REGULATIONS, CURRICULUM & SYLLABUS
FOR

MASTER OF SCIENCE (M.Sc.)

COMPUTER SCIENCE

(For CBCS System in Pondicherry University Affiliated Colleges)
(Effective from the Academic Year (2020 - 2021)

PONDICHERRY UNIVERSITY

PUDUCHERRY-14.

February 2020

PONDICHERRY UNIVERSITY

REGULATIONS AND SYLLABUS
FOR
MASTER OF SCIENCE (COMPUTER SCIENCE)

(for CBCS System in Pondicherry University Affiliated Colleges)

(Effective from the Academic Year 2019-2020)

Eligibility for Admission

Candidates who have secured 55% of marks or above in any one of the following or equivalent, are eligible to apply: Bachelor's Degree in Computer Science / Information Technology / Computer Applications.

Duration of the Course

The course duration shall normally be of two years' duration spread over four semesters. The maximum duration to complete the course shall be 4 years

Medium

The medium of instruction shall be English.

Passing & Classification

Passing Eligibility & Classification for the award of the Degree are as per the Choice Based Credit System norms.

PONDICHERRY UNIVERSITY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE

MASTER OF SCIENCE (COMPUTER SCIENCE)

CURRICULUM
(Effective from the academic year 2019-2020)

COURSE STRUCTURE

Course Category	Number of Credits	
Core Courses	54 Credits	55 Credits
Outreach Programme (Conferences / Symposiums / Technical Meets / Workshops / Etc.,)	1 Credit	
Elective Courses	15 Credits	
Skill Enhancement Courses	02 Credits	
Total	**72**	

BRIDGE COURSE[#]

S. No.	Course Code	Course Title	H/S	Credits	Phase	No. of Hours
1	MSCB 001	Data Structures and Algorithms	S	0	I	21
2	MSCB 002	Operating Systems	S	0	II	24
3	MSCB 003	Programming in C	S	0	I	21
4	MSCB 004	Object Oriented Programming using Java	S	0	II	24
					Total	90

[#] 15 days Course work - 6 hours / day □ 90 hours
Phase I □ 07 days
Phase II □ 08 days

FIRST SEMESTER

S. No.	Course Code	Course Title	H/S	L	T	P	Credits
1	MSCS 411	Design and Analysis of Algorithms	H	3	0	0	3
2	MSCS 412	Advanced Computer Architecture	H	3	0	0	3
3	MSCS 413	Automata Theory & Formal Languages	H	3	0	0	3
4	MSCS 431	Probability and Statistics (Supportive Core – I)	H	3	0	0	3
5	MSCS 414	Communication Skills	H	1	0	2	2
6	MSCS 415	Practical I – Algorithms Lab	H	0	0	3	2
7	MSCS 416	Practical II – Computer Architecture Lab	H	0	0	3	2
						Total	18

SECOND SEMESTER

S. No.	Course Code	Course Title	H/S	L	T	P	Credits
1	MSCS 421	Modern Operating Systems	H	3	0	0	3
2	MSCS 422	Advanced Database Systems	H	3	0	0	3
3	MSCS 432	Optimization Techniques (Supportive Core – II)	H	3	0	0	3
4		Elective – I	S	3	0	0	3
5		Elective – II	S	3	0	0	3
6		Skill Enhancement – I	S	1	0	2	2
7	MSCS 423	Practical III – Operating System Lab	H	0	0	3	2
8	MSCS 424	Practical IV – Database System Lab	H	0	0	3	2
							21

THIRD SEMESTER

S.No.	Course Code	Course Title	H/S	L	T	P	Credits
1	MSCS 511	Advanced Computer Networks	H	3	0	0	3
2	MSCS 512	Web Technology	H	3	0	0	3
3	MSCS 433	Linear Programming (Supportive Core – III)	H	3	0	0	3
4		Elective – III	S	3	0	0	3
5		Elective – IV	S	3	0	0	3
6		Elective – V	S	3	0	0	3
7	MSCS 513	Outreach Programme (Conferences / Symposiums / Technical Meets / Workshops / Etc.,)	S	-	-	-	1
8	MSCS 514	Practical V – Web Technology and Computer Networks Lab	H	0	0	3	2
						Total	21

FOURTH SEMESTER

S. No.	Course Code	Course Title	H/S	L	T	P	Credits
1	MSCS 521	Project Seminar	H	0	0	8	4
2	MSCS 522	Project Work	H	0	0	8	4
3	MSCS 523	Project Report & Viva-Voce	H	0	0	8	4
						Total	12

LIST OF SKILL ENHANCEMENTCOURSES (2 Credits)

S. No.	Course Code	Domain &Course Title	H/S	Credits
1	MSCS 531	Statistical Tools	S	2
2	MSCS 532	Web Designing	S	2
3	MSCS 533	Network Management Tools	S	2
4	MSCS 534	Data Mining Tools	S	2
5	MSCS 535	Data Visualization Tools	S	2
6	MSCS 536	Cloud Computing Tools	S	2
7	MSCS 537	Big Data Tools	S	2
8	MSCS 538	Internet of Things (IoT) Tools	S	2

DOMAIN SPECIFIC ELECTIVES COURSES (15 Credits)

S. No.	COURSE CODE	COURSE TITLE	H/S	L	T	P	Credits
STREAM 1: INFORMATION SECURITY							
1	MSCS 441	Fundamentals of Cryptography (Level 1)	S	3	0	0	3
2	MSCS 442	Database and Application Security (Level 2)	S	3	0	0	3
3	MSCS 443	Mobile and Digital Forensics (Level 2)	S	3	0	0	3
4	MSCS 444	Malware Analysis (Level 2)	S	3	0	0	3
5	MSCS 445	Information System Audit (Level 3)	S	3	0	0	3
6	MSCS 446	Information Security Management (Level 3)	S	3	0	0	3
7	MSCS 447	Cloud Security (Level 3)	S	3	0	0	3
8	MSCS 448	Ethical Hacking (Level 3)	S	3	0	0	3
STREAM 2: SOFTWARE ENGINEERING							
9	MSCS 451	Object Oriented System Design (Level 1)	S	3	0	0	3
10	MSCS 452	Software Architecture (Level 1)	S	3	0	0	3
11	MSCS 453	Software Project Management (Level 2)	S	3	0	0	3
12	MSCS 454	Software Testing (Level 2)	S	3	0	0	3
13	MSCS 455	Software Quality Assurance (Level 3)	S	3	0	0	3
14	MSCS 456	Software Risk Management & Maintenance (Level 3)	S	3	0	0	3
15	MSCS 457	AGILE Software Process (Level 3)	S	3	0	0	3
STREAM 3: HUMAN COMPUTER INTERACTION							
16	MSCS 461	Foundations of Human Computer Interaction (Level 1)	S	3	0	0	3
17	MSCS 462	Introduction to Web Accessibility (Level 1)	S	3	0	0	3
18	MSCS 463	Introduction to Mobile Accessibility (Level 1)	S	3	0	0	3
19	MSCS 464	Fundamentals of Context Aware Computing (Level 2)	S	3	0	0	3
20	MSCS 465	Digital Accessibility Audit (Level 2)	S	3	0	0	3
21	MSCS 466	User Interface Engineering (Level 3)	S	3	0	0	3
22	MSCS 467	Computer Vision and Applications (Level 3)	S	3	0	0	3
STREAM 4 – DATA ANALYTICS							
23	MSCS 561	Big Data (Level 1)	S	3	0	0	3
24	MSCS 562	Python Programming for Data Analytics (Level 1)	S	3	0	0	3
25	MSCS 563	Statistics for Business Analytics (Level 1)	S	3	0	0	3
26	MSCS 564	Marketing Analytics (Level 2)	S	3	0	0	3
27	MSCS 565	Social Network Analytics (Level 2)	S	3	0	0	3
28	MSCS 566	Risk Analytics (Level 2)	S	3	0	0	3
29	MSCS 567	Database Systems in Big Data (Level 3)	S	3	0	0	3
30	MSCS 568	Streaming Analytics (Level 3)	S	3	0	0	3
31	MSCS 569	Video Processing and Analytics (Level 3)	S	3	0	0	3
		STREAM 5 – NETWORK COMPUTING					
32	MSCS 571	Principles of Distributed Computing (Level 1)	S	3	0	0	3
33	MSCS 572	Introduction to Parallel Computing (Level 2)	S	3	0	0	3
34	MSCS 573	Network Design and Management (Level 2)	S	3	0	0	3
35	MSCS 574	Web Services Computing (Level 2)	S	3	0	0	3
36	MSCS 575	Pervasive and Ubiquitous Computing (Level 3)	S	3	0	0	3
37	MSCS 576	Cloud Computing (Level 3)	S	3	0	0	3
38	MSCS 577	Internet of Things (Level 3)	S	3	0	0	3

		STREAM 6 ARTIFICIAL INTELLIGENCE					
39	MSCS 581	Introduction to A.I. and Expert Systems (Level 1)	S	3	0	0	3
40	MSCS 582	Neural Networks (Level 2)	S	3	0	0	3
41	MSCS 583	Fuzzy Logic (Level 2)	S	3	0	0	3
42	MSCS 584	Decision Support Systems (Level 2)	S	3	0	0	3
43	MSCS 585	Introduction to Machine Learning (Level 3)	S	3	0	0	3
44	MSCS 586	Introduction to Robotics (Level 3)	S	3	0	0	3
45	MSCS 587	Soft Computing (Level 3)	S	3	0	0	3

BRIDGE COURSE

MSCB 001: DATA STRUCTURES & ALGORITHMS

Pre-requisite:

- *Nil.*

Objectives:

- *To understand Data Structures used for Programming and Manipulation of Data.*
- *To understand the basics of Design and Analysis of Algorithms.*

Module - I

Introduction to Data Structure: Types of Data Structures – Linear & Non Linear Data Structures. Linear Data Structure – Arrays: Representation of Arrays – Searching: Linear Search and Binary Search – Stacks – Queues – List.

Module - II

Non Linear Data Structures: Trees: Basic Terminology – Binary Tree – Representation – Traversal – Binary Search Tree. Graph: Definition and Terminology – Representation – Traversal – Depth First and Breadth First Traversal Techniques.

Module - III

Introduction to Algorithms: Algorithm Design Techniques – Divide and Conquer – Greedy Method – Backtracking – Dynamic Programming – Branch and Bound.

Text Book:

1. *Ellis Horowitz, Sartaj Sahni and Anderson, Fundamentals of Data Structure in C, University Press, Second Edition, 2008.*
2. *T.H.Cormen, CharlesE. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, PHI Learning, Third Edition, 2009.*

MSCB 002: OPERATING SYSTEMS

Pre-requisite:

- *Nil.*

Objectives:

- *To learn basic Functionality of OS.*
- *To understand the various management activities of OS.*

Module – I

Operating Systems – Introduction – Basic Concepts and Terminology – As Resource Manager – OS Process View Point – OS Hierarchical and Extended Machine View.

Module – II

Memory Management: Relocatable Partitioned Memory Management – Paged Memory Management – Demand Paged Memory Management – Segmented Memory Management – Segmented and Demand Paged Memory Management – Swapping and Overlays.

Module – III

Processor Management – State Model – Job Scheduling –Process Scheduling – Multi Process System – Process Synchronization; Basic File System – Access Control Verification – Logical File System – Physical File System – Allocation Strategy Module.

Text Book:

1. Abraham Silberschatz, Operating System Concepts, Wiley, Ninth Edition, 2012.

MSCB 003: PROGRAMMING IN C

Pre-requisite:

- *Nil.*

Objectives:

- *To develop C Programs using basic programming constructs*
- *To develop C programs using arrays and strings*
- *To develop applications in C using functions , pointers and structures*
- *To do input/output and file handling in C*

Module - I

Introduction to programming paradigms - Structure of C program - C programming: Data Types – Storage classes - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements – Decision making statements - Switch statement - Looping statements – Pre-processor directives - Compilation process.

Module - II

Introduction to Arrays: Declaration, Initialization – One dimensional array – Two dimensional arrays – String operations: length, compare, concatenate and copy – Introduction to functions: Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursive function.

Module - III

Structure - Nested structures – Pointer and Structures – Array of structures – Files – Create, Open, Close, Processing of file content..

Text Book:

1. *Reema Thareja, Programming in C, Oxford University Press, Second Edition, 2016.*
2. *Kernighan, B.W and Ritchie, D.M., The C Programming language, Pearson Education, Second Edition, 2006.*

MSCB 004: OBJECT ORIENTED PROGRAMMING USING JAVA

Pre-requisite:

- *Nil.*

Objectives:

- *To learn the basic concepts of OOP.*
- *To develop Java and Applets Programs.*

Module - I

Concepts of OOP: Introduction OOP – Procedural vs Object Oriented Programming – Principles of OOP – Benefits and Applications of OOPS.

Module – II

Introduction to Java applications – Introduction to Classes, Objects, Methods & Strings – Control statements – Arrays – Constructor – Function Overloading &Overriding – Inheritance –Polymorphism – Exception Handling.

Module – III

Files, Streams & I/O – Introduction – Files & Streams – Sequential Access Text Files; Introduction to Multithreading– Thread Life Cycle– Thread Priorities. Introduction to Applets – Applet Life Cycle– HTML Tags– A Simple Applet Program.

Text Book:

1. Paul Deital & Harvey Deital, Java: How to Program, Pearson Education, Tenth edition, 2015.

FIRST SEMESTER

MSCS 411: DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic Knowledge in Data Structures and Programming.*

Objectives:

- *To analyse the asymptotic performance of algorithms.*
- *To demonstrate a familiarity with major algorithms and data structures.*
- *To synthesize efficient algorithms in common engineering design situations.*

Outcomes:

- *Ability to design efficient algorithms using various algorithm designing strategies.*
- *Ability to classify the problem and apply the appropriate design strategy to develop algorithm.*

Module - I: Introduction (9 hrs)

Notion of Algorithm - Linear and Non-Linear Data Structures -Analysis of Algorithm Efficiency: Analysis Frame-Work - Asymptotic Notations and Basic Efficiency Classes - Mathematical Analysis of Non-Recursive and Recursive Algorithms - Empirical Analysis of Algorithm

Module - II: Divide and Conquer (9 hrs)

Brute Force and Divide and Conquer- General method - Binary Search - Finding the maximum and minimum - merge sort - quick sort - Strassen's matrix multiplication. Decrease-and-Conquer and Transform-and-Conquer: Insertion sort -Depth First Search -Topological sorting – Pre-sorting - Gaussian Elimination -Balanced Search Trees
- Heap Sort - Horner's Rule.

Module - III: Greedy method (9 hrs)

Greedy Method: General method - Optimal Storage on Tapes-Knapsack problem -Job Sequencing - Minimum Cost Spanning Trees: Prims's Algorithm and Kruskal's Algorithm -Optimal Merge Patterns -Single Source Shortest Paths - Huffman Trees.

Module - IV: Dynamic Programming and Backtracking (9 hrs)

Dynamic Programming: General method -Principle of Optimality -Multistage Graphs -All Pairs Shortest Paths: Floyd-Warshall's Algorithms - 0/1 Knapsack -Travelling Salesman Problem. Backtracking: General Method - 8-Queen Problem - Sum of Subsets - Hamiltonian Cycles - Travelling Salesman Problem.

Module - V: Branch and Bound and NP (9 hrs)

Branch and Bound: Introduction FIFO Solution -LC Branch and Bound -Rat in Maze –Travelling Salesman Problem. NP Completeness and Approximation Algorithm: Introduction - Polynomial Time -NP Completeness and Reducibility -Approximation Algorithms.

Text Book(s):

1. *Ellis Horowitz, Sartaj Sahani, Sanguthevar Rajashekaran, Computer Algorithms/C++, Second Edition, 2008*
2. *Horowitz, E. and Sahani, S, Fundamentals of Computer Algorithms, Second Edition, 2008.*

Reference Book(s):

1. *Aho A.V., Hopcroft, J.E. and Ullaman, The Design and Analysis of Computer Algorithms, 1979.*
2. *Sara Baase, Allen Van Gelder, Computer Algorithms – An Introduction to Design and Analysis, Third Edition, 1999.*

3. *Goodman, S.E. and Hedetnieml. S.T, Introduction to the design and analysis of algorithms, McGraw Hill Computer Science Series, 1997.*

MSCS 412: ADVANCED COMPUTER ARCHITECTURE

L	T	P	C
3	0`	0	3

Pre-requisite:

- *Basic knowledge in Digital Design, Microprocessor and Computer Architecture.*

Objectives:

- *To understand the evolution of computer architecture.*
- *To understand memory addressing, pipelining and instruction set architecture.*

Outcomes:

- *Ability to address the design challenges in building a computer system.*

Module - I: Introduction: ***(9 hrs)***

Paradigms of Computing: Synchronous – Vector/Array – SIMD – Systolic Asynchronous – MIMD, reduction Paradigm – Hardware taxonomy: Flynn's classification – Software taxonomy: Kung's taxonomy – SPMD.

Module - II: Memory Organizations: ***(9 hrs)***

Bus – Cache – Shared Memory – Backplane Bus Systems – Cache Memory Organizations – Shared Memory Organizations – Sequential and Weak Consistency Models.

Module - III: Pipeline and Superscalar Techniques: ***(9 hrs)***

Pipelining and Superscalar Techniques – Linear Pipeline Processors– Nonlinear Pipeline Processors– Instruction Pipeline Design– Arithmetic Pipeline Design–Superscalar and Super Pipeline Design.

Module - IV: Parallel Computer Models: ***(9 hrs)***

Parallel Computer Models: Evolution of Computer Architecture– Multiprocessors &Multi-computers– Vector Supercomputers & SIMD supercomputers– VLSI models– Dataflow machines.

Module - V: Parallel Computer Architectures: ***(9 hrs)***

Design Issues–Communication Models, Interconnection Networks–Performance. SIMD Computers: Array Processors & Vector Processors. Shared Memory Multiprocessors: UMA–NUMA &COMA Multiprocessors. Message-Passing Multi-computers.

Text Book(s):

1. *H. El-Rewini& M. Abd-El-Barr, Advanced Computer Architecture and Parallel Processing, J. Wiley, 2005.*
2. *M. R. Bhujade, Parallel Computing, New Age Intr. Publishers, 1998.*
3. *S. Tanenbaum, Structured Computer Organization, Prentice Hall, 2007.*

Reference Book(s):

1. *W. Stallings, Computer Organization & Architecture, Prentice Hall, 2006.*
2. *Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, Tata McGraw- Hill, 2003.*

MSCS 413: AUTOMATA THEORY AND FORMAL LANGUAGES

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in set theory, Rational relations and Functions.*

Objectives:

- *To understand various Computing models like Finite State Machine, Pushdown Automata, and Turing Machine.*
- *To understand Decidability and Undecidability of various problems.*

Outcomes:

- *Ability to get familiar with computability and complexity measures.*

Module - I: Finite Automata ***(9 hrs)***

Introduction- Basic Mathematical Notation and Techniques- Finite State systems – Basic Definitions – Finite Automaton – DFA & NDFA – Finite Automaton with €- moves – Regular Languages- Regular Expression – Equivalence of NFA and DFA – Equivalence of NDFA's with and without €-moves – Equivalence of finite Automaton and regular expressions –Minimization of DFA- Pumping Lemma for Regular sets – Problems based on Pumping Lemma.

Module - II: Grammars ***(9 hrs)***

Grammar Introduction– Types of Grammar - Context Free Grammars and Languages– Derivations and Languages – Ambiguity- Relationship between derivation and derivation trees – Simplification of CFG – Elimination of Useless symbols - Unit productions - Null productions – Greibach Normal form – Chomsky normal form – Problems related to CNF and GNF.

Module - III: Pushdown Automata ***(9 hrs)***

Pushdown Automata- Definitions – Moves – Instantaneous descriptions – Deterministic Pushdown automata – Equivalence of Pushdown automata and CFL - pumping lemma for CFL – problems based on pumping Lemma.

Module - IV: Turing Machine ***(9 hrs)***

Turing Machines- Introduction – Formal definition of Turing machines – Instantaneous descriptions- Turing Machine as Acceptors – Turing Machine as Transducers Computable Languages and functions – Turing Machine constructions – Modifications of Turing Machines.

