questions and more, while generating graphics that are both insightful and beautiful. To learn the essential exploratory techniques for analyzing and visualizing data, and to gain hands-on experience of using software tools for data analytics.

Course Outcomes (CO):

After completion of the course the students will able to

CO1: Describe exploratory data analysis and visualization concepts

CO2: Describe data analysis and visualization models and algorithms

CO3: Describe applicability of different data analysis and visualization models techniques to solve real world problems

CO4: Acquire and pre-process data

CO5: Apply exploratory data analysis to some real data sets and provide interpretations via relevant visualization

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	3	2								3	2	3
CO2	3			3							2	3	3
CO3	2		3								3	3	3
CO4	3				3						3	2	2
CO5	3			3							3	2	2	3

Course Contents:

Module 1: Introduction to Exploratory Data Analysis and Visualization, Overview of the exploratory aspect of data analysis, Data acquisition from on-line data sources and preprocessing techniques.

Module 2: Pattern Discovery, Dimensionality Reduction – Linear and Non-Linear Model, Clustering and Classification, Smoothing Scatterplots and Regression.

Module 3: Graphical Visualization, Visualizing Clusters, Visualization Data Distributions, Multivariate Visualization, Graph Data Visualization.

Module 4: Case Studies in Exploratory Data Analysis for Different Application Domains

Text Books

1. W.L. Martinez and A.R. Martinez. Exploratory Data Analysis with MATLAB, Chapman & Hall/CRC, 2011
2. B. Everitt. An Introduction to Applied Multivariate Analysis with R (Use R!), Springer, New York, 2011

References Books

1. W. McKinney. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly, 2012
2. M.A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub and More, O'Reilly, 2013

TITLE OF COURSE: DATA SCIENTIST'S TOOL BOX

COURSE CODE: DS307

L-T-P: 3-0-0

CREDITS: 3

Pre-requisite: Data Science and Data Visualization Basic Knowledge.

Introduction:

In this course you will get an introduction to the main tools and ideas in the data scientist's toolbox. The course gives an overview of the data, questions, and tools that data analysts and data scientists work with. There are two components to this course. The first is a conceptual introduction to the ideas behind turning data into actionable knowledge. The second is a practical introduction to the tools that will be used in the program like version control, markdown, git, GitHub, R, and RStudio.

Course Outcome:

CO1: Set up R, R-Studio, Github and other useful tools
CO2: Understand the data, problems, and tools that data analysts use
CO3: Explain essential study design concepts
CO4: Create a Github repository

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3							3	2	3
CO2	2	3		3								2	3	3
CO3	3		2									3	3	3
CO4	3				3				3		3	3	2	2

Course Contents:

Module 1: Data Science Fundamentals: Why Automated Videos?, What is Data Science?, What is Data?, Getting Help, The Data Science Process.

Module 2: R and RStudio, Installing R, Installing R Studio, RStudio Tour, R Packages, Projects in R.

Module 3: Version Control and GitHub, Version Control, Github and Git, Linking Github and R Studio, Projects under Version Control.

Module 4: R Markdown, Scientific Thinking, and Big Data, R Markdown, Types of Data Science Questions, Experimental Design, Big Data.

Text Books:

1. Data Science Mindset, Methodologies, and Misconceptions By Zacharias Voulgaris
2. Domain-Specific Languages in R, Advanced Statistical Programming By Thomas Mailund

Reference Books:

1. R programming for data science by *roger d. Peng*
2. The analytics lifecycle toolkit a practical guide for an effective analytics capability, by greg nelson

Specialization Elective Course:
Artificial Intelligence & Machine Learning

TITLE OF COURSE: DEEP LEARNING
COURSE CODE: AIML101
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basics of AI and Machine Learning

Introduction:
Deep learning is a branch of machine learning which is completely based on artificial neural networks, as neural network is going to mimic the human brain so deep learning is also a kind of mimic of human brain.

Course Outcomes (CO):
Upon successful completion of this course, students should be able to:
CO1: To have developed an understanding of neural network and deep learning architectures.
CO2: To acquire concepts regarding convolution and related architectures needed to develop computer vision applications.
CO3: To acquire concepts related to sequential data needed to develop text mining applications.
CO4: Students would be able to solve problems using the deep learning functionalities implemented through open-source deep learning frameworks like Tensorflow 2.0 and PyTorch**.**

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3							3	2	3
CO2	2			2			3				3		3	3
CO3	3	3	3				2				2	3	3	3
CO4	3	2	3		3						3	3	2	2

Course Contents:
Module-1: Fundamentals of Neural Network & Deep Learning:
Challenges in shallow network; Motivation for deep neural network, Different deep neural network architectures – Perceptron, Feedforward network, etc. Forward and backward propagation, Gradient Descent and related problems, Regularization, Batch normalization, Optimization algorithms (Adam's, RMSprop, etc.), Hyperparameters
Module-2: Convolutional Neural Network:

- Foundational concepts of CNN
- Building a CNN architecture
- Popular CNN architectures – LeNet, AlexNet, ResNet

CNN applications
Module-3: Recurrent Neural Network:

- Sequence data
- Architecture of RNN

- Long Short Term Memory (LSTM)
- Bi-directional LSTM
- Gated Recurrent Unit (GRU)

Applications of RNN

Module-4: Important deep learning frameworks:

Tensorflow 2.0, Keras, PyTorch, Theano, Caffe

Text Books

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach, Deep Learning, The MIT Press.
2. Fundamentals of Deep Learning – by Nikhil Buduma (O'Reilly).

References

1. Deep Learning – A practitioner's approach – by Josh Patterson & Adam Gibson (O'Reilly).

TITLE OF COURSE: DEEP LEARNING LAB
COURSE CODE: AIML191
L-T-P: 0-0-2
CREDITS: 3

Hands-on experiments related to the course contents AIML101

TITLE OF COURSE: MACHINE LEARNING TECHNIQUES
COURSE CODE: AIML102
L-T-P: 3-0-0
CREDITS: 3

Pre-Requisites:

Fundamental knowledge of computer science principles and skills, probability and statistics theory, and the theory and application of linear algebra are required.

Introduction:

Machine learning uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention.

