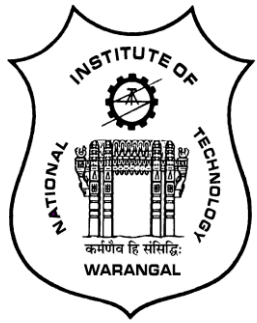
Department of Computer Science and Engineering

MASTER OF COMPUTER APPLICATIONS

(MCA)

Scheme and Syllabus

(2016 – 2017)



NATIONAL INSTITUTE OF TECHNOLOGY

WARANGAL – 506 004

TELANGANA, INDIA

NATIONAL INSTITUTE OF TECHNOLOGY
WARANGAL 506 004
Department of computer science and engineering
Master of Computer Applications
Course Structure (effective from A.Y. 2016-17)

I Year I Semester				
S. No.	**Course No.**	**Course Name**	**(L–T–P)**	**C**
1	MA5011	Probability Statistics and Queuing Theory	(4 – 0 – 0)	4
2	SM5301	Managerial Economics	(4 – 0 – 0)	4
3	CS5301	Mathematical Foundations of Computer Science	(4 – 0 – 0)	4
4	CS5302	Computer Organization	(4 – 0 – 0)	4
5	CS5303	Problem Solving and Programming	(4 – 0 – 0)	4
6	CS5304	Free and Open Software Systems Lab	(1 – 0 – 3)	3
7	CS5305	Problem Solving and Programming Lab	(0 – 0 – 3)	2
		Total		**25**

I Year II Semester				
S. No.	**Course No.**	**Course Name**	**(L–T–P)**	**C**
1	SM5351	Accounting and Financial Management	(4 – 0 – 0)	4
2	CS5351	Data Structures	(4 – 0 – 0)	4
3	CS5352	Fundamentals of Web Programming	(4 – 0 – 0)	4
4	CS5353	Object Oriented Programming	(4 – 0 – 0)	4
5	CS5354	Unix Tools Programming	(4 – 0 – 0)	4
6	CS5355	Data Structures Lab	(0 – 0 – 3)	2
7	CS5356	Web Programming Lab	(0 – 0 – 3)	2
8	CS5357	Programming Lab	(0 – 0 – 3)	2
		Total		**26**

II Year I Semester				
S. No.	**Course No.**	**Course Name**	**(L–T–P)**	**C**
1	SM6312	Organizational Structures and Personal Management	(4 – 0 – 0)	4
2	CS6301	Operating System Concepts	(4 – 0 – 0)	4
3	CS6302	Database Systems	(4 – 0 – 0)	4
4	CS6303	Software Engineering Principles	(4 – 0 – 0)	4
5	CS6304	Operating System Concepts Lab	(0 – 0 – 3)	2
6	CS6305	Database Systems Lab	(0 – 0 – 3)	2
7	CS6306	Software Engineering Lab	(0 – 0 – 3)	2
8	CS63AX	Elective - 1	(3 – 0 – 0)	3
		Total		**25**

II Year II Semester				
S. No.	**Course No.**	**Course Name**	**(L–T–P)**	**C**
1	CS6351	Algorithm Analysis and Design	(4 – 0 – 0)	4
2	CS6352	Computer Communications and Networking	(4 – 0 – 0)	4
3	CS6353	Principles of Data Warehousing and Data Mining	(4 – 0 – 0)	4
4	CS6354	Computer Communications and Networking Lab	(0 – 0 – 3)	2
5	CS6355	Knowledge Engineering Lab	(0 – 0 – 3)	2
6	CS6391	Seminar-1	(0 – 0 – 2)	1
7	CS63BX	Elective – 2	(3 – 0 – 0)	3
8	CS63CY	Elective – 3	(3 – 0 – 0)	3
9	CS63DZ	Elective – 4	(3 – 0 – 0)	3
		Total		**26**

III Year I Semester				
S. No.	**Course No.**	**Course Name**	**(L–T–P)**	**C**
1	CS7301	Mobile Applications Development	(4 – 0 – 0)	4
2	CS7302	Software Testing	(4 – 0 – 0)	4
3	CS7303	Mobile Applications Development Lab	(0 – 0 – 3)	2
4	CS7304	Software Testing Lab	(0 – 0 – 3)	2
5	CS7341	Seminar-2	(0 – 0 – 2)	1
6	CS7342	Comprehensive Viva-voce	(0 – 0 – 0)	2
7	CS73EX	Elective – 5	(3 – 0 – 0)	3
8	CS73FY	Elective – 6	(3 – 0 – 0)	3
9	CS73GZ	Elective – 7	(3 – 0 – 0)	3
		Total		**24**