Module - V: Computational Complexity ***(9 hrs)***

Undecidability- Basic definitions- Decidable and undecidable problems - Properties of Recursive and Recursively enumerable languages – Introduction to Computational Complexity: Definitions-Time and Space complexity of TMs – complexity classes – introduction to NP-Hardness and NP-Completeness.

Text Book(s):

1. *Hopcroft J.E., Motwani R. and Ullman J.D, Introduction to Automata Theory, Languages and Computations, Pearson Education, Second Edition, 2008.*

Reference Book(s):

1. *John.C.Martin, Introduction to Languages and the Theory of Computation, McGraw-Hill Education, 2010.*
2. *Michael Sipser, Introduction to the Theory of Computation, Cengage Learning, 2012.*
3. *Peter Linz, An introduction to formal languages and automata, Jones & Bartlett Learning, 2001.*

MSCS 414: ALGORITHMS LAB

L	T	P	C
0	0	3	2

Skills to be acquired:

- *Able to analyse performance of algorithms and the ability to get them implemented.*

Lab Software Requirements:

- *Any programming Language.*

List of Exercises:

Programs should include but not limited to:

1. *Write a program that implements Binary Search.*
2. *Write a program that implements Quick Sort.*
3. *Write a program that implements Strassen's matrix multiplication.*
4. *Write a program that implements Prim's Algorithm.*
5. *Write a program that implements Kruskal's Algorithm.*
6. *Write a program that implements All pair shortest path problem.*
7. *Write a program that implements N-Queen Problem.*
8. *Write a program that implements Heapsort.*
9. *Write a program that implements Travelling Salesperson Problem.*
10. *Write a program that implements Knapsack using greedy Method.*

MSCS 415: COMPUTER ARCHITECTURE LAB

L	*T*	*P*	*C*
0	*0*	*3*	*2*

Skills to be acquired:

- *Able to Understand Computer Architecture components and the ability to implement.*

Lab Software Requirements:

- *Any Simulation Software.*

List of Exercises:

1. *Simulation of Computer Components.*
2. *Simulation of Pipeline.*
3. *Simulation of Instruction Level Parallelism.*
4. *Simulation of Cache Memory.*
5. *Simulation of Multiprocessor.*
6. *Simulation of Vector Processor.*
7. *Simulation of Thread Level Parallelism.*
8. *Simulation of Data Level Parallelism.*

MSCS 421: MODERN OPERATING SYSTEMS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in computer organizations and operating systems.*

Objectives:

- *To design and understand the following OS components: System calls, Schedulers, Memory management systems, Virtual Memory and Paging systems.*
- *To evaluate, and compare OS components through instrumentation for performance analysis.*

Outcomes:

- *Ability to analyze the various device and resource management techniques for timesharing and distributed systems.*
- *Ability to know the components and management aspects of Real time, Mobile operating systems.*

Module - I: Basics of Operating Systems (9 hrs)

Overview – Synchronization Mechanisms – Processes and Threads – Process Deadlocks – Issues in Distributed Operating Systems – Communication Primitives – Limitations of a Distributed System.

Module - II: Memory Management (9 hrs)

Memory Management - Paging - Segmentation - Virtual Memory- Demand paging - Replacement Algorithms – Design Issues – Implementation Issues – Research on Memory Management.

Module - III: File Systems and I/O (9 hrs)

File systems - Design issues - User interface to file– File System Implementation –File System Management and Optimization. Principle of I/O Hardware & Software - Systems I/O device management - Disk Scheduling approaches

Module - IV: Mobile and Real Time Operating Systems (9 hrs)

Basic Model of Real Time Systems – Characteristics – Applications of Real Time Systems – Real Time Task Scheduling – Handling Resource Sharing. Mobile Operating Systems – Architecture – Layers – Microkernel Design
– Kernel Extensions – Processes and Threads – Memory Management – File system – Android – iOS.

Module - V: Mainframe and Linux (9 hrs)

Mainframe – z/OS – Overview of z/OS Facilities – Virtual Storage and other Mainframe Concepts – Workload Management – I/O and Data Management – Supervising the Execution of Work in the System – Cross-memory Services – Characteristics of z/OS. Linux – Design Principles – Kernel Modules – Process Management – Scheduling
– Memory Management – I/O Management – File System – Inter-process Communication.

Text Book(s):

1. *Andrew S. Tanenbaum and Herbert Bos, Modern Operating Systems, Prentice Hall, Fourth Edition, 2014.*
2. *Mukesh Singhal, Niranjan Shivaratri, Advanced Concepts in Operating Systems – Distributed, Database and Multiprocessor Operating Systems, Tata McGraw-Hill, 2001.*
3. *Rajib Mall, Real-Time Systems: Theory and Practice, Prentice Hall, 2006.*

Reference Book(s):

1. *Jonathan Levin, Mac OS X and iOS Internals: To the Apple's Core, John Wiley & Sons, 2012.*
2. *Mike Ebbers, John Kettner, Wayne O"Brien, Bill Ogden, Introduction to the New Mainframe: z/OS Basics, International Business Machines Corporation, Third Edition, 2011.*
3. *Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, Wiley, Eighth edition, 2008.*

MSCS 422: ADVANCED DATABASE SYSTEMS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in database systems.*

Objectives:

- *To acquaint the students with the use of current relational database systems.*

Outcomes:

- *Ability to build a solid foundation for advanced studies in database area.*

Module - I: Introduction (9 hrs)

Introduction: Purpose of Database Systems - View of Data - Database Languages - Data Storage and Querying - Database Users and Administrators. Relational Databases: Introduction to the Relational Model - Structure of Relational Databases-Database Schema -Keys-Schema Diagrams - Functional Dependency – Normalization. Relational Query Languages - Relational operations. Advanced SQL - Accessing SQL from a Programming Language – Triggers.

Module - II: Transaction Management and Concurrency Control (9 hrs)

Transaction Management: Overview of Transaction Management- The ACID Properties - Transactions and Schedules- Concurrent Execution of Transactions - Lock-Based Concurrency Control - Performance of Locking - Introduction to Crash Recovery. Concurrency Control: 2PL, Serializability, and Recoverability - Introduction to Lock Management - Lock Conversions - Dealing with Deadlocks - Specialized Locking Techniques -Concurrency Control without Locking.

Module - III: Parallel and Distributed Databases (9 hrs)

Parallel DBMS: Architecture - Query evaluation - Query optimization -Parallelizing individual operations. Distributed DBMS: Architecture - Storing data - Cataloguing - Query processing - Updations Transactions – Concurrency and Recovery.

Module - IV: Object and Object Relational Databases (9 hrs)

Object oriented Databases: Object oriented DBs -Object modelling in database systems- Object identity OODBMS architecture and storage issues - Querying persistent objects- Transactions and concurrency control clustering indexing - case study.

Module - V: Multimedia and Mobile Database Technologies (9 hrs)

Multimedia Databases: Nature of Multimedia data and applications - Data Management Issues - Multimedia database applications. Mobile Databases: Mobile computing architecture – Mobile environment – characteristics - Data Management Issues.

Text Book(s):

1. *R. Elmasri, S.B. Navathe, Fundamentals of Database Systems, Fifth Edition, Pearson Education/Addison Wesley, 2007.*
2. *Thomas Cannolly and Carolyn Begg, Database Systems, A Practical Approach to Design, Implementation and Management, Third Edition, Pearson Education, 2007.*
3. *Henry F Korth, Abraham Silberschatz, S. Sudharshan, Database System Concepts, Fifth Edition, McGraw Hill, 2006.*

Reference Book(s):

1. *L. Dunckley, Multimedia Databases: An Object Relational Approach, Addison-Wesley, 2003.*
2. *Vijay Kumar, Mobile Database Systems, John Wiley & Sons, 2006*
3. *Raghu Ramakrishnan, Database Management Systems,Third Edition, McGrawHill, 2003.*

MSCS 423: OPERATING SYSTEM LAB

L	*T*	*P*	*C*
0	*0*	*3*	*2*

Skills to be acquired:

- *Able to understand the design issues associated with Operating Systems.*

Lab Software Requirements:

- *Any Programming Language.*

List of Exercises:

1. *Write a program to simulate the following non-pre-emptive CPU scheduling algorithms to find turnaround time and waiting time. (a) FCFS (b) SJF (c) Round Robin (pre-emptive) (d) Priority.*
2. *Write a program to simulate the following file allocation strategies.*
   (a) Sequential (b) Indexed (c) Linked.
3. *Write a program to simulate paging technique of memory management.*
4. *Write a program to simulate the following file organization techniques*
   (a) Single level directory (b) Two level directory (c) Hierarchical.
5. *Write a program to simulate Bankers algorithm for the purpose of deadlock avoidance.*
6. *Write a program to simulate disk scheduling algorithms*
   (a) FCFS (b) SCAN (c) C-SCAN.
7. *Write a program to simulate page replacement algorithms*
   (a) FIFO (b) LRU (c) LFU.
8. *Write a program to simulate producer-consumer problem using semaphores.*
9. *Write a program to simulate the concept of Dining-Philosophers problem.*

MSCS 424: DATABASE SYSTEMS LAB

L	*T*	*P*	*C*
0	*0*	*3*	*2*

Skills to be acquired:

- *Able to use database efficiently in applications to handle data.*

Lab Software Requirements:

- *Database like MySQL / SQL Server.*

List of Exercises:

1. *Distributed Database for Bookstore.*
2. *Deadlock Detection Algorithm for distributed database using wait- for graph.*
3. *Object Oriented Database – Extended Entity Relationship (EER).*
4. *Parallel Database – University Counselling for Engineering colleges.*
5. *Parallel Database – Implementation of Parallel Join & Parallel Sort.*
6. *Active Database – Implementation of Triggers & Assertions for Bank Database.*
7. *Deductive Database – Constructing Knowledge Database for Kinship Domain (Family Relations).*
8. *Study and Working of WEKA Tool.*
9. *Query Processing – Implementation of an Efficient Query Optimizer.*
10. *Designing XML Schema for Company Database.*

MSCS 511: ADVANCED COMPUTER NETWORKS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Fundamental knowledge about Computer Networks.*

Objectives:

- *To learn about integrated and differentiated services in network architectures.*
- *To understand the working of wireless network protocols.*

Outcomes:

- *Ability to design the new protocols for modern networks.*
- *Ability to get familiarized with next generation networks.*

Module - I: Network Architecture and QoS ***(9 hrs)***

Overview of TCP/IP Network Architecture – Integrated Services Architecture – Approach – Components – Services – Queuing Discipline – FQ – PS – BRFQ – GPS – WFQ – Random Early Detection – Differentiated Services.

Module - II: Wireless Networks ***(9 hrs)***

IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX - 802.16e – Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM – QoS – Comparison of WLAN and UMTS – Bluetooth – Protocol Stack – Security – Profiles

Module - III: Cellular Networks ***(9 hrs)***

GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management – Small Screen Web Browsing over GPRS and EDGE – MMS over GPRS – UMTS – Channel Structure on the Air Interface – UTRAN –Core and Radio Network Mobility Management – UMTS Security

Module - IV: 4G Networks ***(9 hrs)***

LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks –Scheduling – Mobility Management and Power Optimization – LTE Security Architecture – Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) - 4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Introduction to 5G

Module - V: Software Defined Networks ***(9 hrs)***

Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework.

Text Book(s):

1. *William Stallings, High Speed Networks and Internets: Performance and Quality of Service, Prentice Hall, Second Edition, 2002.*
2. *Martin Sauter, From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband, Wiley, 2014.*

Reference Book(s):

1. *Savo G Glisic, Advanced Wireless Networks – 4G Technologies, John Wiley & Sons, 2007.*
2. *Martin Sauter, Beyond 3G - Bringing Networks, Terminals and the Web Together: LTE, WiMAX, IMS, 4G Devices and the Mobile Web 2.0, Wiley, 2009.*
3. *Naveen Chilamkurti, Sherali Zeadally, Hakima Chaouchi, Next-Generation Wireless Technologies, Springer, 2013.*

MSCS 512: WEB TECHNOLOGY

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic Knowledge in computer network, working of Internet.*

Objectives:

- *To inculcate knowledge of web technological concepts and functioning of internet.*
- *To learn and program features of web programming languages.*

Outcomes:

- *Ability to design an innovative application for web.*

Module - I: Review of the Internet technologies (9 hrs)

Introduction Web essentials: Web Vs Internet - Clients -Servers - Communication - Internet Address - Ports – Sockets - DNS - Firewall - Proxy - Internet Service Provider - Internet Services Protocols. Introduction to static web page creation using HTML (Tables, Frames, Forms) and Cascading Style Sheets.

Module - II: Client-Side Scripting (9 hrs)

Client-Side Scripting: Introduction - JavaScript – Data Types – Variable declarations - Language Constructs – JavaScript Functions. Windows Manipulation – Working with Forms and elements – Cookies.

Module - III: Server-Side Scripting (9 hrs)

Sever Side Scripting: Introduction – PHP Language Basics: Data Types – Variable declarations – Arrays – Functions – Language Constructs – OOP with PHP. Session Management – Authentication and Security – Reporting. Database manipulation with PHP and MYSQL.

Module - IV: XML (9 hrs)

XML: Introduction - XML Syntax - XML basics - XML Parser and Processors - XML DTD: Elements and Attributes - Types - XML Schema. SOAP - Creating Simple web services.

Module - V:AJAX (9 hrs)

AJAX: Introduction - creating and sending requests - XML in JavaScript and AJAX – server-side AJAX with PHP.

Text Book(s):

1. *Laure Lemay, Web Publishing with HTML4, Techmedia, Second Edition, 2000.*
2. *Ivan Bayross, Web Enabled Commercial Application Development Using HTML, JavaScript, DHTML and PHP, bpb Publications, Fourth Edition, 2005.*

Reference Book(s):

1. *Thau, The book of JavaScript: a practical guide to interactive Web pages, Second Edition, 2006.*
2. *David Lane, Hugh E. Williams, Web Database Application with PHP and MySQL, O'Reilly, Second Edition, 2004.*
3. *Deital and Deital, XML How to program, Pearson Education, 2000.*

MSCS 514: WEB TECHNOLOGY AND COMPUTER NETWORKS LAB

L	T	P	C
0	0	3	2

Skills to be acquired:

- *Able to design and develop a web applications.*
- *Able to establish and Configure Computer Networks.*

Lab Software Requirements:

- *Dreamweaver or Xampp.*
- *Any Network Simulator.*

List of Exercises:

1. *To create a simple webpage using HTML that includes all tags.*
2. *Applying Style to an HTML Page Using CSS.*
3. *Client-Side Programming:*
   a. *Java script for Displaying and Comparing Date*
   b. *Form Validation including text field, radio buttons, check boxes, list box and other controls.*
4. *Online Applications using PHP.*
5. *Online application with data access.*
6. *To analyze the performance of various configurations and protocols in LAN.*
   a. *Establishing a LAN.*
   b. *Connecting two LANs using multi-router topology with static routes.*
7. *To analyze the performance of RIP and OSPF redistribution.*
8. *To analyze the network security for improving the security of the network.*
9. *To Control Traffic Flow in a network.*
10. *To configure a firewall and analyze it for a network.*

MSCS 432: PROBABILITY AND STATISTICS

L	T	P	C
3	1	0	3

Pre-requisite:

- *Introduction concepts in Probability/Statistics.*
- *Basic discrete Probability.*
- *Basic mathematical concepts like Sets, Number Line.*
- *Equations and Inequalities.*

Objectives:

- *To Understand concepts of discrete probability, conditional probability, independence, and can apply these concepts to engineering applications (selected by instructor).*

Outcomes:

- *Ability to* u*nderstand mathematical descriptions of random variables including probability mass functions (PMFs), cumulative distribution functions (CDFs), probability distribution functions (PDFs), conditional mass, conditional distribution and conditional density functions.*

Module - I: Introduction ***(9 hrs)***

Combinatorial methods- Principles of counting – Permutation – Combination – Binomial theorem- problems.

Module - II: Probability ***(9 hrs)***

Probability: Classical - relative frequency and axiomatic definitions of probability - addition rule and conditional probability - multiplication rule - total probability - Bayes' Theorem and independence – problems.

Module - III: Random Variables ***(9 hrs)***

Random Variables: Discrete - continuous random variables - probability mass - probability density and cumulative distribution functions - mathematical expectation – Variance- Moments - Joint Distribution: Joint - marginal and conditional distribution - correlation - problems.

Module - IV: Special Distributions and Sampling Distributions ***(9 hrs)***

Special Distributions: Discrete uniform – binomial – geometric - negative binomial – Poisson - continuous uniform – exponential – Normal Distribution.

Sampling Distribution: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-square, T and F distributions, problems

Module - V: Testing of Hypotheses ***(9 hrs)***

Testing of Hypotheses: Null and alternative hypotheses, the critical regions, two types of error, level of significance, power of the test, tests for mean for one sample and two sample problems from normal populations, Tests for single mean, difference of means using T, paired T test.

Text Book(s):

1. *1. Gupta, S.C. and Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, Tenth Edition, 2000.*

Reference Book(s):

1. *Irwin Miller and Marlyees Miller, John E Freund's Mathematical Statistics with Applications, PHI Learning, Eight Edition, 2012.*
2. *S.M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, Fourth Edition, 2009.*

MSCS 433: OPTIMIZATION TECHNIQUES

L	T	P	C
3	1	0	3

Pre-requisite:

- *Fundamental knowledge of calculus and linear programming problem.*
- *Mathematical models.*

Objectives:

- *To introduce the fundamental concepts of Optimization Techniques.*
- *To make the learners aware of the importance of optimizations in real scenarios.*

Outcomes:

- *Ability to apply the concepts of various classical and modern methods for constrained and unconstrained problems in both single and multivariable problems.*

Module - I: Classical Methods & Linear Programming Problems Terminology (9 hrs)

Introduction to Classical Methods & Linear Programming Problems Terminology: Design Variables – Constraints - Objective Function - Problem Formulation. Calculus method - Kuhn Tucker conditions - Method of Multipliers. Linear Programming Problem - Simplex method - Concept of Duality.

Module - II: Single Variable Optimization (9 hrs)

Single Variable Optimization: Problems Optimality Criterion - Bracketing Method - Region Elimination Methods - Interval Halving Method - Fibonacci Search Method - Golden Section Method. Gradient Based Methods: Newton - Raphson Method - Bisection Method - Secant Method - Application to Root finding.

Module - III: Multivariable Optimization Algorithms (9 hrs)

Multivariable Optimization Algorithms Optimality: Criteria - Unidirectional Search. Direct Search Methods: Hooke - Jeeves pattern search method - Powell's Conjugate Direction Method. Gradient Based Methods: Cauchy's Steepest Descent Method - Newton's method - Marquardt's Method.

Module - IV: Advance Optimization Techniques (9 hrs)

Quadratics Programming – sequential quadratic programming - Integer Programming - Penalty Function Method - Branch and Bound Method - Geometric Programming.

Module - V: Dynamic Programming (9 hrs)

Dynamic Programming: Genetic algorithm - Problem formulation and application in Design of continuous beam and Optimal geometric layout of a truss - Capacity expansion and Reservoir operation.

Text Book(s):

1. *S. S. Rao: Engineering Optimization: Theory and Practice, New Age International, Third Edition 2013.*
2. *E. J. Haug and J.S. Arora, Applied Optimal Design: Mechanical and Structural Systems, Wiley, 1979.*

Reference Book(s):

1. *Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India, Second Edition, 2012.*
2. *A. Ravindran and K.M. Rogsdell, G.V. Reklaites, Engineering Optimization: Methods and Applications, Wiley, Second Edition, 2006.*

MSCS 434: LINEAR PROGRAMMING

L	T	P	C
3	1	0	3

Pre-requisite:

- *Introduction concepts in linear Programming/Operations, Linear Algebra, Differential Calculus, Mathematical models.*
- *Basic mathematical concepts such as sets, functions, vectors, matrices, etc.*

Objectives:

- *Understand the linear programming problem.*
- *Enumerate LPP simplex methods.*
- *Discuss LPP duality.*
- *Differentiate Non-Linear Programming Problem and LPP.*

Outcomes:

- *Ability to apply the concepts in the many real time applications.*

Module - I: Linear Programming Problem ***(9 hrs)***

Operations Research: Introduction – Applications of OR – Linear Programming Problem: LPP Introduction – Formulation of Linear Programming Model- Illustration on Mathematical Formulation of LPP – Graphical Solution
– General LPP – Canonical and Standard forms of LPP.