Course Outcomes (CO):

By the end of the course, students should be able to

- Develop an appreciation for what is involved in learning models from data.
- Understand a wide variety of learning algorithms.
- Understand how to evaluate models generated from data.
- Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

CO1: Differentiate various Learning Approaches, and to interpret the Concepts of Supervised Learning.
CO2: Compare the different dimensionality reduction techniques.
CO3: Apply theoretical foundations of Decision Trees to identify best split and Bayesian Classifier to Label data points.

CO4: Illustrate the working of classifier models Like SVM, Neural Networks and Deep Neural Networks Classifier Model for typical Machine Learning Applications.

CO5: Illustrate and apply clustering algorithms and identify Its applicability in real life problems.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3					3			2	2	3
CO2	2	3	3	3					2			3	3	3
CO3	3	3	3	3		3			3			3	3	3
CO4	3	2	3	2					3			3	2	2
CO5	3	3	3	3									3	3

Course Contents:

Module-1: Introductions, Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation

Module-2: Linear regression, Decision trees, overfitting

Module-3: Instance based learning, Feature reduction, Collaborative filtering-based recommendation, Probability and Bayes learning

Module-4: Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM

Module-5: Neural network, Perceptron, multilayer network, backpropagation, introduction to deep neural network

Module-6: Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning

Text Books

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. Introduction to Machine Learning Edition 2, by Ethem Alpaydin

References

1. Baldi, P. and Brunak, S. (2002). Bioinformatics: A Machine Learning Approach. Cambridge, MA: MIT Press.

TITLE OF COURSE: SOFT COMPUTING
COURSE CODE: AIML203
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Knowledge is also assumed of basic concepts of artificial intelligence, data base management system.

Introduction:

This course provides a comprehensive introduction to understand the underlying principles, Techniques and approaches fuzzy logic.

Course Outcomes (CO):

The course presents basics of artificial intelligence programming including: Basics of AI, Data Representation, Control structures, Functions, that aims to:

CO1: Understand fuzzy sets and fuzzy logic systems.

CO2: Be able to know Classical Sets and Fuzzy Sets and Fuzzy relations, Membership functions, Fuzzy to Crisp conversions.

CO3: Understand of Neural Network on Hebbian, competitive, Boltzman.

CO4: Understand Genetic Algorithms in different approach. Also understand Other Soft Computing techniques likes Ant colony optimization (ACO), Particle Swarm Optimization (PSO).

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											2	2	3
CO2	2			3								3	3	3
CO3	3			2								3	3	3
CO4	3			3								3	2	2

Course Contents:

Module-1: Introduction:

Introduction to soft computing; introduction to fuzzy sets and fuzzy logic systems; introduction to biological and artificial neural network; introduction to Genetic Algorithm.

Module-2: Fuzzy sets and Fuzzy logic systems:

Classical Sets and Fuzzy Sets and Fuzzy relations: Operations on Classical sets, properties of classical sets, Fuzzy set operations, properties of fuzzy sets, cardinality, operations, and properties of fuzzy relations. Membership functions: Features of membership functions, standard forms and boundaries, different fuzzification methods. Fuzzy to Crisp conversions: Lambda Cuts for fuzzy sets, fuzzy Relations, Defuzzification methods. Classical Logic and Fuzzy Logic: Classical predicate logic, Fuzzy Logic, Approximate reasoning and Fuzzy Implication Fuzzy Rule based Systems: Linguistic Hedges, Fuzzy Rule based system – Aggregation of fuzzy Rules, Fuzzy Inference System-Mamdani Fuzzy Models – Sugeno Fuzzy Models. Applications of Fuzzy Logic: How Fuzzy Logic is applied in Home Appliances, General Fuzzy Logic controllers, Basic Medical Diagnostic systems and Weather forecasting

Module-3: Neural Network

Introduction to Neural Networks: Advent of Modern Neuroscience, Classical AI and Neural Networks, Biological Neurons and Artificial neural network; model of artificial neuron.

Learning Methods: Hebbian, competitive, Boltzman etc.,Neural Network models: Perceptron, Adaline and Madaline networks; single layer network; Back-propagation and multi-layer networks. Competitive learning networks: Kohonen self-organizing networks, Hebbian learning; Hopfield Networks. Neuo-Fuzzy modelling: Applications of Neural Networks: Pattern Recognition and classification

Module-4: Genetic Algorithms:

Simple GA, crossover and mutation, Multi-objective Genetic Algorithm (MOGA). Applications of Genetic Algorithm: genetic algorithms in search and optimization, GA based clustering Algorithm, Image processing and pattern Recognition

Module 5: Other Soft Computing techniques: Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).

Text Books

1. Fuzzy logic with engineering applications, Timothy J. Ross, John Wiley and Sons.
2. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI
3. Principles of Soft Computing, S N Sivanandam, S. Sumathi, John Wiley & Sons
4. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg
5. Neuro-Fuzzy and Soft computing, Jang, Sun, Mizutani, PHI
6. Neural Networks: A Classroom Approach,1/e by Kumar Satish, TMH,
7. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg, Pearson/PHI
8. A beginners approach to Soft Computing, Samir Roy & Udit Chakraborty, Pearson

References

1. Fuzzy Sets and Fuzzy Logic: Theory and Applications, George J. Klir and Bo Yuan, Prentice Hall
2. Neural Networks: A Comprehensive Foundation (2nd Edition), Simon Haykin, Prentice Hall.

TITLE OF COURSE: SOFT COMPUTING Lab
COURSE CODE: AIML293
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents AIML203

TITLE OF COURSE: ALGORITHM FOR INTELLIGENCE SYSTEM & ROBOTICS
COURSE CODE: AIML204
L-T-P: 3-0-2
CREDITS: 4

Pre-Requisites:
Basics of Artificial Intelligence, machine learning techniques are need.

Introduction:
This course provides students with a working knowledge of methods for design and analysis of robotic and intelligent systems

Course Outcomes (CO):
Particular attention is given to modeling dynamic systems, measuring and controlling their behavior, and making decisions about future courses of action.