III Year II Semester				
S. No.	**Course No.**	**Course Name**	**(L–T–P)**	**C**
1	CS7399	Project Work	(0 – 0 – 3)	12
		Total		12
		Grand Total of credits offered and to be earned for award of MCA degree		**138**

Department Elective Courses			
	ELECTIVES FOR II YEAR		
CS6361	Artificial Intelligence	(3 – 0 – 0)	3
CS6362	Information Systems Management	(3 – 0 – 0)	3
CS6363	Information Security	(3 – 0 – 0)	3
CS6364	Modeling and Simulation	(3 – 0 – 0)	3
CS6365	Network Programming	(3 – 0 – 0)	3
CS6366	Cloud Computing	(3 – 0 – 0)	3
CS6367	Distributed Operating Systems	(3 – 0 – 0)	3
CS6368	Ubiquitous Computing	(3 – 0 – 0)	3
CS6369	Image Processing	(3 – 0 – 0)	3
CS6370	Parallel Computing	(3 – 0 – 0)	3
CS6371	Advanced Database Systems	(3 – 0 – 0)	3
CS6372	E-Commerce Technologies and Management	(3 – 0 – 0)	3
CS6373	Advanced Web Technologies	(3 – 0 – 0)	3
CS6374	Advanced Data Structures	(3 – 0 – 0)	3
CS6375	Machine Learning	(3 – 0 – 0)	3
CS6376	Software Architecture	(3 – 0 – 0)	3
CS6377	Randomized Algorithms	(3 – 0 – 0)	3
CS6378	User Interface Design	(3 – 0 – 0)	3
	ELECTIVES FOR III YEAR		
CS7371	Digital Forensics	(3 – 0 – 0)	3
CS7372	Internet of Things	(3 – 0 – 0)	3
CS7373	Human Computer Interaction	(3 – 0 – 0)	3
CS7374	Design Patterns	(3 – 0 – 0)	3
CS7375	Big Data Technologies	(3 – 0 – 0)	3
CS7376	Bioinformatics	(3 – 0 – 0)	3
CS7377	ERP and Supply Chain Management	(3 – 0 – 0)	3
CS7378	Web Analytics	(3 – 0 – 0)	3
CS7379	Algorithmic Graph Theory	(3 – 0 – 0)	3
CS7380	Foundations of Cryptography	(3 – 0 – 0)	3

CS7381	Foundations of Data Science	(3 – 0 – 0)	3
CS7382	Network Security	(3 – 0 – 0)	3
CS7383	Games of Strategy	(3 – 0 – 0)	3

Basic Science and Humanities Course			
MA5011	Probability Statistics and Queuing Theory	(4 – 0 – 0)	4
SM5301	Managerial Economics	(4 – 0 – 0)	4
SM5351	Accounting and Financial Management	(4 – 0 – 0)	4
SM6312	Organizational Structures and Personal Management	(4 – 0 – 0)	4

Syllabus

MASTER OF COMPUTER APPLICATIONS

CS5301 MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE (4–0–0) 4

Sets, Relations, Functions – Fundamentals of Logic – Quantified Propositions – Mathematical Induction – Combinations and Permutations – Enumerations – Recurrence Relations – Generating Functions – Binary Relations – Lattices – Directed Graphs – Graphs – Spanning Trees – Planar Graphs – Euler Circuits – Hamiltonian Graphs

Reading:

1. Mott, Kandel, Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*, 2/e, PHI, 2001.
2. John Harris, Jeffry L. Hirst and Michael Mossinghoff, *Combinatorics and Graph Theory*, 2/e, Springer, 2010

CS5302 COMPUTER ORGANIZATION (4–0–0) 4

Basic Structure – Functional Units – Bus Structure – Addressing Methods – Machine Program Sequence – 68000 example – Instructions – Assembly Language Program – Flow Control – Power PC example – Processing Unit – Hardwired Control – Micro Programmed Control – Memory – Performance Considerations – Arithmetic and Branching Conditions – Computer Peripherals

Reading:

1. Hamacher, Vranesic, Zaky, *Computer Organization*, 5/e, MGH, 2002
2. Wiiliam Stallings,*Compute Organization and Architecture Designing for Performance*, 8/e, Pearson Education, 2010