Module - II: LPP Simplex Method ***(9 hrs)***

Introduction – Fundamental Properties of Solution – The Computational Procedure – Use of Artificial Variables – Degeneracy in LPP – Solutions of Simultaneous Linear Equations– Big M Method- Applications of Simplex Method.

Module - III: Duality in Linear Programming ***(9 hrs)***

Duality LPP – General Prime-Dual Pair – Formulating a Dual Problem – Primal-Dual Pair in Matrix Form – Duality Theorems– Dual Simplex Method – Two-Phase Method.

Module - IV: Dynamic Programming ***(9 hrs)***

Dynamic Programming: Introduction – The Recursive Equation Approach – Characteristics of DPP – Dynamic Programming Algorithm - Applications of DPP.

Module - V: Network Routing and Scheduling ***(9 hrs)***

Network Routing: Network Flow Problems – Minimal Spanning Tree Problem – Shortest Route Problems – Applications of Shortest Route Problem. Network Scheduling: Introduction– Logical Sequencing – Concurrent Activities – Critical Path Analysis – PERT – CPM.

Text Book(s):

1. *R.Panneerselvam, Operations Research, PHI Learning, Second Edition, 2006.*
2. *Kanti Swaroop, Man Mohan and P.K. Gupta, Operations Research, Sultan Chand and Sons, 2005.*
3. *Hamdy A Taha, Operations Research –An Introduction, Prentice Hall India, 2003.*

Reference Book(s):

1. *Philips, Ravindran and Solberg, Operations Research, John Wiley, 2002.*
2. *Ronald L.Rardin, Optimization in Operation Research, Pearson Education Pvt. Ltd. New Delhi, 2005.*

SKILL ENHANCEMENT COURSES

MSCS 531: STATISTICAL TOOLS

L	T	P	C
1	0	2	2

Pre-requisite:

- *Fundamentals of Statistics.*

Objectives:

- *Understand the difference between descriptive & inferential statistics*
- *Understand the concepts of hypothesis testing: risks, p-value, confidence intervals, power*
- *Understand the importance of sample size calculations and the required input parameters*
- *Analyse data more quickly and more accurately*

Outcomes:

- *Ability to use the statistical tools for analysis.*

Module - I:

Introduction- Statistics and its importance–Classification of variables -Importance of identifying the type & role of variables -Descriptive statistics: Visualizing and summarizing data distributions -Frequency tables for categorical variables- Pearson's correlation coefficient for continuous variables.

Module - II:

Plotting Data: Histograms, Scatter, box-plots, bar charts-Inferential statistics - Hypothesis testing principles: Null and alternative hypothesis, one vs. two-tailed test.

Module - III:

Test statistics: T-test, F-tests - Observed significance level or p-value - Statistical significance & decision rules -The importance of sample size calculations -Statistical inference with confidence Intervals -Numerical application to the single sample case

Text Book(s):

1. *Allan G. Bluman, Elementary Statistics, 1992.*
2. *Dr. M.J de Smith, Statistical Analysis Handbook, 2014.*
3. *ARice, John.* Mathematical Statistics and Data Analysis. *Duxbury Press, 2006.*

MSCS 532: WEB DESIGNING

L	T	P	C
1	0	2	2

Pre-requisite:

- *Fundamentals of Statistics.*

Objectives:

- *Able to define the principle of Web page design and the basics in web design.*
- *To Visualize the basic concept of HTML and recognize the elements of HTML.*
- *Understand basics concept of CSS and web publishing.*

Outcomes:

- *Ability to develop web applications.*

Module - I:

Basics in Web Design – Brief History of Internet – What is World Wide Web – Why create a web site – Web Standards – Audience requirement. HTML – Introduction to HTML – What is HTML – HTML Documents – Basic structure of an HTML document – Creating an HTML document – Mark up Tags – Heading-Paragraphs – Line Breaks – HTML Tags.

Module - II:

Introduction to Cascading Style Sheets – Concept of CSS – Creating Style Sheet – CSS Properties – CSS Styling(Background, Text Format, Controlling Fonts) – Working with block elements and objects – Working with Lists and Tables – CSS Id and Class – Box Model(Introduction, Border properties, Padding Properties, Margin properties) – CSS Color – Creating page Layout and Site Designs.

Module - III:

Introduction to Web Publishing or Hosting – Creating the Web Site – Saving the site – Working on the web site – Creating web site structure – Creating Titles for web pages – Themes-Publishing web sites.

Text Book(s):

1. *Thomas Powell, HTML& CSS: The Complete Reference, Mc Graw Hill, Fifth Edition, 2017.*

MSCS 533: NETWORK MANAGEMENT TOOLS

L	T	P	C
1	0	2	2

Pre-requisite:

- *Basic knowledge about Computer Networks*

Objectives:

- *To gain knowledge on how to install, maintain, and manage Local Area Networks and internetworks.*
- *To understand network management architectures and protocols.*
- *To use a variety of network management tools.*

Outcomes:

- *Ability to use the network management tools for configuration, troubleshoot and maintenance.*

Module - I:

Data Communications and Network Management Overview-Review of Computer Network Technology

Module - II:

Basic Foundations: Standards, Models, and Language - Network Management Tools and Systems -Network Management Applications -Web-Based Management

Module - III:

OpUtils - Network Management Tools - Case study on Designing and Managing a Network

Reference Materials:

1. *Network Management: Principles and Practice; by Mani Subramanian; Addison Wesley; 2000; ISBN 0- 201-35742-9.*
2. *The Cuckoo's Egg: Tracking a Spy through the Maze of Computer Espionage by Clifford Stoll Pocket Books ISBN 0671726889.*

MSCS 534: DATA MINING TOOLS

L	T	P	C
1	0	2	2

Pre-requisite:

- *Nil.*

Objectives:

- *To introduce students to the basic concepts and techniques of Data Mining.*
- *To develop skills of using recent data mining software for solving practical problems.*
- *To gain experience of doing independent study and research.*

Outcomes:

- *Ability to use the tools for data analysis.*

Module - I:

Introduction to Data Mining - Related technologies - Machine Learning, DBMS, OLAP, Statistics - Data Mining Goals - Stages of the Data Mining Process - Data Mining Techniques Knowledge Representation Methods - Data Warehouse and OLAP Data Warehouse and DBMS Multidimensional data model OLAP operations - Data preprocessing - Data cleaning - Data transformation - Data reduction.

Module - II:

Discretization and generating concept hierarchies - Installing Weka 3 Data Mining System - Experiments with Weka - filters, discretization - Data mining knowledge representation - Task relevant data - Background knowledge - Interestingness measures Representing input data and output knowledge Visualization techniques
- Experiments with Weka - visualization - Attribute-oriented analysis - Attribute generalization - Attribute relevance Class comparison Statistical measures - Experiments with Weka - using filters and statistics.

Module - III:

Experiments with Weka - training and testing - Mining real data - Preprocessing data from a real medical domain. - Applying various data mining techniques to create a comprehensive and accurate model of the data. Clustering
- Basic issues in clustering First conceptual clustering system: Cluster/2 - Partitioning methods: k-means, expectation maximization (EM) - Hierarchical methods: distance-based agglomerative and divisible clustering - Conceptual clustering: Cobweb.

Required Software:

- *Weka - Data Mining System with Free Open Source Machine Learning Software in Java.*

Data Mining software and Data Sets

- *WEKA (Source: Java)*
- *RapidMiner*
- *MLC++ (Source: C++)*
- *SIPINA*
- *List from KDNuggets (Various)*
- *List from Data Management Center (Various)*

Data Sets

- *IDS data sets*
- *Data Sets for Data Mining*
- *Competition Data Set*
- *UCI Machine learning repository*
- *Quest data repository*
- *KDNuggets*

Reference Book(s):

1. *Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, Introduction to Data Mining, 2005.*
2. *Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, 2000.*

MSCS 535: DATA VISUALIZATION TOOLS

L	T	P	C
1	0	2	2

Pre-requisite:

- *Prior experience in image editing or object oriented programming may lead to a more sophisticated final project but is not required.*

Objectives:

- *To introduce visual perception and core skills for visual analysis*
- *To understand visualization for time-series analysis and ranking analysis*
- *To understand visualization for deviation analysis*
- *To understand visualization for distribution analysis and correlation analysis*
- *To understand visualization for multivariate analysis*
- *To understand issues and best practices in information dashboard design*

Outcomes:

- *Ability to use the tools for data visualization.*

Module - I: CORE SKILLS FOR VISUAL ANALYSIS

Information visualization - effective data analysis - traits of meaningful data - visual perception - making abstract data visible - building blocks of information visualization - analytical interaction - analytical navigation - optimal quantitative scales - reference lines and regions - trellises and crosstabs - multiple concurrent views - focus and context - details on demand - over-plotting reduction - analytical patterns - pattern examples

Module - II: TIME-SERIES, RANKING, AND DEVIATION ANALYSIS

Time-series analysis - time-series patterns - time-series displays - time-series best practices- part-to-whole and ranking patterns - part-to-whole and ranking displays - best practices - deviation analysis - deviation analysis displays - deviation analysis best practices

Module - III: DISTRIBUTION, CORRELATION, AND MULTIVARIATE ANALYSIS

Distribution analysis - describing distributions - distribution patterns - distribution displays - distribution analysis best practices - correlation analysis - describing correlations – correlation patterns - correlation displays - correlation analysis techniques and best practices – multivariate analysis - multivariate patterns - multivariate displays - multivariate analysis techniques and best practices

Reference Book(s):

1. Stephen Few, Now you see it: Simple Visualization techniques for quantitative analysis, Analytics Press, 2009.
2. Stephen Few, Information Dashboard Design: The effective visual communication of data, O'Reilly, 2006.
3. Edward R. Tufte, The visual display of quantitative information, Second Edition, Graphics Press, 2001.
4. Nathan Yau, Data Points: Visualization that means something, Wiley, 2013.
5. Ben Fry, Visualizing data: Exploring and explaining data with the processing environment, O'Reilly, 2008.
6. Gert H. N. Laursen and Jesper Thorlund, Business Analytics for Managers: Taking business intelligence beyond reporting, Wiley, 2010.
7. Evan Stubbs, The value of business analytics: Identifying the path to profitability, Wiley, 2011.

MSCS 536: CLOUD COMPUTING TOOLS

L	T	P	C
1	0	2	2

Pre-requisite:

- *Nil*

Objectives:

- *Analyze the components of cloud computing showing how business agility in an organization can be created*
- *Evaluate the deployment of web services from cloud architecture*
- *Critique the consistency of services deployed from a cloud architecture*
- *Compare and contrast the economic benefits delivered by various cloud models based on application requirements, economic constraints and business requirements.*

Outcomes:

- *Ability to use the tools for simulating cloud computing applications.*

Module - I: Cloud Computing

Definition, Cloud types; IaaS, PaaS, SaaS - Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.

Module - II: Cloud Applications

Technologies and the processes required when deploying web services; Deploying a web service from inside and outside a cloud architecture, advantages and disadvantages.

Module - III: Application Development

Service creation environments to develop cloud based applications - Development environments for service development; Amazon, Azure, Google App.

Text Book(s):

1. *Paul J. Deitel, Harvey Deitel, Abbey Deitel, Internet and World Wide Web How to Program, Fifth Edition, 2011.*
2. *Chris Bates, Web Programming – Building Intranet applications, Wiley Publications, Third Edition, 2009.*

Reference Book(s):

1. *Jeffrey C. Jackson, Web Technologies a Computer Science Perspective, Pearson, 2011.*
2. *Eilliote, Rusty Harold, Java Network Programming, O'Reilly Media, Third Edition, 2004.*
3. *Kogent Solutions, Java server programming java JavaEE5 Black Book, Dreamtech Press, 2012.*

MSCS 537: BIG DATA TOOLS

L	T	P	C
1	0	2	2

Pre-requisite:

- *Processing Big Data with Apache Hadoop.*

Objectives:

- *To enables immediate and effective participation in big data projects.*
- *To learn the basic and advanced methods to big data technology and tools, including MapReduce and Hadoop and its ecosystem.*

Outcomes:

- *Ability to use the tools for big data analysis.*

Module - I: Introduction to Hadoop

The Hadoop Ecosystem-Big Data - Apache Hadoop & Hadoop EcoSystem - Moving Data in and out of Hadoop - Loading data into Hadoop - Handling files in Hadoop - Getting data from Hadoop -Understanding inputs and outputs of MapReduce - Data Serialization. Hadoop components: MapReduce/Pig/Hive/HBase.

Module - II: Hadoop Architecture

Hadoop Storage: HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup - SSH & Hadoop Configuration - HDFS Administering -Monitoring & Maintenance-Querying big data with Hive - From SQL to HiveQL.

Module - III: Hadoop Ecosystem and Yarn

Hadoop ecosystem components - Schedulers - Fair and Capacity, Hadoop 2.0 New Features Name Node High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.

Software(s):

Apache, Hadoop

Reference Book(s):

1. *Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Professional Hadoop Solutions, Wiley, 2015.*
2. *Chris Eaton, Dirk deroos et al., Understanding Big data, McGraw Hill, 2012.*
3. *Tom White, HADOOP: The definitive Guide, O'Reilly 2012.*

MSCS 538: INTERNET OF THINGS (IoT) TOOLS

L	T	P	C
1	0	2	2

Pre-requisite:

- *Nil*

Objectives:

- *To understand the fundamentals of Internet of Things.*
- *To build a small low cost embedded system using Arduino / Raspberry Pi or equivalent boards.*
- *To apply the concept of Internet of Things in the real world scenario.*

Outcomes:

- *Ability to use the tools to simulate IoT applications.*

Module - I: Fundamentals of IOT

Introduction to IoT- Defining IoT, Characteristics of IoT, Physical design of IoT, Logicaldesign of IoT, Functional blocks of IoT, Communication models & APIs.

Module - II: IOT Design Methodology

Introduction to IoT - Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs- IoT systems management - IoT Design Methodology – Specifications Integration and Application Development.

Module - III: Building IOT with Arduino and Raspberry PI

Arduino - Interfaces - Arduino IDE – Programming - APIs – Raspberry Pi Interfaces – Programming – APIs / Packages.

Reference Book(s):

1. *Arshdeep Bahga, Vijay Madisetti, Internet of Things – A hands-on approach, Universities Press, 2015.*
2. *Manoel Carlos Ramon, Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers, Apress, 2014.*
3. *Marco Schwartz, Internet of Things with the Arduino Yun, Packt Publishing, 2014.*
4. *Vijay Madisetti, Arshdeep Bahga, Internet of Things: A Hands-On Approach.*
5. *Waltenegus Dargie,Christian Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice.*

DOMAIN SPECIFIC ELECTIVES

STREAM 1: INFORMATION SECURITY

MSCS 441: FUNDAMENTALS OF CRYPTOGRAPHY

L	T	P	C
3	0	0	3

Prerequisites:

- Basic knowledge of Cryptographic Concepts

Objectives:

- To Learn Mathematical Cryptographic Algorithms
- To Learn Modern Cryptography
- To learn Secure Protocols for Secure Transactions

Outcomes:

- Ability to understand various cryptography concepts.
- Acquiring skills to work with block chain and analyse various cryptographic protocols.

Module-I: Introduction to Cryptography (9 hrs)

History and overview of Cryptography – Introduction to Secure Programming - API's for Secure Programming - Java Cryptography Extension – .Net Cryptography Extension

Module-II: Elementary Number Theory (9 hrs)

Prime numbers, Factoring – Modular Arithmetic – Fermat's & Euler's Theorem – GCD, Euclid's Algorithm – Discrete Logarithm Problem – Implementing all the algorithms and Theorems using JCE/. NCE

Module-III: Modern Cryptography (9 hrs)

Symmetric Key Encryption - Message Integrity – Public Key Cryptography – Digital Signatures – Implementation of DES, RSA, TDES, ECC, IDEA, MD, SHA – Implementing all the algorithms using JCE/. NCE

Module-IV: Financial Cryptography (9 hrs)

Cryptocurrency - Block chain Applications – Contactless Payments and Ticketing Systems – Digital Cash and Payment Systems – Secure banking and Financial Services – Microfinance and Micropayments – Implementation of Cryptocurrency and Block chain using JCE/. NCE

Module-V: Cryptographic Protocols (9 hrs)

SSL/TLS, SSH, TLS, HTTP/HTTPS, IPSEC, P2P, PGP – Security Protocols – Implementation of All Protocols using JCE/. NCE

Text Books:

1. David Hook 'Beginning Cryptography with Java' 2005, ISBN:978-0-7645-9633-9
2. William Stallings, Cryptography and network security, Pearson Education.
3. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Hand- book of Applied Cryptography, CRC Press.

Reference Books:

1. Margaret Cozzens, Steven J Miller, The mathematics of encryption, American Mathematical Society
2. Bruce Schneier Applied Cryptography, John Wiley and Sons
3. Mark Stamp, Information Security: Principles and Practice, John Wiley and Sons
4. Matt Bishop, Computer Security, Art and Science, Pearson Education
5. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder Bitcoin and Cryptocurrency Technologies, Draft 2015.

MSCS 442: DATABASE AND APPLICATION SECURITY

L	T	P	C
3	0	0	3

Prerequisites:

- Knowledge of Database Management Systems and Database Administration

Objectives:

- Describe and apply Security Policies on Databases
- Understand Authentication and Password Security
- Know about Application Vulnerabilities
- Understand about Auditing Techniques

Outcomes:

- Ability to understand various components of database and application security.
- Acquiring skills to encrypt and audit the data, analysing application security and vulnerabilities.

Module-I: Database Security (9 Hrs)

Introduction to database Security – Security in Information Technology – importance of data – data review – identity theft – levels of security – Human level: Corrupt/careless user, Network/User Interface, Database application program, Database system, Operating System, Physical level

Module-II: Authentication and Authorization (9 Hrs)

Passwords, Profiles, Privileges and Roles - Authentication – operating system authentication, database authentication, Network or third-party authentication, Database vector password policies -Authorization – User Account authorization - Database/Application Security - Limitations of SQL Authorization – Access Control in Application Layer - Oracle Virtual Private Database – Privacy

Module-III: Securing Database to Database Communications (9 Hrs)

Monitor and limit outbound communications – secure database links – protect link usernames and passwords – monitor usage of database links – secure replication mechanisms - map and secure all data sources and sinks. Trojans – four types of database Trojans.

Module-IV: Encrypting and Auditing the Data (9 Hrs)

Encrypting data in transit – encrypting data at rest – auditing architectures – audit trail – architectures of external audit systems - archive auditing information – secure auditing information – audit the audit system.

Module-V: Application Security & Vulnerabilities (9 Hrs)

Application Security – Application Vulnerabilities - OWASP Top 10 Web Security Vulnerabilities - Unvalidated input, Broken access control, Broken account/session management, Cross-site scripting (XSS) flaws, Buffer overflows - SQL Injection flaws, Improper error handling, Insecure storage, Denial-of service, Insecure configuration management – Insecure File Handling

Text Books:

1. Ron Ben-Natan, "Implementing Database Security and Auditing: A Guide for DBAs, Information Security Administrators and Auditors", Published by Elsevier, 2005.
2. Silvana Castano, "Database Security", Published by Addison-Wesley, 1994.
3. Alfred Basta, Melissa Zgola, Dana Bullaboy, Thomas L. Witlock SR, "Database Security", google books, 2011.
4. Silberschatz, Korth and Sudarshan, "Database System Concepts", 6th Edition, 2010.