CO1: Learn the foundations of reinforcement learning for robotics
CO2: Understand basic probabilistic principles behind Robotics intelligence
CO3: Learn different measurement techniques for robotics
CO4: Understand PSO and its significance for robotics
CO5: Implement principles of robotics intelligence for solving real world problems

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3					2		2	2	3
CO2	2	3	3		2					3		3	3	3
CO3	3		2		3					3		2	3	3
CO4	3		3		3					2		3	2	2
CO5	3		2	3						3		3	3	3

Course Contents:

Module-1(System Modeling): Biological and Cognitive Paradigms for Robot Design, Declarative-Procedural-Reflexive Hierarchy for Decision-Making and Control, Articulated Robots, Joint-Link (Denavit-Hartenberg) Transformations, Mobile Ground Robots, Intelligent Agents

Module-2(Control System Principles): Open- and Closed-Loop Control, Time-domain and Frequency-domain Analysis, Optimality and Constraints, Stability and Performance, Adaptation, Control Actuation, Closed-form and Probabilistic Path Planning

Module-3(Computing, Measurement, State, and Parameter Estimation): Sensors and Sensing, Formal and Fuzzy Logic, Turing Machines and Concepts of Machine Learning, Analog and Digital Systems, Probability and Error Models, Sensor-Based Estimation, Extended Kalman and Particle Filters, Simultaneous Location and Mapping (SLAM)

Module-4(Decision-Making and Machine Learning): Decision Trees, Bayesian Belief Networks Classification of Data Sets, Task Planning for Individual and Multiple Agents

Module-5(Numerical Methods for Evaluation and Search): Monte Carlo Simulation, Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization

Module-6(Expert Systems): Production Systems, Forward Chaining, Backward Chaining

Module-7(Neural Networks for Classification and Control): Training and Implementation of Network Architectures, Feed-Forward Networks, Associative Networks, Cerebellar Model Articulation Controller, Deep-Learning Algorithms

Text books

1. L. Joseph, Learning Robotics Using Python, PACKT, 2015
2. Albus, J. I., and Meystel, A. M., Engineering of Mind, J. Wiley & Sons, 2001.

References

1. J. Holland, Adaptation in Natural and Artificial Systems, MIT Press, 1994.
2. K. P. Valavanis and G. N. Saridis, Intelligent Robotic Systems: Theory, Design, and Applications, Kluwer, 1992.
3. J. Giarratano and G. Riley, Expert Systems: Principles and Programming, PWS Publishing, 1994.

TITLE OF COURSE: ALGORITHM FOR INTELLIGENCE SYSTEM & ROBOTICS
COURSE CODE: AIML294
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents AIML104

TITLE OF COURSE: ENSEMBLE TECHNIQUE-ML
COURSE CODE: AIML205
L-T-P: 2-0-2
CREDITS: 3

Pre-Requisites: Basic Artificial Intelligence and Machine learning concepts are needed.

Introduction: Ensemble methods is a machine learning technique that combines several base models in order to produce one optimal predictive model. In statistics and machine learning, ensemble methods use multiple learning algorithms to obtain better predictive performance than could be obtained from any of the constituent learning algorithms alone.

Course Outcomes (CO):
Ensemble methods are meta-algorithms that combine several machine learning techniques into one predictive model in order to decrease variance (bagging), bias (boosting), or improve predictions (stacking). Upon completion of this course, student will understand the broad view of the above-mentioned process.
CO1: Identify the way of extracting features that can be used for a machine learning approach
CO2: Explore supervised/ unsupervised/Reinforcement learning techniques
CO3: Learn Ensemble Learning and techniques
CO4: Analyze various advanced approaches and paradigm.
CO5: Investigate bagging and boosting learning approaches.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3					3		3	2	3
CO2	2		3							2		2	3	3
CO3	3		2			3				3		3	3	3
CO4	3			3						3		3	2	2
CO5	2									2		2	3	3

Course Contents:
Module-1: Introduction to Statistics): Statistical Inference, Types of Variables, Probability Distribution, Normal Distribution
Module-2 (Machine Learning Applications & Landscape): Introduction to Machine Learning, Machine Learning Application, Different types of Machine Learning - Supervised, Unsupervised, Reinforcement

Module-3 (Basic Ensemble Techniques): Introduction to Ensemble Learning**,** Max Voting, Averaging, Weighted Average
Module-4 (Advanced Ensemble Techniques): Stacking, Blending, Bagging, Boosting
Module-5 (Algorithms based on Bagging and Boosting): Bagging meta-estimator, Random Forest, AdaBoost, GBM, XGB, Light GBM, CatBoost

Text Books

1. Tom M. Mitchell, "Machine Learning", McGraw Hill Education India Private Limited; First edition (1 May 2013).
2. Christopher M. Bishop, "Pattern Recognition and machine learning", Springer; 1st ed. 2006. Corr. 2nd printing 2011 edition (15 February 2010)

References

1. Duda, Hart and Stork, "Pattern Classification", Wiley-Blackwell; 2nd Revised edition (21November 2000)

TITLE OF COURSE: COGNITIVE ANALYTICS
COURSE CODE: AIML306
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Basics of Artificial Intelligence, Big Data analytics, Machine Learning.

Introduction:
This course explores the area of cognitive computing and its implications for today's world of big data analytics and evidence-based decision making. Topics covered: cognitive computing design principles, natural language processing, knowledge representation, advanced analytics, as well as IBM's Watson DeepQA and Google's TensorFlow deep learning architectures. Students will have an opportunity to build cognitive applications, as well as explore how knowledge-based artificial intelligence and deep learning are impacting the field of data science.

Course Outcomes (CO):
After taking this course, students will be able to:
CO1. Understand and discuss what cognitive computing is, and how it differs from traditional approaches.
CO2. Plan and use the primary tools associated with cognitive computing.
CO3. Plan and execute a project that leverages cognitive computing.
CO4. Understand and discuss the business implications of cognitive computing.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3					3		3	2	3
CO2	2		3							2		2	3	3
CO3	3		2			3				3		3	2	3
CO4	3			2						3		2	3	2
CO5	2									2		2	3	3

Course Contents:
Module-1 (Introduction to Cognitive Computing): Building Cognitive Applications, Building Deep Learning Applications
Module-2 (Cognitive Systems Fundamentals): Introduction to Knowledge-Based AI, Semantic Nets, Generate and Test, Means-Ends Analysis, Production Systems, Frames, Learning by Recording Cases, Case-Based Reasoning
Module-3 (Cognitive Systems and Learning): Concept Learning, Classification Logic, Planning, Understanding, Common Sense Reasoning, Scripts
Module-4 (Cognitive Systems and Reasoning): Explanation-Based Learning, Analogical Reasoning, Version Spaces, Constraint Propagation, Diagnosis, Meta-Reasoning
Module-5 (Cognitive System Design Principles): Machine Learning, Hypothesis Generation and Scoring, Natural Language Processing, Representing Knowledge, Taxonomies and Ontologies
Module-6 (IBM's Watson): DeepQA Architecture, UIMA – Unstructured Information Management Architecture, Structured Knowledge

Text Books

1. Hurwitz, Kaufman, and Bowles, Cognitive Computing and Big Data Analytics, Wiley, Indianapolis, IN, 2005, ISBN: 978-1-118-89662-4.