CS5303 PROBLEM SOLVING AND (4–0–0) 4

PROGRAMMING

Problem Solving – Algorithm – Procedural Abstraction – Functions – Parameter Passing – Recursion– Structures – Classes – Arrays – Pointers – Inheritance – polymorphism – Overloading – Templates

Reading:

1. Walter Savitch, *Problem Solving with C++*, 2/e, Pearson, 2002
2. Cay Horstmann, Timothy Budd, *Big C++*, Wiley, Indian Edition, 2006

CS5304 FREE AND OPEN SOURCE SYSTEMS LAB (1–0–3) 3

Linux- Globus/PGSA – Open Office – GIMP – Apache Aixs – Open LDAP – Apache – MySQL – Open CMS – CVS.

CS5305 PROBLEM SOLVING AND PROGRAMMING LAB (0–0–3) 2

Familiarization – Editing – Expressions – Series Evaluation – Functions – Recursion – Arrays – Pointers – Structures – Classes – Inheritance – Polymorphism – Overloading – Templates

CS5351 DATA STRUCTURES (4–0–0) 4

Order Lists – Stacks – Queues – Trees – Search Trees – BST, AVL Tree – Hashing – Hash Tables – Priority Queues – Internal and External Sorting– Disjoint Sets – Graph Algorithms – Shortest Paths – Spanning Trees

Reading:

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, 2/e, Pearson, 2004.

2. Sartaj Sahni, *Data Structures, Algorithms and Applications in C++*, 2/e, University Press, 2005.

CS5352 FUNDAMENTALS OF WEB PROGRAMMING (4–0–0) 4

Web Essentials - Client-Server Architecture of Internet – File Transfer Protocol - HTTP, HTTPS - SMTP– POP3 - Client Side Programming -Creating Home Pages - Dynamic HTML - JavaScript - Cascading Style Sheets - Including Multimedia - Web Servers- Server side Programming- String Processing and Regular Expressions, Form Processing and Business Logic, Dynamic Content - Database Connectivity - Application Development.

Reading:

1. Deitel, Deitel & Nieto, *Internet and Worldwide Web - How to Program*, 5th Edition, PHI, 2011.
2. Bai and Ekedhi, "The Web Warrior Guide to Web Programming", 3rd Edition, Thomson, 2008.
3. Thomas A Powel, "Web Design: The Complete Reference", 2nd Edition, McGraw-Hill, 2002.

CS5353 OBJECT ORIENTED PROGRAMMING (4–0–0) 4 4

Object Oriented Thinking – Messages and Methods – OO Design – Software Components – Design Paradigms – Inheritance – Mechanisms for software reuse – Polymorphism – AWT Classes – Input output Streams – Design Patterns – Exception handling

Reading:

1. Timothy Budd, "*Understanding Object Oriented Programming with Java"*, Pearson Education, 1999
2. Herbert Schildt, "*Java 2 Complete Reference"*, 5/e, TMH, 2010

CS5354 UNIX TOOLS PROGRAMMING (4–0–0) 4

Unix Introduction : Architecture, Features, Internal and External commands, Manual pages, startup, shutdown, login, logout
Unix Commands : at, banner, batch, bc, cal, cat, cd, cmp, comm, chmod, chown, chgrp, cp, cron, cut, date, dd, diff, echo, finger, find, ftp, head, kill, lock, ln, ls, lp, lpstat, man, mesg, mkdir, more, mv, nl, nice, passwd, pr, paste, ping, ps, pwd, rcp, rlogin, rmdir, rm, rsh, split, sort, tail, talk, tar, telnet, touch, tput, tr, tty, uname, uniq, wc, who, write
Shell Programming : Different types of shells, shell environment, Pattern matching - wild cards, Escaping, quoting, File I/O, Redirection, Pipes, Command substitution, shell variables, Aliases, Command history, interactive shell scripting, if, case, for, while constructs, terminal capabilities, Text based user interface development
Filters : Regular expressions, grep, pr, head, tail, cut, paste, sort, uniq, tr, introduction to sed and awk
Backup: Backup using tar and cpio
Program development tools : make, ar, SCCS, RCS, CVS, gdb, gnu compilers, rpm, memory leakage, autoconf, automake, indent.
Lex and Yacc : (flex, bison), Recognizing words with lex, Regular expressions, Parsing command line, Start states, Example lex programs, Grammars, Shift/Reduce parsing, Definitions, rules and Actions sections, Ambiguity, precedence rules, variables, typed tokens, Symbol tables, Functions and reserved words