Web Resources:

1. The Open Web Application Security Project, http://www.owasp.org
2. Web application security scanners, http: // www. Window security. com / software/Web-Application-Security
3. SQL Injection, http://www.cgisecurity.com/development/sql.shtml
4. 9 ways to hack a web app, http: / / developers. sun. com / learning / javaone online/2005/webtier/TS-5935.pdf
5. Database security, http:/ /docs.oracle.com/cd / B19306_01 / server.102 / b14220/security.htm

MSCS 443: MOBILE AND DIGITAL FORENSICS

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Prerequisites:

- Knowledge of Computer Networks and information security

Objectives:

- Understand the Basics of wireless technologies and security
- Become Knowledgeable in mobile phone forensics and Android Forensics
- Learn the methods of investigation using Digital Forensic techniques

Outcomes:

- Ability to understand the processes involved in mobile and digital forensics.
- Acquiring skills to analyse mobile and digital forensics techniques.

Module-I: Introduction to Wireless Technologies (9 Hrs)

Overview of wireless technologies and security: Personal Area Networks, Wireless Local Area Networks, Metropolitan Area Networks, Wide Area Networks. Wireless threats, vulnerabilities and security: Wireless LANs, War Driving, War Chalking, War Flying, Common Wi-Fi security recommendations, PDA Security, Cell Phones and Security, Wireless DoS attacks, GPS Jamming, Identity theft.

Module-II: Security Framework for Mobile Systems (9 Hrs)

CIA triad in mobile Phones-Voice, SMS and Identification data interception in GSM: Introduction, practical setup and tools, implementation- Software and Hardware Mobile phone tricks: Netmonitor, GSM network service codes, mobile phone codes, catalog tricks and AT command set- SMS security issues.

Module-III: Mobile Phone Forensics (9 Hrs)

Crime and mobile phones, evidences, forensic procedures, files present in SIM card, device data, external memory dump, evidences in memory card, operators systems- Android forensics: Procedures for handling an android device, imaging android USB mass storage devices, logical and physical techniques.

Module-IV: Introduction to Digital Forensics (9 Hrs)

Digital forensics: Introduction – Evidential potential of digital devices: closed vs. open systems, evaluating digital evidence potential- Device handling: seizure issues, device identification, networked devices and contamination.

Module-V: Analysis of Digital Forensic Techniques (9 Hrs)

Digital forensics examination principles: Previewing, imaging, continuity, hashing and evidence locations- Seven element security model- developmental model of digital systems- audit and logs- Evidence interpretation: Data content and context.

References:

1. Iosif I. Androulidakis, "Mobile phone security and forensics: A practical approach", Springer publications, 2012.
2. Andrew Hoog, "Android Forensics: Investigation, Analysis and Mobile Security for Google Android", Elsevier publications, 2011.
3. Angus M. Marshall, "Digital forensics: Digital evidence in criminal investigation", John – Wiley and Sons, 2008
4. Gregory Kipper, "Wireless Crime and Forensic Investigation", Auerbach Publications.

MSCS 444: MALWARE ANALYSIS

L	T	P	C
3	0	0	3

Prerequisites:

- Network Security

Objectives:

- To understand the Computer infection program
- To implement the Covert channel and mechanisms
- To test and exploit various malware in open source environment
- To analyze and design the famous virus and worms

Outcomes:

- Ability to understand various types of malware and threats.
- Acquiring skills to use open source to analyse malware.

Module-I: Introduction (9 hrs)

Computer Infection Program- Life cycle of malware- Virus nomenclature- Worm nomenclature- Tools used in computer virology.

Module-II: Implementation of Covert Channel (9 hrs)

Non-self-reproducing Malware- Working principle of Trojan Horse- Implementation of Remote access and file transfer- Working principle of Logical Bomb - Case Study: Conflicker C worm.

Module-III: Virus Design and Its Implications (9 hrs)

Virus components- Function of replicator, concealer and dispatcher- Trigger Mechanisms- Testing virus codes- Case Study: Brute force logical bomb.

Module-IV: Malware Design Using Open Source (9 hrs)

Computer Virus in Interpreted programming language- Designing Shell bash virus under Linux- Fighting over infection- Anti –antiviral fighting – Polymorphism- Case study: Companion virus.

Module-V: Virus and Worm Analysis (9 hrs)

Klez Virus- Clone Virus- Doom Virus- Black wolf worm- Sassar worm- Happy worm 99.

Text Books:

1. ErciFiliol, "Computer Viruses: from theory to applications", Springer, 1st edition, 2005. ISBN 10: 2-287-23939-1
2. Mark. A. Ludwig, "The Giant black book of computer viruses, Create Space Independent Publishing Platform, 2nd edition, 2009, ISBN 10: 144140712X.

Web Resources:

1. http://www.crysys.hu/downloads/vihimb01/2017/MW-meres.pdf

MSCS 445: INFORMATION SYSTEM AUDIT

L	T	P	C
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Prerequisites:

- Basic knowledge on Information Systems and Security

Objectives:

- Examine the Multiple layers of IS security in organizations.
- Analyze the Risk management approach to information assets' security with respect to operational and organizational goals.
- Evaluate Physical and logical security controls, and the automated approaches in IS security.

Outcomes:

- Ability to understand auditing Information Systems process.
- Acquiring skills to perform information system audit.

Module-I: Introduction (9 hrs)

Information Systems Audit Standards and Practices and Information System Security and Control Practices: Standards and Guidelines for IS Auditing -The Control Objectives - Other Laws and Regulations

Module-II: Auditing Information Systems Organization and Management (9 hrs)

Information Systems Strategies to achieve business management objectives - Policies and Procedures - Information Systems Management Practices - Organizational Structure - Audit and Evaluation Techniques

Module-III: Auditing the Information Systems Process (9 hrs)

Information Systems Hardware Platform - Information Systems Software Platform - Information Systems Network and Telecommunication Infrastructure - Information System Operational Practices

Module-IV: Information Systems Integrity, Confidentiality and Availability (9 hrs)

Logical Access Controls - Physical Access Controls - Environmental Controls - Data validation, processing and balancing controls - Business Continuity Planning and testing

Module-V: Auditing Information Systems Software Development, Acquisition and Maintenance (9 hrs)

System Integration Concepts - SDAM Methodologies - SDAM Practices - Information Systems Maintenance Practices

Text Books:

1. "Principles of Information Security", by Michael E. Whitman and Herbert J. Mattord, Thomson Course Technology, 2003, ISBN: 0619063181
2. Handbook of Information Security Management, by Micki Krause and Harold F. Tipton, ISACA Publication, 1999.
3. Handbook of IT Auditing, D.Warren, L.Edelson, X.Parker, Coopers & Lybrand LLP, Warren, Gorham & Lamont. Boston, 1995 with 1999 supplement.

4. The information audit: an important management tool / Katherine Bertolucci. - Managing Information, June 1996, vol.3, no.6, p.34-35.
5. The value and impact of information / edited by M. Feeney and M. Grieves. - London: Bowker Saur, 1994. - ISBN 1 85739 084 9.
6. The value of information to the intelligent organisation. - Hatfield: University of Hertfordshire Press, 1994. - ISBN 0 900458 54 2.
7. Porter, M. E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. New York, N.Y.: Collier Macmillan.

Web Resources:

1. www.c3i.osd.mil/org/cio/i3/AWG_Digital_Library/index.htm
2. www.isaca.org
3. www.bsi.org
4. www.isaca.org/gir
5. www.isaca.org/cobit.htm

MSCS 446: INFORMATION SECURITY MANAGEMENT

L	T	P	C
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Prerequisites:

- Basic Understanding of Computer Networks.

Objectives:

- Review, Refresh and Expand the Information Security Knowledge (including information security concepts and industry best practices).

Outcomes:

- Ability to understand the processes involved in Information Security management.
- Ability to understand communication and network security, identity and access management.

Module-I: (9 hrs)

Security and Risk Management (Security, Risk, Compliance, Law, Regulations, and Business Continuity): Confidentiality, integrity, and availability concepts - Security governance principles – Compliance - Legal and regulatory issues - Professional ethic - Security policies, standards, procedures and guidelines

Module-II: (9 hrs)

Asset Security (Protecting Security of Assets): Information and asset classification - Ownership (e.g. data owners, system owners) - Protect privacy - Appropriate retention - Data security controls - Handling requirements (e.g. markings, labels, storage)

Module III: (9 hrs)

Security Engineering (Engineering and Management of Security) - Engineering processes using secure design principles - Security models fundamental concepts - Security evaluation models - Security capabilities of information systems - Security architectures, designs, and solution elements vulnerabilities – Web based systems vulnerabilities - Mobile systems vulnerabilities - Embedded devices and cyber physical systems vulnerabilities – Cryptography - Site and facility design secure principles – Physical Security

Module-IV: (9 hrs)

Communication and Network Security (Designing and Protecting Network Security): Secure network architecture design (e.g. IP & non - IP protocols, segmentation) - Secure network components - Secure communication channels - Network attacks

Module-V: (9 hrs)

Identity and Access Management (Controlling Access and Managing Identity) - Physical and logical assets control - Identification and authentication of people and devices - Identity as a service (e.g. cloud identity) – Third-party identity services (e.g. on- premise) - Access control attacks - Identity and access provisioning lifecycle (e.g. provisioning review)

References:

1. James M. Stewart, Ed Tittel, Mike Chapple 'CISSP: Certified Information Systems Security Professional Study Guide', Wiley 2008.

MSCS 447: CLOUD SECURITY

L	T	P	C
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***Pre-requisite**:*

- *Security and methods to improve virtualization security are also dealt with in this course Cloud security introduces the basic concepts of security systems and cryptographic protocols, which are widely used in the design of cloud security. The issues related multi tenancy operation, virtualized infrastructure*

***Objectives**:*

- *Compare modern security concepts as they are applied to cloud computing*
- *Assess the security of virtual systems*
- *Evaluate the security issues related to multi-tenancy*
- *Appraise compliance issues that arise from cloud computing*

***Outcomes**:*

- *Ability to understand the processes involved in cloud security.*
- *Acquiring skills to implement virtualization systems and enhancing virtualization based security.*

Module-I: Security Concepts (9 hrs)

Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, defense in depth, least privilege, how these concepts apply in the cloud, what these concepts mean and their importance in PaaS, IaaS and SaaS. e.g. User authentication in the cloud; Cryptographic Systems- Symmetric cryptography, stream ciphers, block ciphers, modes of operation, public-key cryptography, hashing, digital signatures, public-key infrastructures, key management, X.509 certificates, OpenSSL.

Module-II: Multi-Tenancy Issues (9 hrs)

Isolation of users/VMs from each other. How the cloud provider can provide this; Virtualization System Security Issues- e.g. ESX and ESXi Security, ESX file system security, storage considerations, backup and recovery; Virtualization System Vulnerabilities- Management console vulnerabilities, management server vulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisor vulnerabilities, hypervisor escape vulnerabilities, configuration issues, malware (botnets etc).

Module-III: Virtualization System (9 hrs)

Specific Attacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyper jacking. System attacks: Management Server attack, Administrative VM attack, Guest VM attacks, Hypervisor attacks.

Module-IV: Technologies for Virtualization-Based Security Enhancement (9 hrs)

IBM security virtual server protection, virtualization-based sandboxing; Storage Security- HIDPS, log management, Data Loss Prevention. Location of the Perimeter.

Module-V: Legal and Compliance Issues ***(9 hrs)***

Responsibility, ownership of data, right to penetration test, local law where data is held, examination of modern Security Standards (eg PCIDSS), how standards deal with cloud services and virtualization, compliance for the cloud provider vs. compliance for the customer.

References:

1. *Tim Mather, SubraKumaraswamy, ShahedLatif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance [ISBN: 0596802765]*
2. *Ronald L. Krutz, Russell Dean Vines, Cloud Security [ISBN: 0470589876]*
3. *John Rittinghouse, James Ransome, Cloud Computing [ISBN: 1439806802]*
4. *J.R. ("Vic") Winkler, Securing the Cloud [ISBN: 1597495921]*
5. *Cloud Security Alliance 2009, Security Guidance for Critical Areas of Focus in Cloud ComputingVMware Security Hardening Guide*
6. *Cloud Security Alliance 2010, Top Threats to Cloud Computing*
7. *NIST Guidelines on Security and Privacy in Public Cloud Computing*
8. *NIST Guide to Security for Full Virtualization Technologies*
9. *NIST The NIST Definition of Cloud Computing*
10. *William Hau, Rudolph Araujo et al How Virtualization Affects PCI DSS*
    www.mcafee.com/us/resources/.../wp-how-virt-affect-pci-dss-part-1.pdf

MSCS 448: ETHICAL HACKING

L	T	P	C
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Prerequisites:

- Basic Understanding of Network Security & Threat Mechanisms

Objectives:

- To Understand the Ethical Hacking Process
- To Get familiarized with Tools and Techniques of Ethical Hacking

Outcomes:

- Ability to understand the processes involved in ethical hacking.
- Acquiring skills to analyse malware threats and developing solutions.

Module-I: **(9 hrs)**

Introduction to Ethical Hacking: Information security overview – skills of an ethical hacker – Hacking concepts and phases - Types of attacks – Information Security threats, attack vectors, and controls – Information Assurance (IA) – Information Security Laws and Standards – Security Policies types, HR/legal implications – Physical Security – Threat Modelling – Enterprise Information Security Architecture (EISA) – Network Security Zoning.

Module-II: **(9 hrs)**

Foot Printing & Reconnaissance: Foot printing concepts, threats, attack vectors and controls, Foot printing through Search Engines, Foot Printing through Social Networking sites, Website Foot printing, Competitive Intelligence, WHOIS Foot printing, Foot Printing tools. Scanning Networks: Scanning Methodology, techniques, and countermeasures -Techniques for IDS evasion, scanning, HTTP tunneling, and IP spoofing - Drawing network diagrams—latest network discovery and mapping tools, network discovery tools for mobile - Proxy chaining—latest proxy tools, proxy tools for mobile Enumeration: Protocols: NetBIOS, SNMP, LDAP, NTP, SMTP, DNS – Countermeasures - Techniques

Module-III: **(9 hrs)**

System Hacking: Cracking passwords, escalating privileges, executing applications, hiding files and covering tracks – Steganography application and classification, tools, methods/attacks on Steganography, Steganography detection tools. Practical: Foot Printing & Reconnaissance, Scanning Networks, Enumeration, System Hacking

Module-IV: **(9 hrs)**

Malware Threats: Introduction to malware – Trojans attacks, how to infect a system, crypters, how to deploy, latest types, analysis, countermeasures - Viruses—stages, types, latest virus maker, analysis, countermeasures - Worms—types, makers, analysis, countermeasures - Malware analysis - Antivirus tools - Penetration testing.

Module-V: **(9 hrs)**

Sniffing: Attacks: MAC, DHCP, and spoofing - Poisoning: ARP and DNS – Tools Social Engineering: Concepts, techniques, impersonation, identity theft, and Counter measures - Phases of an attack - Common targets of an attack - Impersonation scenario - Computer based, mobile based, social networking based Denial of Service: Concepts, case study, tools, attack techniques, and Countermeasures Botnet - Scanning methods for vulnerable machines - Detection Techniques and tools. Session Hijacking: Concepts, case study, tools, attack techniques, and Countermeasures - Five stages of a web malware attack - Application level session hijacking - Network level session hijacking - TCP/IP Hijacking. Practical: Trojans and Backdoors, Viruses and Worms, Sniffers, Social Engineering, Denial of Service, Session Hijacking

References:

1. Kimberly Graves, "CEH: Certified Ethical Hacker Study Guide", Wiley; 2010.

STREAM 2:
SOFTWARE ENGINEERING

MSCS 451: OBJECT ORIENTED SYSTEM DESIGN

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Pre-requisite:

Nil

Objectives:

- To learn the fundamentals of OOSD
- To learn the various Object Oriented Design Models and Testing Objects

Outcomes:

- Ability to understand the fundamentals of object oriented system design.
- Acquiring skills to develop object oriented system design.

Module-I: Object Oriented Design Fundamentals (9 hrs)

Review of Object Oriented systems, Design objects, class hierarchy, Inheritance, Polymorphism, Object relationship, Association, Object persistence, metaclass - Object Oriented Systems development life cycle, Comparison of Object oriented methodologies over Traditional methodologies, Different methodologies for Object Oriented design (Rumbaugh, Booch, Jacobson)

Module-II: Object Oriented Analysis (9 hrs)

Different approaches for identifying classes, CRC , COAD Yourdon, Shellor mellor method, Identifying object relationships, attributes and methods. Aggregations, Use case analysis.

Module-III: Object Oriented Design and Development (9 hrs)

The Unified approach, UML History, Overview of UML, Different diagrams of UML, Capabilities Usage of UML. Architecture (4+1 view) OO Software Development Process – Different phases

Module-IV: Object Oriented Testing Maintenance (9 hrs)

Quality assurance Tests - Testing strategies - impact of object orientation on Testing - Test cases - Test Plan- Continuous Testing - Evaluation Testing, Coding, Maintenance, Metrics

Module-V: Case Studies (9 hrs)

Object oriented data model, query languages, storage organization and indexing techniques; object relational databases, ATM, Telecom and Different Case Studies.

Text Books:

1. Ali Bahrami, “Object Oriented System Development”, Mc-Graw Hill International Edition, 1999.
2. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Language User Guide”, Addison - Wesley Longman, 1999.

Reference Book:

1. The Unified Modeling Language User Guide. – Addison Wesley, Booch, Rambaush, Jacobson, 2000.

MSCS 452: SOFTWARE ARCHITECTURE

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Pre-requisite:

- Basic Knowledge in Software Engineering

Objectives:

- Understand software Architectural Requirements and drivers.
- Be exposed to architectural styles and views.

Outcomes:

- Get familiarized with various software architectures and emerging technologies.

Module-I: Introduction and Architectural Drivers (9 hrs)

Introduction – What is software architecture? – Standard Definitions – Architectural structures – Influence of software architecture on organization-both business and technical – Architecture Business Cycle- Introduction – Functional requirements – Technical constraints – Quality Attributes.

Module-II: Quality Attribute Workshop (9 hrs)

Quality Attribute Workshop – Documenting Quality Attributes – Six-part scenarios – Case studies.

Module-III: Architectural Views (9 hrs)

Introduction – Standard Definitions for views – Structures and views – Representing views-available notations – Standard views – 4+1 view of RUP, Siemens 4 views, SEI's perspectives and views – Case studies.

Module-IV: Architectural Styles (9 hrs)

Introduction – Data flow styles – Call-return styles – Shared Information styles – Event styles – Case studies for each style.

Module-V: Documenting the Architecture (9 hrs)

Good practices – Documenting the Views using UML – Merits and Demerits of using visual languages – Need for formal languages – Architectural Description Languages – ACME – Case studies. Special topics: SOA and Web services – Cloud Computing – Adaptive structures.

Text Books:

1. Len Bass, Paul Clements, and Rick Kazman, "Software Architectures Principles and Practices", 2nd Edition, Addison-Wesley, 2003.
2. Anthony J Lattanze, "Architecting Software Intensive System. A Practitioner's Guide", Auerbach Publications, 2010.

Reference Books:

1. Paul Clements, Felix Bachmann, Len Bass, David Garlan, James Ivers, Reed Little, Paulo Merson, Robert Nord, and Judith Stafford, "Documenting Software Architectures. Views and Beyond", 2nd Edition, Addison-Wesley, 2010.
2. Paul Clements, Rick Kazman, and Mark Klein, "Evaluating software architectures: Methods and case studies. Addison-Wesley, 2001.
3. Rajkumar Buyya, James Broberg, and Andrzej Goscinski, "Cloud Computing. Principles and Paradigms", John Wiley & Sons, 2011.
4. Mark Hansen, "SOA Using Java Web Services", Prentice Hall, 2007.

MSCS 453: SOFTWARE PROJECT MANAGEMENT

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Pre-requisite:

- Software Engineering Principles.

Objectives:

- This Course is intended to provide the students with an overall view over Software Engineering Discipline and with insight into the processes of software development.
- To understand the various methods of Cost Estimation.
- To Study about Software Quality Management.
- To Study about Software Metrics

Outcomes:

- Ability to understand various software project management concepts.
- Ability to perform cost estimation and project evaluation.

Module-I: Project Concepts and Its Management (9 hrs)

Project life cycle models-ISO 9001 model - Capability Maturity Model - Project, Planning-Project tracking-Project closure - Evolution of Software Economics –Software Management Process Framework: Phases, Artifacts, Workflows, Checkpoints – Software Management Disciplines: Planning / Project Organization and Responsibilities / Automation / Project Control – Modern Project.