TITLE OF COURSE: COMPUTER VISION
COURSE CODE: AIML307
L-T-P: 3-0-0
CREDITS: 3

Pre-Requisites: Knowledge in Mathematics and Python programming

Introduction:
This course provides an introduction to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification and scene understanding. We'll develop basic methods for applications that include finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment, tracking, boundary detection, and recognition. The focus of the course is to develop the intuitions and mathematics of the methods in lecture, and then to learn about the difference between theory and practice in the projects.

Course Outcomes (CO):
Computer Vision focuses on development of algorithms and techniques to analyze and interpret the visible world around us. This requires understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis visual geometric modeling, stochastic optimization etc. Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision. Applications range from Biometrics, Medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.
CO1: Appreciate the detailed models of image formation.
CO2: Analyze the techniques for image feature detection and segmentation
CO3: Apply various algorithms for pattern recognition
CO4: Examine various clustering algorithms analysis
CO5: Analyze structural pattern recognition and feature extraction techniques

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											2	3
CO2	3												3	3
CO3		3	3	3									3	3
CO4	3	3											2	2
CO5				3				3				3	3	3

Course Contents:

Module-1: Digital Image Formation and low-level processing

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Module-2: Depth estimation and Multi-camera views

Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. apparel

Module-3: Feature Extraction

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Module-4: Image Segmentation

Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Module-5: Pattern Analysis

Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Module-6: Motion Analysis

Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Module-7: Shape from X

Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Text Books

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

References

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

TITLE OF COURSE: APPLICATION OF MACHINE LEARNING IN INDUSTRIES
COURSE CODE: AIML308
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Basic concepts in image processing and programming languages.

Introduction:
Machine learning (ML) is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task

Course Outcomes (CO):

CO1: This incredible form of artificial intelligence is already being used in various industries and professions. For Example, Image and Speech Recognition, Medical Diagnosis, Prediction, Classification, Learning Associations, Statistical Arbitrage, Extraction, Regression.

CO2: After completion of the course student can understand how all these Machine Learning Applications are useful in today's modern world.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										3	3	2
CO2	3											3	2	3

Course Contents:

Module -1(Overview of Machine Learning): Process and Techniques, Demonstration of ML concepts with Deep Playground, Data Input and Preprocessing with Tensorflow, Machine Learning Model Building, Prediction with Tensorflow, Monitoring and evaluating models using Tensorboard

Module -2 (Education and training): tutoring systems and personalized learning, how they work

Module -3 (Health and medicine): learning treatment policies in the medical sciences, optimal treatment policies, usage of medical equipment, medication dosing, and two-stage clinical trials

Module -4 (Text, speech, and dialog systems): Different procedure of text, speech processing, how chatbot works etc.

Module -5 (Finance): Machine Learning Examples in Finance for Fraud Detection

Module -6 (Retail): Machine Learning Examples in Retail for Product Recommendations, Improved Customer Service; practically how it is done

Module -7 (Image Classification): How Image Recognition and Classification Works, Different procedure, practical example.

Module -8 (miscellaneous): More applications of Machine Learning (like Travel for Dynamic Pricing)

Text Books

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. Introduction to Machine Learning Edition 2, by Ethem Alpaydin

References

1. Baldi, P. and Brunak, S. (2002). Bioinformatics: A Machine Learning Approach. Cambridge, MA: MIT Press.

TITLE OF COURSE: HUMAN COMPUTER INTERACTION
COURSE CODE: AIML309
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite:
Basic subjects of CSE like Basic Data structures, Algorithms, FLAT, Software Engg, Operating Systems, Databases, OS, Computer Architecture.

Introduction:
Human-computer interaction is an emerging field of study at present, due to the proliferation of large number of consumer electronic products. The key issue in this field is to make the products usable to lay-persons. In order to do that, we need to take care of the (creative) design aspects (the look-and-feel of the interface) and also the system design aspect (both software and hardware). The field is interdisciplinary with inputs required from various other fields. However, the computer science and engineering plays the central role in the design of such systems

Course Outcomes (CO):
After completion of the course, student will understand
CO1: the engineering life cycles for design of interactive systems,
CO2: computational design framework (as part of the life cycle),
CO3: components of the framework including the computational models of users and systems,
CO4: evaluation of such systems (with or without users)

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										3	2	3
CO2	3		3									3	3	3
CO3	3	3		3									3	3
CO4	3	3											2	2
CO5	3	2	3	2	2	1						2	3	3

Course Contents:
Module 1: Introduction to user-centric design, historical evolution, issues and challenges and current trend, Components of HCI Types of interfaces Design process
Module 2: Engineering user-centric systems – relation with software engineering, iterative life-cycle, prototyping, guidelines, Contextual inquiry Importance of users / talking to users Task analysis
Module 3: Sketching Low & hi fidelity prototyping, mental models, Usability evaluation think aloud, observing users Modelling users, expert evaluations
Module 4: Information visualization, Empirical research – research question formulation, experiment design, data analysis, statistical significance test
Module 5: HCI & mobility New faces of HCI, Refresher for all modules seen in the course, User-centric design evaluation – overview of evaluation techniques, expert evaluation, user evaluation, model-based evaluation with case studies

Text Books

1. Samit Bhattacharya (July, 2019). Human-Computer Interaction: User-Centric Computing for Design, McGraw-Hill India, Print Edition: ISBN-13: 978-93-5316-804-9; ISBN-10: 93-5316-804-X, E-book Edition: ISBN-13: 978-93-5316-805-6; ISBN-10: 93-5316-805-8
2. Alan Dix, Janet E. Finlay, Gregory D. Abowd and Russel Beale. (2003). Human-Computer Interaction (3rd Edition), Pearson.