Module-II: Cost Estimation (9 hrs)

Problems in Software Estimation – Algorithmic Cost Estimation Process, Function, Points, SLIM (Software Life cycle Management), COCOMO II (Constructive Cost Model) – Estimating Web Application Development – Concepts of Finance, Activity Based Costing and Economic Value Added (EVA) – Balanced Score Card.

Module-III: Software Quality Management (9 hrs)

Software Quality Factors – Software Quality Components – Software Quality Plan– Software Quality Metrics – Software Quality Costs – Software Quality Assurance-Standard – Certification – Assessment.

Module-IV: Software Management and Metrics (9 hrs)

Software Configuration Management – Risk Management: Risk Assessment: Identification / Analysis / Prioritization – Risk Control: Planning / Resolution /Monitoring – Failure Mode and Effects Analysis (FMEA) –Defect Management-Cost Management. Software Metrics – Classification of Software Metrics: Product-Metrics: Size Metrics, Complexity Metrics, Halstead's Product Metrics, Quality, Metrics, and Process metrics.

Module-V: Project Evaluation and Emerging Trends (9 hrs)

Strategic Assessment–Technical Assessment–Cost Benefit Analysis–Cash Flow Forecasting–Cost Benefit Evaluation Technique–Risk Evaluation–Software Effort Estimation. Emerging Trends: Import of the internet on project Management –people Focused Process Models.

Text Book:

1. Ramesh Gopalaswamy, “Managing and Global Software Projects”, Tata McGraw Hill, 2017.
2. Neal Whitten, “Managing Software Development Projects”, John Wiley & Sons, Inc., 2nd Ed., 1995.

Reference Book(s):

1. Demarco, T. and Lister, T. “Peopleware: Productive Projects and Teams, 2nd Ed.”, Dorset House, 1999.
2. Royce, W. “Software Project Management: A Unified Framework”, Addison-Wesley, 1998. Demarco, T. and Lister, T. “Peopleware: Productive Projects and Teams, 2ndEd.”, Dorset House,1999.
3. Fenton, N.E., and Pfleeger, S.L. “Software Metrics: A Rigorous and Practical Approach, Revised” Brooks Cole, 1998.
4. Kaplan, R.S., Norton, D.P. “The Balanced Scorecard: Translating Strategy into Action”, Harvard Business School Press, 1996.
5. Boehm, B. W. "Software Risk Management: Principles and Practices" in IEEE Software, January 1991, pp32-41.
6. Grant, J.L. “Foundations of Economic Value Added”, John Wiley & Sons, 1997.
7. Cooper, R., “The Rise of Activity-Based Costing- PartOne: What is an Activity-Based Cost System” Journal of Cost Management, Vol.2, No.2.

MSCS 454: SOFTWARE TESTING

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Pre-requisite:

- Basic Knowledge in Software Engineering

Objectives:

- To understand Standard Software Testing Principles .
- To learn the Functionality of Automated Testing tools.

Outcomes:

- Ability to understand various software testing techniques.
- Ability to incorporate specialize testing responsibilities

Module-I: Testing Environment and Test Processes (9 hrs)

World-Class Software Testing Model – Building a Software Testing Environment – The Seven Step Testing process: Overview of Software Testing Process – Organizing for Testing – Developing the Test Plan – Verification Testing – Analyzing and Reporting Test Results – Acceptance Testing – Operational Testing – Post Implementation Analysis.

Module-II: Testing Techniques and Levels of Testing (9 hrs)

Using White Box Approach to Test design - Static Testing Vs. Structural Testing – Code Functional Testing – Coverage and Control Flow Graphs –Using Black Box Approaches to Test Case Design – Random Testing – Requirements based testing –Decision tables –State-based testing – Cause-effect graphing – Error guessing – Compatibility testing – Levels of Testing - Unit Testing - Integration Testing - Defect Bash Elimination. System Testing - Usability and Accessibility Testing – Configuration Testing - Compatibility Testing - Case study for White box testing and Black box testing techniques.

Module-III: Incorporating Specialized Testing Responsibilities (9 hrs)

Testing Client/Server Systems – Rapid Application Development Testing – Testing in a Multiplatform Environment – Testing Software System Security - Testing Object-Oriented Software – Object Oriented Testing – Testing Web based systems – Web based system – Web Technology Evolution – Traditional Software and Web based Software – Challenges in Testing for Web-based Software –Testing a Data Warehouse - Case Study for Web Application Testing.

Module-IV: Test Automation (9 hrs)

Selecting and Installing Software Testing Tools - Software Test Automation – Skills needed for Automation – Scope of Automation – Design and Architecture for Automation – Requirements for a Test Tool – Challenges in Automation – Tracking the Bug – Debugging – Case study using Bug Tracking Tool.

Module-V: Software Testing and Quality Metrics (9 hrs)

Testing Software System Security - Six-Sigma – TQM - Complexity Metrics and Models – Quality Management Metrics - Availability Metrics - Defect Removal Effectiveness - FMEA - Quality Function Deployment – Taguchi Quality Loss Function – Cost of Quality. Case Study for Complexity and Object-Oriented Metrics

Text Book(s):

1. William Perry, "Effective Methods of Software Testing", Third Edition, Wiley Publishing 2007
2. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education, 2007.

Reference Book(s):

1. Naresh Chauhan, "Software Testing Principles and Practices" Oxford University Press, New Delhi, 2010.
2. Dale H. Besterfiled et al., "Total Quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).
3. Stephen Kan, "Metrics and Models in Software Quality", Addison – Wesley, Second Edition, 2004
4. Llene Burnstein, " Practical Software Testing", Springer International Edition, Chennai, 2003
5. Renu Rajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill,2004
6. Edward Kit, "Software Testing in the Real World – Improving the Process", Pearson Education, 1995.
7. Boris Beizer, " Software Testing Techniques" – 2nd Edition, Van Nostr and Reinhold, New York, 1990.

MSCS 455: SOFTWARE QUALITY ASSURANCE

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Pre-requisite:

- Basic Knowledge in Software Design Process.

Objectives:

- To understand the basic tenets of Software Quality and quality factors.
- To Understand the SQA Components.

Outcomes:

- Ability to understand SQA components and project life cycle.
- Ability to understand software quality management and apply various metrics.

Module-I: Introduction to Software Quality & Architecture (9 hrs)

Need for Software quality – Quality challenges – Software quality assurance (SQA) – Definition and objectives – Software quality factors- McCall‟s quality model – SQA system and architecture – Software Project life cycle Components – Pre project quality components – Development and quality plans.

Module-II: SQA Components and Project Life Cycle (9 hrs)

Software Development methodologies – Quality assurance activities in the development process - Verification & Validation – Reviews – Software Testing – Software Testing implementations – Quality of software maintenance – Pre-Maintenance of software quality components – Quality assurance tools – CASE tools for software quality – Software maintenance quality – Project Management

Module-III: Software Quality Infrastructure (9 hrs)

Procedures and work instructions - Templates - Checklists – 3S development team - Staff training and certification Corrective and preventive actions – Configuration management – Software change control – Configuration management audit -Documentation control – Storage and retrieval.

Module-IV: Software Quality Management & Metrics (9 hrs)

Project process control – Computerized tools - Software quality metrics – Objectives of quality measurement – Process metrics – Product metrics – Implementation – Limitations of software metrics – Cost of software quality – Classical quality cost model – Extended model – Application of Cost model

Module-V: Standards, Certifications & Assessments (9 hrs)

Quality management standards – ISO 9001 and ISO 9000-3 – capability Maturity Models – CMM and CMMI assessment methodologies - Bootstrap methodology – SPICE Project – SQA project process standards – IEEE st 1012 & 1028 – Organization of Quality Assurance – Department management responsibilities – Project management responsibilities – SQA units and other actors in SQA systems

Text Book(s):

1. Daniel Galin, "Software Quality Assurance", Pearson Publication, 2009.

Reference Book(s):

1. Alan C. Gillies, "Software Quality: Theory and Management", International Thomson Computer Press, 1997.
2. Mordechai Ben-Menachem "Software Quality: Producing Practical Consistent Software", International Thompson Computer Press, 1997.

MSCS 456: SOFTWARE RISK MANAGEMENT AND MAINTENANCE

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisite:

- Basic Knowledge in Software Analysis & Design Process

Objectives:

- To understand the various Risk levels in software development.
- To understand the Risk plan, implementation and tracking Risks
- To realize the Software maintenance process, Measurement and benchmarking

Outcomes:

- Ability to understand the basics concepts of software risk management and maintenance.
- Ability to identify, asses, respond and track risk

Module-I: Risk Culture and Management Process (9 hrs)

Risk- Basic Terms- Risk Vocabulary – Risk- Driven Project Management- Controlling the Process, Environment and Risk- Maturity in Risk Culture – Risk Scale – Preparing for Risk – Risk Management- Paradigms- Five Models of Risk Management – Thinking about Less Risky alternatives – Risk Management at Different Levels – Risk Escalation – Risk Models- Risk Intelligence - Software Risk Management steps.

Module-II: Discovering Risk and Assessment (9 hrs)

Identifying software risk - Classification of Risks – Risk Taxonomy – Risk Mapping – Statements – Risk Reviews – Risk Ownership and stakeholder management – Risk Assessment Approach – Risk Assessment tools and techniques – Risk Probability, impact, exposure, matrix and Application Problem - Self - assessment checklist.

Module-III: Responding to Risks and Tracking (9 hrs)

Special Treatment for Catastrophic risks- Constraint Risks – Risk Mitigation Plan Case Study – Contingency Plans- Implementing Risk Response- Tracking Risk Response and Hazards – Trigger Levels- Tracking Project Risks and Operational Risks- Learning by Tracking and Risk Tracker Tool.

Module-IV: Maintenance Process (9 hrs)

Software Maintenance- Customer's Viewpoint- Economics of Maintenance- Issues in Maintenance- Software Maintenance Standard, Process, Activities and Categories – Maintenance Measurement – Service Measurement and Benchmarking – Problem Resolution – Reporting – Fix Distribution.

Module-V: Activities for Maintenance (9 hrs)

Role of SQA for Support and Maintenance – SQA tools for Maintenance- Configuration Management and Maintenance – Maintenance of Mission Critical Systems – Global Maintenance Teams – Foundation of S3m Process Model- Exemplary Practices.

Text Book(s):

1. C. RavindranathPandian, "Applied Software Risk Management: A guide for Software Project Managers", Auerbach Publications, 2007.
2. John Mcmanus, "Risk Management in Software Development Projects", Elsevier Butterworth- Heinemann, First Edition, 2004.

Reference Book(s):

1. Alian April and Alain Abran, "Software Maintenance Management: Evaluation and Continuous Improvement", John Wiley & Sons Inc, 2008
2. Gopalaswamy Ramesh and Ramesh Bhattiprolu, "Software Maintenance: Effective Practices for Geographically Distributed Environments", Second Reprint, Tata McGraw Hill, 2009.

MSCS 457: AGILE SOFTWARE PROCESS

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisite:

- Basic Understanding of Software Design Process

Objectives:

- To Understand the basic concepts of Agile Software Process
- To gain knowledge in the area of various Agile Methodologies.
- To Understand the Principles of Agile Testing

Outcomes:

- Ability to understand basic agile and its significance.
- Ability to understand the methodology of agile through various case studies.

Module-I: Introduction (9 hrs)

Software is new product development –Iterative development: Risk-Driven and Client-Driven iterative planning – Time boxed iterative development – During the iteration, No changes from external stakeholders – Evolutionary and adaptive development - Evolutionary requirements analysis – Early "Top Ten" high-level requirements and skillful analysis – Evolutionary and adaptive planning –Incremental delivery – Evolutionary delivery – The most common mistake –Specific iterative and Evolutionary methods.

Module-II: Agile and Its Significance (9 hrs)

Agile development: Classification of methods – The agile manifesto and principles – Agile project management – Embrace communication and feedback –Simple practices and project tools – Empirical Vs defined and prescriptive process – Principle-based versus Rule-Based – Sustainable discipline: The human touch – Team as a complex adaptive system – Agile hype – Specific agile methods. Motivation: The facts of change on software projects – Key motivations for iterative development – Meeting the requirements challenge iteratively – Problems with the waterfall. Evidence: Research evidence – Early historical project evidence – Standards-Body evidence – Expert and thought leader evidence – A Business case for iterative development – The historical accident of waterfall validity.

Module-III: Agile Methodology (9 hrs)

Scrum: Method overview – Lifecycle – Work products, Roles and Practices values –Common mistakes and misunderstandings – Sample projects – Process mixtures– Adoption strategies – Fact versus fantasy –Strengths versus "Other" history.

Module-IV: Case Study (9 hrs)

Agile – Motivation – Evidence – Scrum – Extreme Programming – Unified Process –Evo– Practice Tips.

Module-V: Agile Practising and Testing (9 hrs)

Practice: Project management – Environment – Requirements – Test – The agile alliances – The manifesto – Supporting the values – Agile testing: Nine principles and six concrete practices for testing on agile teams.

Text Book(s):

1. Craig Larman "Agile and Iterative Development – A Manager's Guide" Pearson Education – 2004.
2. Elisabeth Hendrickson, "Agile Testing" Quality Tree Software Inc 2008.

Reference Book(s):

1. Alistair Cockburn, "Agile Software Development Series", Addison-Wesley Professional, 2001.
2. Robert C. Martin, "Agile Software Development Principles, Patterns and Practices", Prentice Hall, 2002.

STREAM 3:
HUMAN COMPUTER INTERACTION

MSCS 461: FOUNDATIONS OF HUMAN COMPUTER INTERACTION

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisites:

- Basic Understanding of Graphical User Interface.

Objectives:

- Understanding the Components of Human Computer Interaction
- Getting insights into the world of Universal Design

Outcomes:

- Ability to understand various components of Human Computer Interaction.
- Ability to understand the role of HCI in software process.

Module- I: Introduction (9 hrs)

Computer: Text Entry Devices – Pointing Devices – Display Devices – Devices for Virtual Reality and 3D interaction – Physical Controls, Sensors and Special Devices – Memory – Processing and Networks.

Module-II: HCI Framework (9 hrs)

Models of Interaction – HCI frameworks- Basics of Ergonomics – Interaction Styles – Interactivity – User Experience; Fundamentals of Interaction design : The process of Design – User Focus – Scenarios – Navigation Design – Iteration and prototyping.

Modul- III: HCI in the software process (9 hrs)

The software life cycle – Iterative design and prototyping – Design rationale – HCI Patterns.

Module-IV: Dialog Notations and design (9 hrs)

Dialog Notations and design – Dialog semantics – Modeling rich interaction – Cognitive models – Evaluation techniques.

Module-V: Universal Design (9 hrs)

Introduction to Universal design – Benefits - design for diversity; User Support: requirements of user support – approaches to user support – adaptive help systems – designing user support systems.

Text Book:

1. Alan Dix, Janet Finaly, Gregory D. Abowd, Russell Beale., "Human Computer Interaction", 3rd Edition, Prentice Hall Publishers, 2003.

Reference Book:

1. Jonathan Lazar, "Research Methods in Human–Computer Interaction", John Wiley & Sons, 2009.

MSCS 462: INTRODUCTION TO WEB ACCESSIBILITY

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisites:

- Basic Understanding of Human Computer Interaction Concepts.

Objectives:

- Understanding the elements of Web accessibility
- Acquiring skills to Design accessible web pages

Outcomes:

- Ability to understand the processes involved in web accessibility.
- Ability to acquire skills to perform web accessibility analysis.

Module-I: **(9 hrs)**

Web accessibility - Definitions – Universal Design – Disabilities and Accessibility Requirements – Introduction to Accessible web design – Accessibility Myths – Assistive Technologies.

Module- II: **(9 hrs)**

Basics of Web Content Accessibility Guidelines – Principles: Perceivable – Operable – Understandable – Robust – Various Levels of Accessibility – WCAG standards evaluation tools and Comparative analysis.

Module-III: **(9 hrs)**

Accessibility of web page components: Images – Hyperlinks – Color contrast – Tables – Forms – Document Accessibility – Video accessibility – Audio accessibility – Static vs Dynamic page accessibility.

Module-IV: **(9 hrs)**

W3C Web Accessibility Initiatives (WAI) – Ajax applications accessibility – Features. Authoring tools accessibility guidelines – UAAG: User Agents Accessibility Guidelines – Accessibility regulations: Global and Indian context.

Module-V: **(9 hrs)**

Introduction to web accessibility analysis tools: Open Source vs. commercial – Features of accessibility analysis tools; Introduction to Mobile web accessibility – Tools and techniques.

Reference Book:

1. Simon Harper, Yeliz Yesilada (Editors) . Web Accessibility: A Foundation for Research – Springer Publications, 2010.

Web Resources:

1. W3C Resources on Web Accessibility *https://www.w3.org/WAI/intro/accessibility.php*
2. WebAIM(Web Accessibility in Mind) Resources : *http://webaim.org*

Online Courses:

1. Introduction to Web Accessibility by Google : *https://webaccessibility.withgoogle.com/course*

MSCS 463: INTRODUCTION TO MOBILE ACCESSIBILITY

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisites:

- Basic Understanding of Human Computer Interaction.
- Basic Understanding of Web Accessibility.

Objectives:

- Introducing Android Mobile App development.
- Making the learner to understand the basics of Mobile accessibility.
- Acquiring skills in designing accessible mobile applications.

Outcomes:

- Ability to understand the processes involved in mobile accessibility.
- Ability to acquire skills to perform mobile accessibility analysis.

Module-I: **(9 hrs)**

Mobile Application types: Native, Mobile web and Hybrid apps – Standards and guidelines – The business case for accessibility – Legal and regulatory requirements. Introduction to Android – Versions – Features – The Android Studio – Architecture of Android – Creating and Publishing an application.

Module-II: **(9 hrs)**

Activities – Fragments – Intents – Layouts – Action Bar – UI Notifications – Building UI with Views – Images, Menus with views – Data Persistence : Files – Internal Storage – External Storage – Creating and using Databases.

Module-III: **(9 hrs)**

Accessible Design Principles – Color and Contrast – Sound and motion – Style – Hierarchy and focus – Implementation – Text accessibility.

Module-IV: **(9 hrs)**

Screen Reader Access: Talkback – Select to Speak ; Switch access – Voice commands. Accessibility Factors : Labeling UI Elements – Grouping Content – Touch target size – Color contrasts - Non-color cues- Media content accessibility.

Module-V: **(9 hrs)**

Accessibility analysis : Success criterion and components – Mapping WCAG to Mobile devices : Screen size factors – Contrast – Keyboard control for touchscreen devices – touch target size and spacing – device manipulation gestures – Tools for analyzing mobile accessibility.

Reference Books:

1. Colin Shanley. Cracking Accessibility on Mobile Devices: The definitive field guide to accessibility and digital inclusion for business managers and project teams. RS Books Publishers (2016).
2. J.F. DiMarzio. Beginning Android Programming with Android Studio, Fourth Edition – 2016 – Wiley Publications.

Web Resources:

1. https://developer.android.com/guide/topics/ui/accessibility/apps.html
2. https://material.io/guidelines/usability/accessibility.html

MSCS 464: FUNDAMENTALS OF CONTEXT AWARE COMPUTING

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisites:

- Knowledge of Mobile computing and Distributed systems

Objectives:

- Understanding the Components of context awareness.
- Getting familiar with Context acquisition, interpretation and use.

Outcomes:

- Ability to understand the various components of context aware systems.
- Ability to analyse security of context aware systems.

Module-I: **(9 hrs)**

Basics of Context Awareness – Surrounding Context – User Attention in a Meeting - Activity context from multiple sensors.

Module-II: **(9 hrs)**

Distributed and Heterogeneous Context for Ambient Intelligence: Fundamental Concepts – Ontology Representation and Reasoning about Context – Ontology Alignment Approaches .

Module-III: **(9 hrs)**

Ubiquitous web – System Description – System Deployment – Collaborative Optimizations- Context Acquisition – Provisioning.

Module-IV: **(9 hrs)**

Elements of a context aware pervasive system- Architecture- Infrastructure, Middleware, Tool Kits – context for mobile device users – Location based Services – Ambient services – context aware mobile services – Mobile code and policy – Multi agent technology.

Module-V: **(9 hrs)**

Context Aware Security: Traditional Security issues – models – context aware security systems – context aware safety.

Reference Books:

1. Context aware pervasive systems-Architecture for a new breed of applications Sengloke, Auerbach publications, 2006.
2. Context Aware Computing and Self Managing systems ,Waltenegus Dargie,A chapman & Hall Book/CRC press, 2010.
3. Context-Aware Mobile and Ubiquitous Computing for Enhanced Usability: Adaptive Technologies and Applications: Dragan Stojanović, IGI Global Snippet, 2009.
4. Context Management for Distributed and Dynamic Context-Aware Computing, Rocha, RicardoCouto Antunes da, Endler, Markus,Springer,2012.
5. Context-Aware Computing: A Special Triple Issue of Human-Computer Interaction,Thomas P.Moran Paul Dourish, 2002.

MSCS 465: DIGITAL ACCESSIBILITY AUDIT

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisites:

- Basic Understanding of HCI
- Basic Understanding of Web Accessibility.

Objectives:

- Understanding the components of digital accessibility audit.
- Acquiring skills in Conducting the digital accessibility audit.

Outcomes:

- Ability to understand the processes involved in performing digital accessibility audit.
- Ability to carry out digital accessibility audit.

Module-I: Types of Disability and Special Needs (9 hrs)

Visual conditions – Auditory conditions – Motor conditions – cognitive conditions – Legal and regulatory requirements.

Module-II: POUR Principles (9 hrs)

Introduction - Perceivable: Text alternatives – Time Based media – adaptable – distinguishable; Operable: Keyboard accessibility – Time factor - Seizures – Navigable. Understandable principles: Readable – Language specific features – predictable – Input assistance; Robust – Compatible.

Module-III: (9 hrs)

Personas and Scenarios - Comprehensive Accessibility Evaluation – Standards Review – Heuristic Evaluation – Design Walkthroughs – Screening Techniques – Usability Testing.

Module-IV: Accessibility Analysis Tools (9 hrs)

AChecker – Wave – Cynthia Says - Tenon – HERA – Comparative analysis.

Module-V: Accessibility Simulations (9 hrs)

Screen reader simulations – Low vision simulation – dyslexia simulation. Building the accessibility evaluation reports : Components.

Reference Books:

1. Shawn Lawton Henry, "Just Ask – Integrating Accessibility Throughout Design" (Online Open Book : http://www.uiaccess.com/accessucd/), 2007.
2. Colin Shanley, "Cracking Accessibility on Mobile Devices: The definitive field guide to accessibility and digital inclusion for business managers and project teams", RS Books Publishers, 2016.

Web Resources:

1. https://www.w3.org/WAI/ER/tools/
2. https://www.w3.org/WAI/eval/preliminary.html
3. https://www.w3.org/WAI/eval/template

MSCS 466: USER INTERFACE ENGINEERING

L	*T*	*P*	*C*
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Pre-requisites:

- Basic Understanding of Human-Computer Interaction
- Basic Understanding of Graphical User Interfaces.

Objectives:

- Exploring the interaction design process.
- Explaining the role of interaction designers and the tools they use.

Outcomes:

- Ability to understand the principles of User interface design.
- Ability to develop effective user interface design.

Module-I: **(9 hrs)**

Introduction: Goals of User Interface Design – Motivations of Human factors in Design – High Level Theories – Three Principles – Guidelines for Data Display and Data Entry.

Module-II: **(9 hrs)**

The Three Pillars of Design Development Methodologies- Ethnographic Observation – Participating Design- Scenario Development- Social Impact Statement for Early Design – Legal Issues- Reviews.

Module-III: **(9 hrs)**

Usability Testing and laboratories- Surveys- Acceptance tests – Evaluation during Active use- Specification Methods- Interface – Building Tools- Evaluation and Critiquing tools. Visual Thinking and Icons – Direct manipulation Programming – Virtual Environments- Task-Related Organization – Item Presentation Sequence- Response Time and Display Rate – Fast Movement Through Menus- Menu Layouts- Form Filling – Dialog Box – Functionality to Support User's Tasks – Command Organization Strategies –Natural Language in Computing.

Module-IV: **(9 hrs)**

Interaction Devices: Introduction – Keyboards and Functions – Pointing Devices- Speech recognition ,Digitization and Generation – Image and Video Displays – Printers – User Productivity – Variability – Error messages – Non-anthropomorphic Design –Display Design – Color-Reading from Paper versus from Displays- Preparation of Printed Manuals- Preparation of Online Facilities.

Module-V: **(9 hrs)**

Windows Strategies and Information Search: Introduction- Individual Widow Design- Multiple Window Design- Coordination by Tightly –Coupled Widow- Image Browsing- Multimedia Documents Searches – Information Visualization – Advance Filtering Hypertext and Hypermedia – World Wide Web- Genres and Goals and Designers – Users and their tasks – Object Action Interface Model for Web site Design

Text book:

1. Ben Shneiderman, "Designing the User Interface", 5th Edition, Addison-Wesley, 2010.

Reference books:

1. Jacob Nielsen, "Usability Engineering ", Elsevier; First edition, 2015
2. Wilbert O. Galiz , "The Essential guide to User Interface Design", Wiley, 2002.
3. Barfied , Lon , "The User Interface : Concepts and Design", Addison Wesley, 1993.

MSCS 467: COMPUTER VISION AND APPLICATIONS

L	*T*	*P*	*C*
3	*0*	*0*	*3*

Pre-requisites:

- Basic Understanding of Image Processing
- Basic Understanding of Programming

Objectives:

- Understanding the Basics of Computer Vision
- Acquiring skills to develop computer vision based applications.

Outcomes:

- Ability to understand the computer vision pipeline.
- Ability to build solutions using computer vision algorithms.

Module-I: **(9 hrs)**

Basic Image Handling and Processing : Loading images – Converting image formats – Plotting images, points and lines – Image contours and histograms – Image resizing – Histogram equalization- PCA of Images – Image denoising.

Module-II: **(9 hrs)**

Local image descriptors – Harris corner detector – Scale Invariant Feature Transform - Matching geo-tagged images.

Module-III: **(9 hrs)**

Image to image mappings : Homo-graphics – warping images – creating panoramas; Camera models and augmented reality – Multiple view geometry.

Module-IV: **(9 hrs)**

Clustering images – Searching images: content based image retrieval – visual words – indexing images – searching the database for images – ranking with geometry.

Module-V: **(9 hrs)**

Classifying image content – Image segmentation: Graph cuts – Segmentation using clustering – OpenCV: Basics – processing video – tracking.

Text Book:

1. Jan Erik Solem. “Programming Computer Vision with Python”. O’Reilly Publishers, 2012.

STREAM 4:

DATA ANALYTICS

MSCS 561: BIG DATA

L	T	P	C
3	0	0	3

***Pre-requisite**:*

- *Data mining and Information Systems.*

***Objectives**:*

- *This course brings together several key big data technologies used for storage, analysis and manipulation of data.*
- *To recognize the key concepts of Hadoop framework, MapReduce, Pig, Hive, and No-SQL.*

Outcomes:

- *Ability to do a sample project in Hadoop API.*

Module - I: Introduction to Big Data (9 hrs)

Big Data and its Importance – Four V's of Big Data – Drivers for Big Data – Introduction to Big Data Analytics – Big Data Analytics applications.

Module - II: Big Data Technologies (9 hrs)

Hadoop's Parallel World – Data discovery – Open source technology for Big Data Analytics – cloud and Big Data –Predictive Analytics – Mobile Business Intelligence and Big Data – Crowd Sourcing Analytics – Inter- and Trans-Firewall Analytics - Information Management.

Module - III: Processing Big Data (9 hrs)

Integrating disparate data stores - Mapping data to the programming framework - Connecting and extracting data from storage - Transforming data for processing - Subdividing data in preparation for Hadoop Map Reduce.

Module - IV: Hadoop MapReduce (9 hrs)

Employing Hadoop Map Reduce - Creating the components of Hadoop Map Reduce jobs - Distributing data processing across server farms –Executing Hadoop Map Reduce jobs - Monitoring the progress of job flows - The Building Blocks of Hadoop Map Reduce - Distinguishing Hadoop daemons - Investigating the Hadoop Distributed File System Selecting appropriate execution modes: local, pseudo-distributed, fully distributed.

Module - V:Advanced Analytics Platform (9 hrs)

Real-Time Architecture – Orchestration and Synthesis Using Analytics Engines – Discovery using Data at Rest – Implementation of Big Data Analytics – Big Data Convergence – Analytics Business Maturity Model.

Text Book(s):

1. *Michael Minelli, Michehe Chambers, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business, Ambiga Dhiraj, Wiely CIO Series, First Edition, 2013.*
2. *Arvind Sathi, Big Data Analytics: Disruptive Technologies for Changing the Game, IBM Corporation, First Edition, 2012.*
3. *Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Wiley and SAS Business Series, First Edition, 2012.*

Reference Book(s):

1. *Tom White, Hadoop: The Definitive Guide, O'Reilly, Third Edition, 2012.*

MSCS 562: PYTHON PROGRAMMING FOR DATA ANALYTICS

L	T	P	C
3	0	0	3

***Pre-requisite**:*

- *Programming knowledge in any OO language.*

***Objectives**:*

- *Understanding the basic concepts of Python.*
- *Preparing and pre-processing data.*
- *Understanding the data aggregation and grouping concepts.*
- *Leveraging web scraping.*
- *Visualizing the results of analytics effectively.*

Outcomes:

- *Ability to do a data analytics using python programs.*

Module - I: Python Concepts, Data Structures, Classes (9 hrs)

Interpreter – Program Execution – Statements – Expressions – Flow Controls – Functions - Numeric Types – Sequences - Strings, Tuples, Lists and - Class Definition – Constructors – Inheritance – Overloading – Text & Binary Files - Reading and Writing.

Module - II: Data Wrangling (9 hrs)

Combining and Merging DataSets – Reshaping and Pivoting – Data Transformation – String Manipulation, Regular Expressions.

Module - III: Data Aggregation, Group Operations, Time series (9 hrs)

GoupBy Mechanics – Data Aggregation – GroupWise Operations and Transformations – Pivot Tables and Cross Tabulations – Date and Time Date Type tools – Time Series Basics – Data Ranges, Frequencies and Shifting.

Module - IV: Web Scraping (9 hrs)

Data Acquisition by Scraping web applications –Submitting a form - Fetching web pages – Downloading web pages through form submission – CSS Selectors.

Module - V: Visualization in Python (9 hrs)

Matplotlib package – Plotting Graphs – Controlling Graph – Adding Text – More Graph Types – Getting and setting values – Patches.

Text Book(s):

1. *Mark Lutz, Programming Python, O'Reilly Media, Fourth edition, 2010.*
2. *Mark Lutz, Learning Python, O'Reilly Media, Fifth Edition, 2013.*
3. *Tim Hall and J-P Stacey, Python 3 for Absolute Beginners, Apress, First Edition, 2009.*
4. *Magnus Lie Hetland, Beginning Python: From Novice to Professional, Apress, Second Edition, 2005.*
5. *Shai Vaingast, Beginning Python Visualization Crafting Visual Transformation Scripts, Apress, Second Edition, 2014.*

Reference Book(s):

1. *Wes Mc Kinney, Python for Data Analysis, O'Reilly Media, 2012.*
2. *White, Hadoop: The Definitive Guide, Third Edition - O'Reilly , 2012.*
3. *Brandon Rhodes and John Goerzen, Foundations of Python Network Programming: The Comprehensive Guide to Building Network Applications with Python, Apress, Second Edition, 2010.*
4. *http://blog.matthewrathbone.com/2013/11/17/python-map-reduce-on-hadoop---a-beginnerstutorial.html*
5. *http://www.michael-noll.com/tutorials/writing-an-hadoop-mapreduce-program-in-python/*

6. *http://allthingshadoop.com/category/python/*

MSCS 563: STATISTICS FOR BUSINESS ANALYTICS

L	T	P	C
3	0	0	3

***Pre-requisite**:*

- *Data mining and its concepts.*

***Objectives**:*

- *To identify the association between various types of data.*
- *To apply statistical inference techniques.*
- *To apply methods of inference to applied business situations.*
- *To identify, build and validate appropriate statistical regression models.*

Outcomes:

- *Ability to do a business analytics using statistical models.*

Module - I: Introduction *(9 hrs)*

Data -Data Tables - Categorical and Numerical Data - Recoding and Aggregation - Time Series - Describing Categorical Data - Charts of Categorical Data -The Area Principle - Mode and Median - Describing numerical data
- Summaries of Numerical Variables -Histograms and the Distribution of - Numerical Data – Box plot - Shape of a Distribution.

Module - II: Association in Categorical and Numerical Data: *(9 hrs)*

Contingency Tables -Lurking Variables and Simpson's Paradox - Strength of Association – Scatter plots - Association in Scatter plots - Measuring Association - Summarizing Association with a Line - Spurious Correlation.

Module - III: Probability *(9 hrs)*

Probability - Conditional Probability - Random Variables - Association between Random Variables - Probability models for Counts - Normality – Managing Financial Risk - Modelling Sampling Variation.

Module - IV: Inference *(9 hrs)*

Samples and Surveys - Sampling Variation and Quality - Confidence Intervals- Hypothesis Tests - Alternative Approaches to Inference - Data for Comparisons -Two-sample T-test - Confidence Interval for the Difference - Rare Events -Testing Association.

Module - V: Regression Models – I *(9 hrs)*

Linear Patterns - Curved Patterns - Simple Regression – Regression Diagnostics - Multiple Regressions.

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Text Book(s):

1. *Robert Stine, Dean Foster, Statistics for Business: Decision Making and Analysis, Pearson Education, Second Edition, 2013.*
2. *Paul Newbold, William L. Carlson, Betty Thorne, Statistics for Business and Economics, Pearson Education, Sixth Edition, 2007.*

Reference Book(s):

1. *Keller Gerald, Statistics for Management and Economics, South Western, Tenth Edition, 2015.*

MSCS 564: MARKETING ANALYTICS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Data mining with Statistics.*

Objectives:

- *Learn how to tap a simple and cost-effective tool, Microsoft Excel, to solve specific business problems using powerful analytic techniques.*
- *Helps to forecast sales and improve response rates for marketing campaigns.*
- *Explores how to optimize price points for products and services, optimize store layouts, and improve online advertising.*

Outcomes:

- *Ability to do a marketing analytics for business related applications.*

Module - I: Marketing Data Summarization *(9 hrs)*

Slicing and Dicing Marketing Data with PivotTables - Using Excel Charts to Summarize Marketing Data - Using Excel Functions to Summarize Marketing Data.

Module - II: Forecasting Techniques *(9 hrs)*

Simple Linear Regression and Correlation - Using Multiple Regression to Forecast Sales - Forecasting in the Presence of Special Events - Modelling Trend and Seasonality - Ratio to Moving Average Forecasting Method - Winter's Method - Using Neural Networks to Forecast Sales.

Module - III: Customer Needs *(9 hrs)*

Conjoint Analysis - Logistic Regression - Discrete Choice Analysis – Customer Value - Introduction to Customer value, Benefits.

Module - IV: Market Segmentation *(9 hrs)*

Cluster Analysis - User-Based Collaborative Filtering - Collaborative Filtering – Using Classification Trees for Segmentation.

Module - V: Retailing and Market Research Tools *(9 hrs)*

Retailing - Introduction to retailing, Market Basket Analysis and Lift - Marketing Research Tools - Principal Components Analysis.

Text Book(s):

1. *Wayne. L. Winston, Marketing Analytics: Data driven techniques with MS-Excel, Wiley, First Edition, 2014.*

Reference Book(s):

1. *Stephan Sorger, Marketing Analytics: Strategic models and metrics, CreateSpace Independent Publishing Platform, First Edition, 2013.*

MSCS 565: SOCIAL NETWORK ANALYTICS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Nil.*

Objectives:

- *Analyse the structure and evolution of networks.*
- *Able to gain knowledge from disciplines as diverse as sociology, mathematics, computer science.*

Outcomes:

- *Ability to do Online interactive demonstrations and hands-on analysis of real-world data sets.*

Module - I: Introduction (9 hrs)

Social network data-Formal methods- Paths and Connectivity-Graphs to represent social relations-Working with network data- Network Datasets-Strong and weak ties - Closure, Structural.

Module - II: Social Influence (9 hrs)

Homophily- Mechanisms Underlying Homophily, Selection and Social Influence, Affiliation, Tracking Link Formation in On-Line Data, Spatial Model of Segregation - Positive and Negative Relationships - Structural Balance - Applications of Structural Balance, Weaker Form of Structural Balance.

Module - III: Information Networks and The World Wide Web (9 hrs)

The Structure of the Web- World Wide Web- Information Networks, Hypertext, and Associative Memory- Web as a Directed Graph, Bow-Tie Structure of the Web- Link Analysis and Web Search Searching the Web: Ranking, Link Analysis using Hubs and Authorities- Page Rank- Link Analysis in Modern Web Search, Applications, Spectral Analysis, Random Walks, and Web Search.

Module - IV: Social Network Mining (9 hrs)

Clustering of Social Network graphs: Betweenness, Girvan Newman Algorithm-Discovery of communities- Cliques and Bipartite Graphs-Graph Partitioning Methods-Matrices-Eigen values Sim-rank.

Module - V: Network Dynamics (9 hrs)

Cascading Behaviour in Networks: Diffusion in Networks, Modelling Diffusion - Cascades and Cluster, Thresholds, Extensions of the Basic Cascade Model- Six Degrees of Separation-Structure and Randomness, Decentralized Search- Empirical Analysis and Generalized Models- Analysis of Decentralized Search.

Text Book(s):

1. *Easley and Kleinberg, Networks, Crowds, and Markets: Reasoning about a highly connected world, Cambridge Univ. Press, 2010.*
2. *Robert A. Hanneman and Mark Riddle, Introduction to social network methods, University of California, 2005.*
3. *Jure Leskovec, Anand Rajaraman, Milliway Labs, Jeffrey D. Ullman, Mining of Massive Datasets, Cambridge University Press, Second Edition, 2014.*

Reference Book(s):

1. *Wasserman, S., & Faust, K, Social Network Analysis: Methods and Applications, Cambridge University Press; First Edition, 1994.*
2. *Borgatti, S. P., Everett, M. G., & Johnson, J. C., Analyzing social networks, SAGE Publications Ltd; First Edition, 2013.*
3. *John Scott , Social Network Analysis: A Handbook , SAGE Publications Ltd; Second Edition, 2000.*

MSCS 566: RISK ANALYTICS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Nil.*

Objectives:

- *To understand the functioning of Banking and apply analytic techniques to mitigate risks.*
- *To understand the operations of Insurance sector and apply analytic techniques to mitigate risks and improve profitability.*
- *To understand the processes involved in Healthcare industry and use data analysis to improve patient care and optimize cost.*
- *To understand human relationship management techniques for effective management of people.*

Outcomes:

- *Ability to analyze impacts of risk on various sensitive applications.*

Module - I: Introduction *(9 hrs)*

Risk – Definition and Examples, Components and Factors; Understanding Risk Assessment, Risk Mitigation and Risk Management; Risk Analytics- Definition and Objectives.

Module - II: Risk Analytics for Banking Domain *(9 hrs)*

Introduction to Banking Sector; National and International laws; Credit Risk Analytics, Internal capital Adequacy Assessment Process Related Risk Analytics, Limit Management, Risk-Adjusted Performance Management, Fraud Risk; Case Studies.

Module - III: Risk Analytics for Insurance Domain *(9 hrs)*

Introduction to Insurance Sector; Property & Causality Insurance Companies and Life Insurance Companies; Using Analytics for Customer Acquisition and Retention; Detecting, Preventing and Managing Fraud using Analytics; Case Studies.

Module - IV: Risk Analytics for Healthcare Domain *(9 hrs)*

Introduction to Healthcare Sector; HIPAA, Four Enterprise Disciplines of Health Analytics, Health Outcome Analysis, Health Value and Cost; Customer Insights, Actuary Services, Framework for Customer Analytics; Risk Management.