References

1. Ben Shneiderman, Catherine Plaisant, Maxine Cohen and Steven Jacobs. (2009). Designing the User Interfaces: Strategies for Effective Human-Computer Interaction (5th Edison), Pearson

Specialization Elective Course:
Information Security

TITLE OF COURSE: DATA ENCRYPTION & COMPRESSION
COURSE CODE: IS101
L-T-P: 3-0-2
CREDITS: 3

Pre-requisite: Participants will be expected to have a fairly good background in steganography.
Introduction:
This course will cover the concept of security, types of attack experienced, encryption and authentication for deal with attacks, what are Network Perimeter Security, Access Control Lists and Virtual Private Networks.

Course Outcomes (COs):
On successful completion of this course, students will be able to:
CO1: Understand the significance of cryptography to the modern world and the internet.
CO2: Understand the rationale behind block cipher design.
CO3: Perform the cryptanalysis of a simple block cipher.
CO4: Integrate cryptographic algorithms into software projects.
CO5: Solve elementary problems in number theory relating to cryptography and build on number theoretic basics to further their knowledge of advanced methods of cryptography.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	2	3
CO2	3			3								2	3	3
CO3	2	3	3									3	3	3
CO4	3	3	2		3							2	2	2
CO5												3	3	3

Course Contents:
Module-1: Introduction to Security, Need for security, Security approaches, Principles of security, Types of attacks.
Module-2: Encryption Techniques, Plaintext, Cipher text, Substitution & Transposition techniques, Encryption & Decryption, Types of attacks, Key range & Size.
Module-3: Symmetric & Asymmetric Key Cryptography, Algorithm types & Modes, DES, IDEA, Differential & Linear Cryptanalysis, RSA, Symmetric & Asymmetric key together, Digital signature, Knapsack algorithm.
Module-4: User Authentication Mechanism, Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication, Firewall.

Module-5: Case Studies of Cryptography, Denial of service attacks, IP spoofing attacks, Secure inter branch payment transactions. Conventional Encryption and Message Confidentiality, Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution.
Module-6: Public Key Cryptography and Message Authentication, Approaches to Message Authentication, SHA-1, MD5, Public-Key Cryptography Principles, RSA, Digital Signatures, Key Management.
Module-7: Introduction, Need for data compression, Fundamental concept of data compression & coding, Communication model, Compression ratio, Requirements of data compression, Classification.
Module-8: Methods of Data Compression: Data compression-- Loss less &Lossy; Entropy encoding-- Repetitive character encoding, Run length encoding, Zero/Blank encoding; Statistical encoding-- Huffman, Arithmetic & Lempel-Ziv coding; Source encoding-- Vector quantization (Simple vector quantization & with error term); Differential encoding—Predictive coding, Differential pulse code modulation, Delta modulation, Adaptive differential pulse code modulation; Transform based coding : Discrete cosine transform & JPEG standards; Fractal compression

Text Books:

1. Cryptography and Network Security – B. Forouzan, McGraw-Hill.

Reference Books:

1. The Data Compression Book, Nelson, BPB.
2. Cryptography & Network Security: Atul Kahate, TMH

TITLE OF COURSE: DATA ENCRYPTION & COMPRESSION
COURSE CODE: IS191
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents IS101

TITLE OF COURSE: STEGANOGRAPHY & DIGITAL WATERMARKING
COURSE CODE: IS102
L-T-P: 2-0-2
CREDITS: 3

Pre-requisite: Participants will be expected to basic knowledge in steganography.

Introduction:
Digital watermarking and information hiding are the ascendant technology subjects in information security. A digital watermarking is a mark covertly embedded in a noise-tolerant signal carrier such as an audio, video, image data or other. It is typically used to identify ownership of the copyright of such signal, verify the authenticity or integrity of the carrier signal or to show the identity of its users. Different from digital watermarking, information hiding usually embeds a secret into an unrelated audio, video, image data or other carrier to hide the existence of important information. No matter digital watermarking or information hiding, the embedded mark or hidden secret does not make any distinguishable change or affect carrier actual practice values to meet some visual, auditory, statistical or other invisibility.

Course Outcomes (COs):

By the end of the course, students should be able understand how Digital Watermarking and Steganography works and how can they be used in Applications for making it more secure.

CO1: To learn about the watermarking models and message coding.

CO2: To learn about watermark security and authentication.

CO3: To learn about steganography, Perceptual model.

CO4: Basic knowledge of image carrier: image type, storage format, color model and transfer method etc.

CO5: Basic principle of random number generator: basic principle, applications in image scrambling and encryption ; Hash function: basic principle, applications in image authentication ; Frequency domain transformation: DFT, DCT and DWT ; Typical methods of information hiding and digital watermarking in spatial and frequency domain; Typical attack methods and evaluation criteria.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		2							3	3	2
CO2	3			3								2	3	3
CO3	2		2									3	3	3
CO4	3	3	3		3							2	2	3
CO5				3				3				3	2	2

Course Contents:

Module-1: Introduction: Information Hiding, Steganography and Watermarking, History of watermarking, Importance of digital watermarking, Applications, Properties, Evaluating watermarking systems. Watermarking Models & Message Coding: Notation, Communications, Communication based models, Geometric models, Mapping messages into message vectors, Error correction coding, Detecting multi-symbol watermarks.

Module-2: Watermarking with Side Information & Analyzing Errors: Informed Embedding, Informed Coding, Structured dirty-paper codes, Message errors, False positive errors, False negative errors, ROC curves, Effect of whitening on error rates**.**

Module-3: Perceptual Models: Evaluating perceptual impact, General form of a perceptual model, Examples of perceptual models, Robust watermarking approaches, Redundant Embedding, Spread Spectrum Coding, Embedding in Perceptually significant coefficients

Module-4: Watermark Security & Authentication: Security requirements, Watermark security and cryptography, Attacks, Exact authentication, Selective authentication, Localization, Restoration.

Module-5: Steganography: Steganography communication, Notation and terminology Information theoretic foundations of steganography, Practical steganographic methods, minimizing the embedding impact, Steg-analysis.