Module - V: Workforce Analytics *(9 hrs)*

Workforce Environment and Psychology, HR Analytics and Talent Management- Understanding and Predicting Retention, Boosting Employee Engagement, Sources of Hire and Quality of Hire, Profiling High Performers.

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Text Book(s):

1. *Clark Abrahams and Mingyuan Zhang, Credit Risk Assessment: The New Lending System for Borrowers, Lenders, and Investors, John Wiley & Sons, First Edition, 2009.*
2. *Naeem Siddiqi, Credit Risk Scorecards: Developing and Implementing Intelligent Credit Scoring, John Wiley & Sons, 2005.*

Reference Book(s):

1. *Laura B. Madsen, Data-Driven Healthcare: How Analytics and BI are Transforming the Industry, John Wiley & Sons, First Edition, 2014.*
2. *Jason Burke, Health Analytics: Gaining the Insights to Transform Health Care, John Wiley & Sons, 2013.*
3. *Jac Fitz-Enz , John R. Mattox II, Predictive Analytics for Human Resources, Wiley, 2014.*
4. *James C. Sesil, Applying Advanced Analytics to HR Management Decisions: Methods for Selection, Developing Incentives, and Improving Collaboration, Pearson Education, 2017.*

MSCS 567: DATABASE SYSTEMS IN BIG DATA

L	T	P	C
3	0	0	3

Pre-requisite:

- *Nil.*

Objectives:

- *To understand the design of database in Big Data.*

Outcomes:

- *Ability to use the datdbase with big data.*

Module - I: Getting Started With Cassandra (9 hrs)

Introduction of NoSQL Database concepts: -: ACID Vs. BASE, Advantages, Where Applicable, Schema, Two Phase Commit, Sharing and Share Nothing Architecture, Feature Based, Key Based, Lookup Table Based, NoSQL Databases, Brewers CAP Theorem, Cassandra Definition and Features, Distributed and Decentralised, Elastic Scalability, High Availability and Fault Tolerance, Tuneable Consistency, Strict Consistency, Casual Consistency, Weak (Eventual Consistency), Column Orientation, Schema Free, High Performance, Features and comparisons of few NOSQL Databases (Cassandra, Mongo, Cloudera, CouchDB, HBase.

Module - II: Understanding Cassandra Data Model (9 hrs)

USE Cases for Cassandra, Cassandra Installation: Installing Cassandra, Running the CommandLine Client Interface, Basic CLI Commands, Help, Connecting to a Server, Describing the Environment, Creating and Keyspace and Column Family, Writing and Reading Data, The Relational Data Model, Simple Introduction, Cluster, Keyspaces, Column Families, Column Family Options, Columns, Wide Rows, Skinny Rows, Column Sorting, Super Columns, Composite Keys, Design Differences between RDBMS and CASSANDRA, Query Language, Referential Integrity, Secondary Indexes, Sorting, DeNormalisation, Design Patterns, Materialized Views.

Module - III: Understanding Cassandra Architecture (9 hrs)

System Keyspace, Peer-To-Peer, Gossip and Failure Detection, Anti-Entropy and Read Repair, Memtables, SSTables, and Commit Logs, Hinted Handoff, Compaction, Bloom Filters, Tombstones, Staged Event-Driven Architecture (SEDA), Read, Mutation, Gossip, Response, Anti-Entropy, Load Balance, Migration, Streaming, Managers and Services, Casssandra Daemon, Storage Service, Messaging Service, Hinted Handoff Manager.

Module - IV: Creating Sample Application (9 hrs)

Database Design, Sample Application RDBMS Design, Sample Application Cassandra Design, Application Code, Creating Database, Loading Schema, Data Structures, Setting Connections, Population of database, Application Features. Integrating Cassandra With Hadoop - Hadoop, MapReduce, Cassandra Hadoop Source Package, Outputting Data to Cassandra, PIG, HIVE, Use Cases.

Module - V: Configuring, Reading and Writing Data in Cassandra (9 hrs)

Key spaces, Replicas, Replica Placement Strategy, Replication Factor, Partitioner, Snitches, Creating Clusters, Dynamic Ring Participation, Security, Miscellaneous Settings, Additional Tools, Query differences between RDBMS and Cassandra, Basic Write Properties, Consistency Level, Basic Read Properties, API's, Set Up and Inserting Data, Slice Predicate, Get Range Slices, Multiget Slice, Deleting, Programmatically Defining Keyspaces and Column Families. CQL-Data Definition language(DDL) Statements, Data Manipulation Language (DML), Create and modify Users, User permission, Capture CQL output to a file, Import and export data, CQL scripts from within CQL, CQL Scripts from the command prompt.

Text Book(s):

1. *Tom Plunkett, Brian Macdonald, Bruce Nelson, Oracle Big Data Handbook, (Oracle Press), Fujitsu*
2. *Madhu Jagadeesh, Soumendra Mohanty, Harsha Srivatsa, Big Data Imperatives: Enterprise Big Data Warehouse, BI Implementations and Analytics, Apress, First Edition, 2013.*
3. *Frank J. Ohlhorst, Big Data Analytics: Turning Big Data into Big Money, Wiley Publishers, 2012.*

Reference Book(s):

1. *Cristian Molaro, Surekha Parekh, Terry Purcell, DB2 11: The Database for Big Data & Analytics, MC Press, 2013.*

MSCS 568: STREAMING ANALYTICS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Nil.*

Objectives:

- *Understanding the need for stream computing.*
- *Comprehend the architecture of stream analytics.*
- *Building data flow management pipelines for streams.*
- *Processing streaming data.*
- *Delivering the results of streaming analytics.*

Outcomes:

- *Ability to do streaming analytics.*

Module - I: Introduction to Stream Computing *(9 hrs)*

Streaming Data – Sources – Difference between Streaming Data and Static Data. Overview of Large Scale Stream Processing Engines – Issues in Stream Processing.

Module - II: Streaming Analytics Architecture (*9 hrs)*

Phases in Streaming Analytics Architecture - Vital Attributes - High Availability – Low Latency – Horizontal Scalability-Fault Tolerance - Service Configuration and Management – Apache ZooKeeper.

Module - III:Data Flow Management *(9 hrs)*

Distributed Data Flows – At Least One Delivery – Apache Kafka – Apache Flume – Zero MQ - Messages, Events, Tasks & File Passing.

Module - IV: Processing & Storing Streaming Data *(9 hrs)*

Distributed Stream Data Processing: Co-ordination, Partition and Merges, Transactions. Duplication Detection using Bloom Filters - Apache Spark Streaming Examples Choosing a storage system – NoSQL Storage Systems.

Module - V: Delivering Streaming Metrics *(9 hrs)*

Visualizing Data – Mobile Streaming Apps –Times Counting and Summation – Stochastic Optimization – Delivering Time Series Data.

Text Book(s):

1. *Byron Ellis, Real-Time Analytics: Techniques to Analyze and Visualize Streaming Data, Wiley, First Edition, 2014.*
2. *Sherif Sakr, Large Scale and Big Data: Processing and Management, CRC Press, 2014.*
3. *Bill Franks, Taming The Big Data Tidal Wave Finding Opportunities In Huge Data Streams With Advanced Analytics, Wiley, 2012.*
4. *Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, Mining of Massive Datasets, Cambridge University Press, 2014.*

Reference Book(s):

1. *Paul C Zikopoulos, Chris Eaton, Paul Zikopoulos, Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGraw-Hil, First Edition, 2011.*
2. *kafka.apache.org*
3. *flume.apache.org*
4. *zookeeper.apache.org*

MSCS 569: VIDEO PROCESSING AND ANALYTICS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Image processing and it's working.*

Objectives:

- *To have a better knowledge about videos.*
- *To enrich students with data analytics.*
- *To understand the video content analysis.*

Outcomes:

- *Ability to expose various applications and case studies of Video analytics.*

Module - I: Video Fundamentals *(9 hrs)*

Basic concepts and Terminology-Monochrome Analog video – Colour in Video – Analog video standards – Digital video basics – Analog to Digital conversion – Colour representation and chroma sub sampling – Digital video formats and standards Video sampling rate and standards conversion.

Module - II: Video Segmentation and Video Features *(9 hrs)*

Fundamentals of Motion Estimation – Optical flow - Pixel Video Features - colour, shape features, Textural features - Feature selection and Dimensionality Reduction.

Module - III: Introduction to Analytics *(9 hrs)*

Big-Data - Descriptive data analysis - Analytic Processes and Tools - Regression – Classification - Clustering algorithms - Validation - Multimodal approach to Image and Video data mining - Probabilistic semantic mode - Model based annotation and video mining.

Module - IV: Video Content Analysis and Analytics *(9 hrs)*

Introduction- Detecting Shot Boundaries in Video – Parsing a Video into Semantic Segments – Video Indexing and Abstraction for Retrievals – Affective Video Content Analysis – Automatic Video Trailer Generation - Video database - Video categorization - Video query categorization.

Module - V: Emerging Trends *(9 hrs)*

Object Segmentation and Tracking in the Presence of Complex Background – Video In painting – Video Summarization – Forensic video analysis.

Text Book(s):

1. *Oges Marques, Practical Image and Video Processing Using MATLAB, Wiley-IEEE Press, 2011.*
2. *Michael Berthold, David J.Hand, Intelligent Data Analysis, Springer, 2007.*

Reference Book(s):

1. *Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.*

STREAM 5:

NETWORK COMPUTING

MSCS 571: PRINCIPLES OF DISTRIBUTED COMPUTING

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in Operating System and Computer Networks.*

Objectives:

- *To learn the principles, architectures, algorithms and programming models used in distributed systems.*
- *To examine state-of-the-art distributed systems, such as JINI.*

Outcomes:

- *Ability to design and implement sample distributed systems.*

Module - I: Introduction (*9 hrs)*

Definition – Goals – Hardware and Software Concepts – Client/Server Model Communication – Layered Protocols RPC –Remote Object Invocation – Message Oriented Communication.

Module - II: Client Server and Naming Entity (*9 hrs)*

Threads Client Server – Code Migration – S/W Agents – Naming Entity – Location Mobile Entity.

Module - III: Synchronization and Distributed Transactions (9 hrs)

Synchronization – Clock Synchronization – Logical Clocks – Global States – Election Algorithms – Mutual Exclusion – Distributed Transaction Consistence and Replication – Introduction – Data Centric Consistence – Fault Tolerance – Reliable Client/Server Communication – Distributed Commit – Recovery.

Module - IV: Distributed Object Database System (9 hrs)

Distributed Object Database System: CORBA – DCOM – GLOBE.

Module - V:Distributed File System (9 hrs)

Distributed File System – Distributed Document Base System – WWW – Distributed Co-ordination Base System – JINI.

Text Book(s):

1. *Andrew S.Tanenbaum, Maarten van Steer, Distributed Systems Principles and Paradigms, Prentice Hall India, 2002.*

Reference Book(s):

1. *George Couloursis, Jean Dollomore and Tim Kinderberg, Distributed Systems - Concepts and Design, Addison Wesley.*

MSCS 571: INTRODUCTION TO PARALLEL COMPUTING

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in computer architecture and computer networks.*

Objectives:

- *To study various types of parallel computers and their architectures.*
- *To describe the concepts underlying the design, implementation, and use of message-passing computing and shared-memory computing.*
- *To set up cluster computing systems, code and evaluate the performance of parallel programs.*

Outcomes:

- *Ability to choose suitable programming strategies in parallelizing computational tasks.*

Module - I: Introduction (9 hrs)

Introduction – Motivation – Scope - Parallel Programming Platforms: Implicit Parallelism – Limitations of Memory System Performance - Dichotomy of Parallel Computing Platforms – Communication cost in Parallel Machines – Routing Mechanism for Interconnection Networks.

Module - II: Principles of Parallel Algorithm (9 hrs)

Decomposition Techniques – Characteristics of Tasks and Interactions – Mapping Techniques for Load Balancing – Methods for containing Interaction overheads – Parallel Algorithm Models – Basic communication Operations: One-to-all Broadcast and All-to-one Reduction – Scatter and Gather – Improving the Speed of some communication Operations.

Module - III: Analytical Modelling of Parallel programs (9 hrs)

Sources of Overhead in Parallel Programs – Performance metrics for parallel systems – effect of granularity and data mapping on performance – scalability of parallel systems – Minimum analysis of parallel Programs – other Scalability Metrics.

Module - IV: Programming using Message Passing Paradigm (9 hrs)

Principles of Message-Passing Programming – The Building Blocks: Send and Receive Operations – MPI: The Message Passing Interface – Topologies and Embedding -Overlapping Communication with Computation - Collective Communication and Computation Operations - Groups and Communicators.

Module - V: Parallel Algorithms and Applications (9 hrs)

Dense Matrix Algorithms: Matrix-Vector Multiplication - Matrix-Matrix Multiplication - Solving a System of Linear Equations. Sorting: Issues in Sorting on Parallel Computers - Sorting Networks - Bubble Sort and its Variants – Quick sort - Bucket and Sample Sort - Other Sorting Algorithms.

Text Book(s):

1. *Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, , Pearson, Second Edition, 2003.*

Reference Book(s):

1. *Peter S. Pacheco, An introduction to Parallel Programming, Morgan Kaufmann, First Edition, 2011.*
2. *Fayez Gebali, Algorithms and Parallel Computing, Wiley series, 2011.*

MSCS 573: NETWORK DESIGN AND MANAGEMENT

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in computer networks.*

Objectives:

- *Learn design considerations for Layer 2 and Layer 3 components and network identity.*
- *Understand design considerations for common applications such as DNS, mail, and web.*
- *Identify the key roles and placement issues for network elements such as firewalls, intrusion detection systems, VPN gateways.*

Outcomes:

- *Ability to choose the various testing and optimizations strategies to select the technologies and devices for current network design.*

Module - I: Introduction *(9 hrs)*

Basic Networking Concepts: Network – Telephone Network - Network Architecture Types - Network Services – LANs, MANs and WANs – OSI Model and IEEE Standards: Protocols for Data Transmission – Protocol Stacks – OSI Management – Layering Concepts – IEEE 802 Standards.

Module - II: Protocols, Services and Interfaces *(9 hrs)*

Definition – The X.25 Protocol – Routable Protocols – Non-Routable Protocols – Connectionless and Connection Oriented Protocols – TCP/IP Protocol Suite – IP Addressing – Sub-netting – IPX/SPX Protocol Suite – Other Protocols within the TCP/IP Suite: Microsoft Protocol Suite - AppleTalk Protocol Suite.

Module - III: Network Designs and Ethernet Networking *(9 hrs)*

Physical Topologies – Bus, Star, Ring, Mesh - Network Types – ARCNet – The Ethernet – Fast Ethernet Networks – Token Ring Networks – FDDI – Settings in Network Adapters.

Module - IV: Wired and Wireless Media *(9 hrs)*

Network cables – Wired Media – Twisted-Pair Cable – Fiber-Optic Cable – HFC Cable – Multiplexing – Multiple Access Systems – Microwaves – Network Design Considerations – Token-Ring, CDDI and FDDI Networks – Future Trends in Networking – Quality of Service (QoS).

Module - V: SNMP and RMON *(9 hrs)*

SNMP and UDP – Management Information Bases (MIBs) – Types of MIBs - Lexicographic Order – Structure of Management Information (SMI) Standards – SNMPv1 – SNMPv2 – RMON: Structure of MIB Defined in RFC 1751
– Host Group – Packet Capture Group – Control of RMON Devices.

Text Book(s):

1. *Steven T. Karris, Network Design and Management, Orchard Publications, 2002.*
2. *Teresa C. Piliouras, Network Design: Management and Technical Perspectives, Auerbach Publications, Second Edition, 2004.*

Reference Book(s):

1. *Oppenheimer, Top-Down Network Design, CISCO, 2010.*
2. *Ralph J Tyser, S Raghavan, Telecommunications Network Design and Management, Springer Science Business Media, 2014.*

MSCS 574: WEB SERVICES COMPUTING

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in Web Technology and Computer Networks.*

Objectives:

- *To understand the details of Web services technologies: SOAP, WSDL, UDDI.*
- *To learn how to implement and deploy web service clients and servers.*
- *To explore interoperability between different frameworks.*
- *To learn basic concepts of SOA.*

Outcomes:

- *Ability to develop small applications using web services.*

Module - I: Fundamental Concepts and Theories (9 hrs)

Introduction to Web Services — The definition of web services, basic operational model of web services, tools and technologies enabling web services, benefits and challenges of using web services.
Web Services Architecture — Web services Architecture and its characteristics, core building blocks of web services, standards and technologies available for implementing web services, web services communication models, basic steps of implementing web services.

Module - II: Service Oriented Architecture (9 hrs)

Overview of Service Oriented Architecture — SOA concepts, Key Service Characteristics, Technical Benefits of a SOA. SOA and Web Services — Web Services Platform, Service-Level Data Models, Discovery, Security and Interaction Patterns, Atomic and Composite services, Service—level communication and alternative transports.

Module - III: Web Services using SOAP (9 hrs)

Fundamentals of SOAP — SOAP Message Structure, SOAP encoding, SOAP message exchange models, SOAP communication and messaging, SOAP security.
Developing Web Services using SOAP — Building SOAP Web Services, developing SOAP Web Services using Java and Axis, limitations of SOAP.

Module - IV: Tools and Technologies (9 hrs)

Describing Web Services — WSDL — WSDL in the world of Web Services, Web Services life cycle, anatomy of WSDL definition document, WSDL bindings, WSDL Tools, limitations of WSDL.
Discovering Web Services — Service discovery, role of service discovery in a SOA, service discovery mechanisms, UDDI — UDDI Registries, uses of UDDI Registry, Programming with UDDI, UDDI data structures, Publishing API, Publishing, searching and deleting information in a UDDI Registry, limitations of UDDI.

Module - V: Web Services Interoperability (9 hrs)

Web Services Interoperability — Means of ensuring Interoperability, Overview of .NET, Creating a .NTE client for an Axis Web Service, Creating java client for a web service, Challenges in Web Services Interoperability. Web Services Security — XML security frame work, Goals of Cryptography, Hash Cipher, Symmetric Cipher, Asymmetric Cipher, XML encryption, Digital signature, Digital Certificate, XML Encryption, SAML, structure.

Text Book(s):

1. *R. Nagappan, R. Skoczylas, R.P. Sriganesh, Developing Java Web Services, , Wiley India, 2008.*
2. *Eric Newcomer and Greg Lomow, Understanding SQA with Web Services, Pearson, 2009*
3. *James McGovern, Sameer Tyagi et.al., Java Web Service Architecture, Elsevier, 2009.*

Reference Book(s):

1. *S. Graham, Building Web Services with Java, Pearson, Second Edition, 2008.*
2. *D.A. Chappell & T. Jewell, Java Web Services, O'Reilly, SPD.*
3. *McGovern, et al., Java Neb Services Architecture, Morgan Kaufmann Publishers, 2005.*

MSCS 575: PERVASIVE AND UBIQUITOUS COMPUTING

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in Distributed systems.*

Objectives:

- *to acquire a conceptual foundation in the area of Pervasive Computing aspects.*
- *to provide a balanced treatment of the mechanisms and environments of pervasive computing.*

Outcomes:

- *Ability to use the concepts in developing new applications.*

Module - I: Fundamental Concepts and Theories (9 hrs)

Introduction to ubiquitous Computing – History – Development – The Ubiquitous Portal – Grid, RFID Technologies – Ambient Intelligence.

Module - II: Development and Design Methodologies (9 hrs)

Ubiquitous and Pervasive Application Design – Designing Pervasive and Multimodal Interactive System – pervasive computing: A Conceptual Framework – Deploying User Interfaces for workflow information systems – Ubiquitous and Pervasive case study Applications.

Module - III: Tools and Technologies (9 hrs)

Deploying Pervasive Technologies – Embedding ubiquitous Technologies – Ubiquitous Computing Technologies in Education – Potential and possibilities – problem and pitfalls.