Text Books:

1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker,"Digital Watermarking and Steganography", Margan Kaufmann Publishers, New York, 2008.
2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, "Digital Watermarking", Margan Kaufmann Publishers, New York, 2003.
3. Michael Arnold, Martin Schmucker, Stephen D. Wolthusen, "Techniques and Applications of Digital Watermarking and Contest Protection", Artech House, London, 2003.

Reference:

1. Juergen Seits, “Digital Watermarking for Digital Media”, IDEA Group Publisher, New York, 2005.
2. Peter Wayner, “Disappearing Cryptography, Information Hiding: Steganography & Watermarking”, Morgan Kaufmann Publishers, New York, 2002.

TITLE OF COURSE: INFORMATION THEORY & CODING
COURSE CODE: IS203
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Probability and Random Processes, Digital Communications.

Introduction:
It can be subdivided into source coding theory and channel coding theory. Using a statistical description for data, information theory quantifies the number of bits needed to describe the data, which is the information entropy of the source.

Course Outcomes (CO):
After completion of the course, the student is able to
CO1: Design the channel performance using Information theory.
CO2: Comprehend various error control code properties
CO3: Apply linear block codes for error detection and correction
CO4: Apply convolution codes for performance analysis & cyclic codes for error detection and correction.
CO5: Design BCH & RS codes for Channel performance improvement against burst errors.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3								3	3	2
CO2	2	3		3								2	3	3
CO3	3		3		2							3	3	3
CO4	3		2		3							2	2	3
CO5	3		3		3							3	2	2

Course Contents:
Module-1: Information Theory:
Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Mark off Sources
Module-2: Source Coding:
Source coding theorem, Prefix Codes, Kraft McMillan Inequality property – KMI
Encoding of the Source Output, Shannon’s Encoding Algorithm.
Shannon Fano Encoding Algorithm, Huffman codes, Extended Huffman coding, Arithmetic Coding, Lempel – Ziv Algorithm

Module-3: Information Channels:
Communication Channels (Section 4.4 of Text 1).Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity, Channel Capacity of :Binary Symmetric Channel, Binary Erasure Channel, Muroga's Theorem, Contineuos Channels

Module-4: Error Control Coding:
Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Single Error Correcting hamming Codes, Table lookup Decoding using Standard Array.

Binary Cyclic Codes:
Algebraic Structure of Cyclic Codes, Encoding using an (n-k) BitShift register, Syndrome Calculation, Error Detection and Correction

Module-5: Some Important Cyclic Codes:
Golay Codes, BCH Codes.

Convolution Codes:
Convolution Encoder, Time domain approach, Transform domain approach, Code Tree, Trellis and State Diagram, The Viterbi Algorithm)

Text Books:
1. Elements of Information Theory by Thomas Cover, Joy Thomas
2. Channel Codes: Classical and Modern by William Ryan, Shu Lin
3. John Proakis, "Digital Communications", TMH, 5th Ed., 2008.

References:
1. Information Theory and Reliable Communication by Robert Gallager

TITLE OF COURSE: INFORMATION THEORY & CODING LAB
COURSE CODE: IS293
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents IS103

TITLE OF COURSE: SECURITY IDENTITY & RISK MANAGEMENT
COURSE CODE: IS204
L-T-P: 3-0-2
CREDITS: 4

Pre-requisite: Basic concepts in digital network security.

Introduction:
This course examines Security Identity & Risk Management. The Topics to be covered (tentatively) include: an introduction to security management, Threats, Risks and SANS 20, Risk modeling and IT risk framework, Forensic and Exam review, Legal and ethical issues in computer security.

Course Outcomes (CO):

In this course we will study the basic Security Identity & Risk Management. Students are expected to be capable of understanding the Legal and ethical issues in computer security, their advantages and drawbacks, how to implement them in digital world, how their drawbacks can be overcome and what the applications are and where they can be used. To reach this goal, the following objectives need to be met:

CO1: Students would be able to understand the role of Security Management in information technology systems

CO2: Student would be able to understanding of the role of firewalls, guards, proxy servers and intrusion detection in networks on a Linux OS with traffic analysis

CO3: Student would be able to evaluate the residual risk of a protected network

CO4: Student would be able to apply legal and ethical standards in the Information Security context.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3	2	2
CO2	2			3								2	3	3
CO3	3	3	3									3	3	3
CO4	3	3	2		3							3	2	3

Course Contents:

Module-1: Introduction to security management and to the different cyber security courses taught at Morgan State. cyber risks, basic computer security and network security concepts.

Module-2: Threats, Risks and SANS 20 Critical Controls Overview SANS 20 critical control for security management, cyber security concepts: Threats, Vulnerabilities. SANS 20 critical controls for security management vulnerabilities and threats will be presented, key terms.

Module-3: Risk modeling and IT risk framework, A novel risk framework, Numerical risk computation. Quantification of risk and costs associated with attacks are explained and determined compare the advantages and disadvantages of various risk assessment methodologies. Balance the defense and control to minimize cost associated with successful breach.

Module-4: Risk decisions and IT risk framework analysis. IT risk framework reasonable decisions to minimize the cost of a cyber-attack based on simulation of the risk, evaluate and categorize risk.

Module-5: Risk management: NIST 800-30 and 800-39 documents. Assess security risks and costs based on NIST 800-30/39 document and discuss risk assessment from NIST POV. various risk, analysis methodologies and decisions on risk management issues based on the NIST guidelines and Program a risk assessment model to relation between risk and system security policy.

Module-6: Forensic and incident response. monitoring, forensics and incident response. security monitoring, identify key concepts in forensic analysis, and make recommendation on incident response given any scenario.

Module-7: More on Incident response. we will have a closer look of the NIST SP800-61 document and identify SP800-61 key goals. Also, incident response mechanisms will be explained as well as how to select the best response possible in any given situation.