Module - IV: Utilization and Application (9 hrs)

Pervasive Healthcare: Problems and Potentials – Implementing RFID technologies in Hospital – Ubiquitous Healthcare (RFID) in Hospitals – Ubiquitous Risk Analysis – RFID: A framework of Uses and Opportunities.

Module - V: Critical Issues and Emerging Trends (9 hrs)

Privacy Issues of Applying RFID – An Evaluation of the EFID Security Benefits – Security and Privacy Issues in RFID based Wireless Networks – Pervasive and Ubiquitous Computing Databases: critical Issues and Challenges – Emerging Trends – case study.

Text Book(s):

1. *Symonds, Judith, ed. Ubiquitous and Pervasive Computing: Concepts, Methodologies, Tools, and Applications: Concepts, Methodologies, Tools, and Applications. IGI Global, 2009.*

Reference Book:

1. *Bakhouya, Mohamed. Ubiquitous and pervasive computing: architectures and protocols for applications design. Proceedings of the 3rd workshop on Agent-oriented software engineering challenges for ubiquitous and pervasive computing. ACM, 2009.*

MSCS 576: CLOUD COMPUTING

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in distributed systems.*

Objectives:

- *To analyze the components of cloud computing and its business perspective.*
- *To evaluate the various cloud development tools.*
- *To collaborate with real time cloud services.*

Outcomes:

- *Ability to use the concepts in developing new applications.*

Module - I: Introduction (9 hrs)

Overview of Computing Paradigm - Recent trends in Computing - Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing - Evolution of cloud computing - Cloud Computing (NIST Model)
– Characteristics - Pros and Cons of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing - Role of Open Standards - Cloud Computing Architecture - Cloud computing stack - Service Models (XaaS) - Deployment Models.

Module - II: Infrastructure as a Service (IaaS) (9 hrs)

Infrastructure as a Service(IaaS) – Introduction- IaaS definition, virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine(VM) - Resource Virtualization – Server, Storage, Network, Virtual Machine(resource) provisioning and manageability, storage as a service, Data storage in cloud computing (storage as a service) - Examples - Amazon EC2 - Renting, EC2 Compute Unit, Platform and Storage, pricing, customers – Eucalyptus.

Module - III: Platform as a Service(PaaS) (9 hrs)

Platform as a Service(PaaS) - Introduction - What is PaaS, Service Oriented Architecture (SOA) - Cloud Platform and Management – Computation, Storage – Examples - Google App Engine, Microsoft Azure, SalesForce.com, Force.com platform - Software as a Service(PaaS) - Introduction to SaaS - Web services - Web 2.0 - Web OS - Case Study on SaaS.

Module - IV: Service Management in Cloud Computing (9 hrs)

Service Management in Cloud Computing - Service Level Agreements(SLAs) - Billing & Accounting - Comparing Scaling Hardware: Traditional vs. Cloud - Economics of scaling: Benefitting enormously - Managing Data - Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing.

Module - V: Cloud Security (9 hrs)

Cloud Security - Infrastructure Security - Network level security, Host level security, Application level security - Data security and Storage - Data privacy and security Issues, Jurisdictional issues raised by Data location - Identity & Access Management - Access Control - Trust, Reputation, Risk - Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations.

Text Book(s):

1. *Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2011.*
2. *Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley-India, 2010.*

Reference Book(s):

1. *Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, Mc Graw Hill Education, 2013.*
2. *Nikos Antonopoulos, Lee Gillam, Cloud Computing: Principles, Systems and Applications, Springer, 2012.*

3. *Barrie Sosinsky,Cloud Computing Bible, Wiley-India, 2010.*

MSCS 577: INTERNET OF THINGS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in computer networks and working of sensors.*

Objectives:

- *To understand IoT Market perspective.*
- *To understand State of the Art – IoT Architecture.*
- *To understand Real World IoT Design Constraints, Industrial Automation and Commercial Building Automation in IoT.*

Outcomes:

- *Ability to develop small applications using IoT.*

Module - I: M2M and IoT- Introduction *(9 hrs)*

The Vision – Introduction – From M2M to IoT – M2M towards IoT – the global context – A use case example – Differing Characteristics.

Module - II: M2M and IoT-A Market Perspective *(9 hrs)*

Introduction – Some Definitions – M2M Value Chains – IoT Value Chains – An emerging industrial structure for IoT – M2M to IoT – An Architectural Overview – Building an architecture – Main design principles and needed capabilities – An IoT architecture outline – standards considerations.

Module - III: M2M and IoT Technology Fundamentals *(9 hrs)*

Devices and gateways – Local and wide area networking – Data management – Business processes in IoT – Everything as a Service(XaaS) – M2M and IoT Analytics – Knowledge Management.

Module - IV: IoT Architecture – State of the Art *(9 hrs)*

Introduction – State of the art – Architecture Reference Model – Introduction – Reference Model and architecture – IoT reference Model.

Module - V: IoT Reference Architecture *(9 hrs)*

Introduction – Functional View – Information View – Deployment and Operational View – Other Relevant architectural views – Real-World Design Constraints – Introduction – Technical Design constraints – hardware is popular again – Data representation and visualization – Interaction and remote control – Industrial Automation – Service-oriented architecture – based device integration.

Text Book(s):

1. *Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, First Edition, 2014.*

Reference Book(s):

1. *Vijay Madisetti and ArshdeepBahga, Internet of Things (A Hands-on-Approach), VPT, FirstEdition,2014.*
2. *Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Publications, First Edition, 2013.*

STREAM 6:

ARTIFICIAL INTELLIGENCE

MSCS 581: INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Exposure to Algorithms, Data structure and Mathematical Logic.*

Objectives:

- *Explore basic concepts of AI and expert systems.*

Outcomes:

- *Ability to explore logic for solving various AI problems.*

Module - I: Introduction *(9 hrs)*

AI – Foundations of AI, Intelligent Agents – Agents and Environments – Good Behaviour – Nature of Environments – Structure of Agents.

Module - II: Problem solving *(9 hrs)*

Problem Solving Agents – Searching for solutions- Uninformed Search Strategies – Informed Search Strategies, heuristic functions.

Module - III: Search Algorithms *(9 hrs)*

Local search algorithms and optimization problems – Searching with nondeterministic Actions, Constraint satisfaction problems.

Module - IV: Expert systems *(9 hrs)*

Expert systems – Introduction – Difference between expert system and conventional programs – Expert system organization – Architecture of Expert system – Knowledge representation techniques- Knowledge acquisition techniques - Inference Engine- Explanation systems.

Module - V: Languages and Tools *(9 hrs)*

Working with LISP, Prolog – Apache Spark.

Text Book(s):

1. *Stuart J Russell and Peter Norvig, Artificial Intelligence – A Modern Approach, PHI Learning, Third Edition, 2010.*
2. *Patterson W D, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, First Edition, 1995.*

Reference Book:

1. *Elaine Rich and Kelvin Knight, Artificial Intelligence, TMH, Third Edition, 2009.*

MSCS 582: NEURAL NETWORKS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Knowledge in Artificial Intelligence.*

Objectives:

- *Develop the skill in basic understanding on neural network.*
- *Explore the Advanced methods of representing information in ANN.*
- *Exposure to many real-world control problems.*

Outcomes:

- *Ability to use in various AI problems.*

Module - I: Introduction *(9 hrs)*

Fundamentals of neural networks – model of an artificial neuron – neural network architectures – Learning methods – Taxonomy of Neural network architectures – Standard back propagation algorithms – selection of various parameters – variations Applications of back propagation algorithms.

Module - II: ANN Architectures *(9 hrs)*

Associative memory – exponential BAM – Associative memory for real coded pattern pairs– Applications adaptive resonance theory – introduction – ART 1 – ART2 – Applications.

Module - III: Self organizing maps *(9 hrs)*

Kohenen self-organizing maps – learning vector quantization – counter propagation networks – industrial applications.

Module - IV: Advances in NN *(9 hrs)*

Fundamentals of genetic algorithms – genetic modelling – hybrid systems – integration of fuzzy logic, neural networks and genetic algorithms – non-traditional optimization techniques like ant colony optimization – Particle swarm optimization and artificial immune systems.

Module - V: Applications *(9 hrs)*

Pattern Recognition-Prediction-Robotics-Case study.

Text Book(s):

1. *James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, 2003, Addison Wesley, 2003.*
2. *LauranceFausett, Fundamentals of Neural Networks, 1992, Prentice hall.*
3. *C.M.Bishop, Neural networks and Pattern recognition, 2003, Oxford University*
4. *Mitchell Melanie, An Introduction to Genetic Algorithm,1996, MIT Press.*

MSCS 583: FUZZY LOGIC

L	T	P	C
3	0	0	3

Pre-requisites:

- *Mathematical Foundation of Computer Science and probability theory.*
- *Knowledge in programming languages.*

Objectives:

- *To develop an elementary practical theory for automatic control of uncertain or imperfectly modelled systems encountered in engineering applications.*
- *To provide a basic exposition to the goals and methods of Fuzzy Logic.*

Outcomes:

- *Ability to explore the concepts in various AI problems.*

Module - I: Fuzzy Set Theory (9 hrs)

The notion of fuzziness - what, why and when to apply fuzzy set, operations on fuzzy sets, fuzzy numbers, Crisp relations, fuzzy relations, Max-composition of fuzzy relation, Max_-transitive closure, probability measures of fuzzy events, fuzzy expected value, fuzzy inference principle, Examples of use of fuzzy logic in control of real-world systems.

Module - II: Neural Networks and Fuzzy Logic Fundamentals (9 hrs)

Artificial Neural Network Representation, Exclusive- OR-Problem, Linear Separability, learning and training algorithms, Back propagation – Back propagation training algorithm.

Module - III: Neuro Fuzzy Modelling (9 hrs)

Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modelling – Framework Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.

Module - IV: Fuzziness Measures (9 hrs)

Fuzzy measures – belief, plausibility and their properties, Dempster's rule of combination, consonant body of evidence – possibility, necessities, Measures of uncertainty Axiomatic formulation of Hartley information, Shannon's entropy, concepts of joint and conditional entropy and their properties; measures of non-specificity, Measures of dissonance and confusion.

Module - V: Case Study (9 hrs)

Fuzzy geometry Applications to some selected topics like pattern recognition, image processing, computer vision, optimization, control, data mining, Integration with other computing paradigm.

Reference Book(s):

1. *G. J. Klir and T. A. Folger: Fuzzy Sets, Uncertainty, and Information, Prentice Hall, Englewood Cliffs, 1988*
2. *A. Kandel: Fuzzy Mathematical Techniques With Applications, Addison-Wesley, Englewood Cliffs, 1986.*
3. *J. C. Bezdek and S. K. Pal (Eds.): Fuzzy Models for Pattern Recognition – Methods that Search for Structures in Data, IEEE Press, Los Alamos, California, 1992.*
4. *S. K. Pal and D. Dutta Majumder: Fuzzy Mathematical Approach to Pattern Recognition, John Wiley (Halsted Press), New York, 1986.*
5. *M. M. Gupta: Fuzzy Mathematical Models with Applications to Engineering and Management Science, North Holland, Amsterdam, 1988.*
6. *T. J. Ross: Fuzzy Logic With Engineering Applications, McGraw Hill, Singapore, 1997.*
7. *J. C.Bezdek, J. M. Keller, R. Krishnapuram, and N. R. Pal: Fuzzy Models and Algorithms for Pattern Recognition and Image Processing, Kluwer Academic Publisher, Boston, 1999.*

MSCS 584: DECISION SUPPORT SYSTEMS

L	T	P	C
3	0	0	3

Pre-requisite:

- *Exposure to AI and Mathematical Logic*

Objectives:

- *Explore basic concepts of DSS*

Outcomes:

- *Ability to explore the concepts in various AI problems.*

Module - I: Decision making systems *(9 hrs)*

Management support systems, Decision making systems, modelling and support – Introduction – Systems - models- Phases of decision making process- Making process- intelligence Phase – Design Phase- Choice phase – Implementation Phase – Decision makers – case study.

Module - II: Decision Support system *(9 hrs)*

Overview – DSS configurations – Characteristics and capabilities of DSS – Components of DSS – Data Management Subsystem – Model management subsystems- Knowledge management subsystem – User- hardware- Classifications- Case study.
Modelling and Analysis - MSS modelling – Static and dynamic models – Certainty and uncertainty and Risk – Influence diagrams – Structure of MSS mathematical models.

Module - III: Business Intelligence and DSS Development *(9 hrs)*

Nature and Sources of data, Data collections, problem and quality, DBMS in DSS- Data warehousing – Data Mart- Business Intelligence – OLAP- Data mining – Data visualization – GIS.
Introduction to DSS development- Change management – Technology levels and tools- Platforms- Tool selections- Team developed and End user developed DSS.

Module - IV: Collaborative Computing and intelligent *(9 hrs)*

Group decision making, communication and collaboration – Group support system – GSS technologies – GSS meeting process- Distance learning and creativity and idea generation.
Intelligent systems over Internet – Web based intelligent systems – Intelligent agents – Characteristics, classification, types of agents – Intelligent based software agents – DSS agents and multi-agents – Web based recommendation system – managerial issues of Intelligent agents.

Module - V: Languages and Tools *(9 hrs)*

Working with Lumina Analytical, Open rules, paramount decisions, PROSUITE.

Text Book(s):

1. *E Turban, J E Aronson, Decision Support systems and Intelligent systems, 2005, Seventh Edition, Pearson Education.*

MSCS 585: INTRODUCTION TO MACHINE LEARNING

L	T	P	C
3	0	0	3

Pre-requisite:

- *Basic knowledge in artificial intelligence, learning activities.*

Objectives:

- *To understand the concepts of machine learning.*
- *To appreciate supervised and unsupervised learning and their applications.*
- *To appreciate the concepts and algorithms of learning.*

Outcomes:

- *Ability to explore logic for solving various AI problems.*

Module - I: Introduction (9 hrs)

Introduction: Definition-Examples of machine learning applications –Well posed learning problems- Designing a learning system- Perspectives and issues Concept learning and general to specific ordering: Inductive learning hypothesis- Concept learning as search – candidate elimination algorithm-inductive bias.

Module - II: Regression and classification (9 hrs)

Regression: Linear Regression-Simple-Multiple Decision Tree-Pruning: Introduction –Representation-Algorithm- issues Classification: Support Vector machine – Naïve Bayes-Applications

Module - III: Clustering and Learning (9 hrs)

Clustering: k-Means clustering– adaptive Hierarchical clustering –Applications- Neural network : Perceptron, multilayer network- back propagation- introduction to deep neural network Instance based learning :k-NN– Radial basis functions Case based reasoning- Reinforcement learning -Applications.

Module - IV: Probabilistic graphical models (9 hrs)

Graphical Models: Undirected graphical models - Markov Random Fields - Directed Graphical Models -Bayesian Networks - Conditional independence properties - Inference – Learning Generalization - Hidden Markov Models - Conditional random fields(CRFs)

Module - V: Machine learning experiments (9 hrs)

Design-Cross validation - Measuring Performance -Hypothesis testing- Assessing Performance -Comparison of algorithms, Datasets-Case study

Text Book(s):

1. *Tom M. Mitchell, Machine learning, McGraw-Hill, 1997.*
2. *Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Third Edition, 2014.*

MSCS 586: INTRODUCTION TO ROBOTICS

L	T	P	C
3	0	0	3

Pre-requisites:

- *Mathematical Foundation of Computer Science*
- *Machine Learning*
- *Natural Language Processing*

Objectives:

- *To understand the different robotic configurations and their subsystems*

Outcomes:

- *Ability to use the concepts in various AI problems.*

Module - I: Introduction *(9 hrs)*

Introduction to Robotics: Robot Anatomy - Coordinate Systems, Manipulators & Mobile Robots, Classification of Robots, Robot and effectors - special reference to servomotors Transmission and actuators, Robot Applications - Industrial application environment and work cells, Feeders and Oriented Device.

Module - II: Drive systems *(9 hrs)*

Types of Robot Drives: Mechanical – Magnetic – Vacuum, Robot arm kinematics, World, Tool, DH transformation and Inverse Kinematics. Fundamentals of Closed loop control, PWM amplifiers, PID control.

Module - III: Sensors and Machine Vision *(9 hrs)*

Robotics sensors: Range, Proximity, Touch, Force and Torque Sensing, uses of sensors in Robotics, Applications- Inspection – Identification - Visual Serving and Navigation, Machine Vision - The sensing and digitizing function in Machine Vision - Image processing and analysis, Training and vision system, Robotic Application - Low and High-level vision.

Module - IV: Robot Programming *(9 hrs)*

Features of various programming methods, Robot Task planning: concept, different methods, robot learning, Mobile Robot: Introduction, obstacle Representatives, Motion Planning in fixed and Changing structure - Simple Programs.

Module - V: Industrial Applications and Case Studies *(9 hrs)*

Application of robots: Material handling - Machine loading and unloading – Assembly – Inspection – Welding - Pray Painting - Mobile Robot Micro Robots - Recent developments in Robotics- Safety Considerations.

Text Book(s):

1. *Deb, S. R., Robotics Technology and Flexible Automation, Tata McGraw Hill publishing company limited, 1994.*
2. *Richard David Klafter, Thomas A. Chmielewski, Michael Negin, Robot Engineering: An integrated Approach, Prentice Hall of India Pvt. Ltd, 1994.*

Reference Book(s):

1. *King Sun Fu, Rafael C. González, C. S. George Lee, Robotics: control, sensing, vision, and intelligence, McGraw-Hill, 1987.*
2. *Craig, J. J, Introduction to Robotics: Mechanics and Control, Addison-Wesley, London, Third Edition, 2004.*
3. *M.P.Groover, M. Weins, R.N.Nage, N.C.Odrey, Industrial Robotics, McGraw Hill*
4. *K.D. Richard, Chmielewski T.A and Michael, Robotic Engineering, PHI Learning.*
5. *K.S. Fu Gonzalez, Lee, Robotics Control, Sensing, Vision and intelligence.*

MSCS 587: SOFT COMPUTING

L	T	P	C
3	0	0	3

Pre-requisites:

- *Linear Algebra, Multivariate Calculus, Probability Theory*
- *Knowledge in programming languages*

Objectives:

- *To provide a strong foundation of fundamental concepts in Artificial Intelligence.*
- *To provide a basic exposition to the goals and methods of Artificial Intelligence.*

Outcomes:

- *Ability to apply these techniques in applications which involve perception, reasoning and learning.*

Module - I: Introduction (9 hrs)

Introduction to soft computing - brief description of separate theories, Introduction to biological and artificial neural network, Classification algorithms- Decision Trees, Bayesian classifier - Neural Networks and Probabilistic Reasoning

Module - II: Neural Networks (9 hrs)

Basic concepts of neural networks, Neural network architectures, Learning methods, Supervised and un-supervised learning, Architecture of a back-propagation network, Applications

Module - III: Fuzzy Sets (9 hrs)

Fundamentals of fuzzy sets and fuzzy logic theory, fuzzy inference principle, Examples of use of fuzzy logic in control of real-world systems

Module - IV: Optimization (9 hrs)

Derivative-based Optimization – Descent Methods – The Method of Steepest Descent – Classical Newton's Method – Step Size Determination – Derivative-free Optimization – Genetic Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search

Module - V: Applications of computational intelligence (9 hrs)

AI Search Algorithm-Predicate calculus- rules of interface - Semantic networks – frames – objects -Hybrid models, Applications -Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Colour Recipe Prediction

Reference Book(s):

1. *Jang J.S.R.,Sun C.T and Mizutami E - Neuro Fuzzy and Soft Computing Prentice hall, New Jersey,1998.*
2. *Munakata, T.: Fundamentals of the New Artificial Intelligence, Springer-Verlag New York, Inc.,1998.*
3. *Goldberg, Introduction to Genetic Algorithms.*
4. *Jang, Nero-Fuzzy & Soft Computing, Pearsons.*
5. *Cordón, O., Herrera, F., Hoffman, F., Magdalena, L.: Genetic Fuzzy systems, World Scientific Publishing Co. Pte. Ltd., 2001.*
6. *Kecman, V.: Learning and Soft Computing, The MIT Press, 2001.*
7. *Nih.J.Ndssen Artificial Intelligence, Harcourt Asia Ltd., 1998.*