Module-8: Forensic and Exam review. NIST SP800-86 document, network forensics. Cyber forensics will be studied in details, the best forensic analysis in any given situation.
Module-9: Forensic SP800-86 document, handle an incident, integrate forensic techniques into incident response, and use data from data files for forensic analysis, use data from operating systems for forensic analysis. Lastly, detect and prevent intrusion.
Module-10: Supply Chain Risk Management Practices, NIST SP800-161 (Supply Chain Risk Management Practices for Federal Information Systems and Organizations), identify core components ICT SCRM controls, integrate ICT SCRM into organization wide risk management, and identify ICT supply chain threat events.
Module-11: Policy, legal and ethical implications of the security management, data security and its importance. Legal, Ethical and compliance issues regarding data security and identity theft. Identify the risk of identity theft, distinguish different data handling policies, and explain different federal and statewide policies related to cyber security and acts addressing issues of data security such as HIPAA/FERPA.
Module-12: Legal and ethical issues in computer security: Evaluating legal, ethical and compliance issues regarding computer security. The key legal terms in computer security such as Patents, copyrights, and IP in Information Concept. Identify different computer crimes, examine a computer fraud case for ethical issues, and comply by the rules of the ethics as dealing with cybercrimes.

Text Books

1. Security Awareness—Applying Practical Security in Your World, 4th Ed. Mark Ciampa Copyright © 2014 Course Technology, ISBN-13: 978-1-111-64418-5

References

1. Computer Forensics and Cyber Crime, An Introduction, 3rd Ed. Marjie Britz, Copyright © 2013 Pearson/Prentice Hall, ISBN-13: 978-0-13-267771-4

TITLE OF COURSE: SECURITY IDENTITY & RISK MANAGEMENT LAB
COURSE CODE: IS294
L-T-P: 0-0-2
CREDITS: 1

Hands-on experiments related to the course contents IS294

TITLE OF COURSE: SECURE CODING
COURSE CODE: IS205
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Knowledge is also assumed of basic concepts of C language and networking.
Introduction:
This course provides a comprehensive introduction to understand the underlying principles, Techniques and approaches which constitute a coherent body of knowledge in coding.

Course Outcomes (COs):
This course aims to provide an understanding of the various security attacks and knowledge to recognize and remove common coding errors that lead to vulnerabilities. It gives an outline of the techniques for developing a secure application

CO1: To implement security as a culture and show mistakes that make applications vulnerable to attacks.
CO2: To understand various attacks like DoS, buffer overflow, web specific, database specific, web-spoofing attacks.
CO3: To demonstrate skills needed to deal with common programming errors that lead to most security problems and to learn how to develop secure applications.
CO4: To identify the nature of the threats to software and incorporate secure coding practices throughout the planning and development of the product.
CO5: Able to properly handle application faults, implement secure authentication, authorization and data validation controls used to prevent common vulnerabilities.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3	2	2
CO2	2			3								2	3	3
CO3	3	3	3									3	3	3
CO4							3	3					2	3
CO5					3	2						3	3	3

Course Contents:
Module-1: Introduction: Security, CIA Triad, Viruses, Trojans, and Worms In a Nutshell, Security Concepts-exploit, threat, vulnerability, risk, attack. Malware Terminology: Rootkits, Trapdoors, Botnets, Key loggers, Honey pots. Active and Passive Security Attacks. IP Spoofing, Tear drop, DoS, DDoS, XSS, SQL injection, Smurf, Man in middle, Format String attack. Types of Security Vulnerabilities-buffer overflows, Invalidated input, race conditions, access-control problems, weaknesses in authentication, authorization, or cryptographic practices. Access Control Problems.
Module-2: Need for secure systems: Pro-active Security development process, Secure Software Development Cycle (S-SDLC) , Security issues while writing SRS, Design phase security, Development Phase, Test Phase, Maintenance Phase, Writing Secure Code –Best Practices SD3 (Secure by design, default and deployment), Security principles and Secure Product Development Timeline.
Module-3: Threat modelling process and its benefits: Identifying the Threats by Using Attack Trees and rating threats using DREAD, Risk Mitigation Techniques and Security Best Practices. Security techniques, authentication, authorization. Defense in Depth and Principle of Least Privilege.
Module-4: Secure Coding Techniques: Protection against DoS attacks, Application Failure Attacks, CPU Starvation Attacks, Insecure Coding Practices In Java Technology. ARP Spoofing and its countermeasures. Buffer Overrun-Stack overrun, Heap Overrun, Array Indexing Errors, Format String Bugs. Security Issues in C Language: String Handling, Avoiding Integer Overflows and Underflows and Type Conversion Issues-Memory Management Issues, Code Injection Attacks, Canary based countermeasures using Stack Guard and Pro police. Socket Security, Avoiding Server Hijacking, Securing RPC, ActiveX and DCOM
Module-5: Database and Web-specific issues: SQL Injection Techniques and Remedies, Race conditions, Time of Check Versus Time of Use and its protection mechanisms. Securing Signal Handlers and File Operations. XSS scripting attack and its types –Persistent and Non persistent attack XSS Countermeasures and Bypassing the XSS Filters.

Module-6: Testing Secure Applications: Security code overview, secure software installation. The Role of the Security Tester, Building the Security Test Plan. Testing HTTP-Based Applications, Testing File-Based Applications, Testing Clients with Rogue Servers

Text Books

1. Writing Secure Code, Michael Howard and David LeBlanc, Microsoft Press, 2ndEdition, 2004
2. Buffer Overflow Attacks: Detect, Exploit, Prevent by Jason Deckar, Syngress,1stEdition,2005

References

1. Threat Modeling, Frank Swiderski and Window Snyder, Microsoft Professional, 1st Edition,2004

TITLE OF COURSE: BIOMETRICS
COURSE CODE: IS306
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Knowledge is also assumed of basic concepts in programming languages, algorithms, networking, mathematics etc.

Introduction:

Biometric Systems are automated methods of verifying or recognizing the identity of a living person on the basis of some physiological characteristics, like a fingerprint or face pattern, or some aspects of behavior, like handwriting or keystroke patterns. Some of the most used biometric characteristics are shown in the picture below. A biometric system based on physiological characteristics is more reliable than one which adopts behavioral features, even if the latter may be easier to integrate within certain specific applications.

Course Outcomes (COs):

Upon Completion of the course, the students will be able to

CO1: Implement basic security algorithms required by the biometric system.

CO2: Analyze the vulnerabilities in biometric system and hence be able to design a security Solution.

CO3: Analyze the possible security attacks in complex real time systems and their effective Countermeasures

CO4: Identify the security issues in the network and resolve it.

CO5: Formulate research problems in the biometric security field.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3		3							3	3	3
CO2	2			3								3	2	3
CO3	3	3	3									3	3	3
CO4							3	2					3	3
CO5					2	3						3	3	2

Course Contents:

Module-I: ATTACKS IN BIOMETRIC

Adversary attacks-attacks at the user Interface-Attacks on the biometric processing, Attacks on template database –system security analysis – spoofing and mimicry attacks

Module-II: BIOMETRIC AUTHENTICATION PROTOCOLS

Introduction-biometric based secure cryptographic protocols – biometrics based cryptographic key Regeneration and sharing – Biometrics based session key generation and sharing protocol – performance evaluation strategies.

Module-III: BIOMETRIC CRYPTOGRAPHY

Protection of biometric data –biometric data shuffling scheme- experimental results –security analysis - cryptographic key Reservation - cryptographic key with biometrics-Revocability in key generation system-Adaptations of Generalized key Regeneration scheme –IRIS Biometrics –Face Biometrics –Extension of Key Regeneration scheme.

Module-IV: BIOMETRIC DATA PROTECTION

Biometric data – Concept of personal data – Data protection and privacy – Security criteria for Biometric system – Adoption of security – Revocation procedures – Security and organizational aspects of biometric system.

Module-V: BIOMETRIC MULTI MODAL AND APPLICATIONS

Integration – Multiple traits – Multiple snapshots – Score fusion methods – Applications – Board Security – Identification cards – Biometrics on smart cards – Overview of local and global structure – Mechanism for on card comparison – Off card and On card alignment – Smart textile sensors – Bio-signals – Biometrics and intelligence services.

Text Books:

1. David Check Ling Ngo, Andrew Beng Jin Teoh, Jiankun Hu "Biometric Security" Cambridge Scholars,2015
2. Els. J.Kindt, ―Privacy and data protection issues of Biometric Applications ―, Springer,2013.
3. Eliza Yinzi Du, ―Biometrics from fiction to practice‖, Pan standford Publishers 2012.
4. James wayman, ―Introduction to Biometrics‖, Springer 2011

Reference:

1. Liangwang, XinGeng "Behavioral Biometrics for Human Identifications Intelligent Applications" Medical Information Science Reference, IGI Global 2010
2. Patriziocampisi "Security and Privacy in Biometrics" Springer 2013
3. Sanjay G. Kanade ―Enhancing Information Security and Privacy‖, by combining Biometrics with Cryptography, Morgan and Claypool Publishers,2012.

TITLE OF COURSE: WEB SEARCH & INFORMATION RETRIEVAL
COURSE CODE: IS307
L-T-P: 3-0-0
CREDITS: 3

Pre-requisite: Knowledge is also assumed of basic concepts in data base management system, and mathematics.

Introduction:

1. To learn techniques for making recommendations, including non-personalized, content-based, and collaborative filtering
2. To automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations

Course Outcomes (COs):

After completion of course, students would be able to:

CO1: Design recommendation system for a particular application domain.

CO2: Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3							3	3	2
CO2	3			3								3	2	3

Course Contents:

Module 1:

Introduction: Overview of Information Retrieval, Retrieval Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system.

Module 2:

Content-based Filtering: High level architecture of content-based systems, Advantages and drawbacks of content-based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

Module 3:

Collaborative Filtering: User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.

Module 4:

Hybrid approaches: Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascaded Meta-level, Limitations of hybridization strategies

Module 5:

Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability, serendipity, Evaluation on historical datasets, Offline evaluations.

Module 6:

Types of Recommender Systems: Recommender systems in personalized web search, knowledge-based recommender system, Social tagging recommender systems, Trust-centric recommendations, Group recommender systems.

Text Books:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.

2. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1st ed.

References:

1. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer (2011), 1st ed. Manouselis N., Drachsler

TITLE OF COURSE: DATA SECURITY AND ACCESS CONTROL
COURSE CODE: IS308
L-T-P: 3-0-0
CREDITS: 3

Introduction:

- This course introduces the concept of Ethical Hacking
- Gives the students the opportunity to learn about different tools and techniques in Ethical hacking
- Understand ethics behind hacking and vulnerability disclosure.

Course Outcomes (COs):

After completion of course, students would be able to:

CO1: In this course, the students will be enabled to understand and implement classical models and algorithms

CO2: They will learn how to analyze the data, identify the problems, and choose the relevant models and algorithms to apply.

CO3: They will further be able to assess the strengths and weaknesses of various access control models and to analyze their behavior.

Mapping of Course Outcomes (CO) and Program Outcomes (PO):

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3							3	3	3
CO2		3		3									2	3
CO3	3	3					3						3	2

Course Contents:

Module-1: Introduction to Access Control, Purpose and fundamentals of access control, brief history, Policies of Access Control, Models of Access Control, and Mechanisms, Discretionary Access Control (DAC), Non- Discretionary Access Control, Mandatory Access Control (MAC). Capabilities and Limitations of Access Control Mechanisms: Access Control List (ACL) and Limitations, Capability List and Limitations.

Module-2: Role-Based Access Control (RBAC) and Limitations, Core RBAC, Hierarchical RBAC, Statically Constrained RBAC, Dynamically Constrained RBAC, Limitations of RBAC. Comparing RBAC to DAC and MAC Access control policy.

Module-3: Biba's integrity model, Clark-Wilson model, Domain type enforcement model, mapping the enterprise view to the system view, Role hierarchies- inheritance schemes, hierarchy structures and inheritance forms, using SoD in real system Temporal Constraints in RBAC, MAC AND DAC. Integrating RBAC with enterprise IT infrastructures: RBAC for WFMSs, RBAC for UNIX and JAVA environments Case study: Multi-line Insurance Company

Module-4: Smart Card based Information Security, Smart card operating system fundamentals, design and implantation principles, memory organization, smart card files, file management, atomic operation, smart card data transmission ATR, PPS Security techniques- user identification, smart card security, quality assurance and testing, smart card life cycle-5 phases, smart card terminals.

Module-5: Recent trends in Database security and access control mechanisms. Case study of Role-Based Access Control (RBAC) systems.

Module -6: Recent Trends related to data security management, vulnerabilities in different DBMS.

References:

1. Role Based Access Control: David F. Ferraiolo, D. Richard Kuhn, Ramaswamy Chandramouli.
2. http://www.smartcard.co.uk/tutorials/sct-itsc.pdf : Smart Card Tutorial.