Reading:

1. Sumitabha Das, "*Unix Concepts and Applications*", TMH, 4/e, 2008
2. John R Levine, Tony Mason, Doug Brown, "*Lex and Yacc*", Orielly, 2nd Edition, 2009

CS5355 DATA STRUCTURES LAB (0–0–3) 2

Implementation of ordered lists – Generic Queues – conversion of expressions, evaluation, expression trees – Search Trees – BST – AVL Trees – Splaying – Sorting algorithms – Graph traversals – Shortest paths – Spanning Trees

CS5356 WEB PROGRAMMING LAB (0–0–3) 2

Creating home pages - Online shopping - Online examination - Chat system - Mailing system.

CS5357 PROGRAMMING LAB (0–0–3) 2

Java Assignments:
CRC Case studies – Inheritance – Implementation of graphical Programs Using Java AWT classes – Exception Handling in Java
UTP Assignments:
Practicing commands, Text based user interface development, Text database processing, Report generation, Scripts for backup and restoring, Calculator program and a parser for simple arithmetic expression language using Lex and Yacc tools.

CS6301 OPERATING SYSTEM CONCEPTS (4–0–0) 4

Batch, iterative, time sharing and real-time systems – Operating system structure – Concurrent processes – Synchronization – CPU scheduling – Deadlocks – Memory management – Virtual memory – Secondary storage management – File systems – I/O systems – Mass-storage structure – Protection – Security

Reading:

1. A. Silberschatz, Galvin, Gagne, *Operating System Concepts,* 8/e, John Wiley & Sons, 2009

2. Andrew S Tanenbaum, *Modern Operating Systems,* 3/e, Pearson Education, 2007

CS6302 DATABASE SYSTEMS (4–0–0) 4

Entity Relationship model, Relational model – structure and operations, query languages – relational algebra – relational calculus – Mapping ER model to relation form - Features of SQL - Functional Dependencies – normalization process. Multi valued dependencies - Query optimization Transaction processing concepts - Concurrency Control and recovery -Security and Authorization

Reading:

1. Elamsri, Navathe, Somayajulu and Gupta, *Database Concepts*, Pearson Edition, 2006
2. Adhsakkdi Y Raghuram Krishnan and Johannes Gehrke, *Database Management Systems*, 3/e, TMH, 2007.

CS6303 SOFTWARE ENGINEERING PRINCIPLES (4–0–0) 4

The Software Process – Requirements, Specification, Design, Implementation and Maintenance – Cohesion – Data Encapsulation – Reusability – Software Life Cycle – Use-case modeling – Data flow Analysis – Transaction Analysis – 4GL – Coding Standards – Module reuse – Module Testing – CASE tools for integration and Complete Software Process

Reading:

1. Stephen R Schach, *Object Oriented and Classical Software Engineering*, 5/e, TMH, 2010
2. Ian Sommerville, *Software Engineering*, 9/e, Pearson, 2010.

CS6304 OPERATING SYSTEM CONCEPTS LAB (0–0–3) 2

Study of race conditions – Use of semaphores to solve concurrency problems – Implementation of critical region construct, monitor – Comparison of different scheduling algorithms – Implementation of Dekker's algorithm – Implementation of memory manager

CS6305 DATABASE SYSTEMS LAB (0–0–3) 2

Familiarization of Oracle RDBMS - Features of SQL*Plus - Design and development of database using Oracle - implementation of application with GUI - Implementation of relational operators using C/C++ - DSL - Front end development - Case study/project.

CS6306 SOFTWARE ENGINEERING LAB (0–0–3) 2

Problem Analysis and Project Planning – Software Requirement Analysis – Modeling – Software Developments and Debugging – Software Testing

CS6351 ALGORITHM ANALYSIS AND DESIGN (4–0–0) 4

Algorithm Analysis – Asymptotic notation– Greedy method – Divide and conquer – Dynamic programming – example problems in each case of design methods – Sorting Algorithms – Graph Algorithms – Shortest path, search algorithms, Minimum spanning tree – Strings and Pattern matching Algorithms – Backtracking, and Branch and Bound methods - P, NP, NP-hard, NP-complete classes.

Reading:

1. M T Goodrich, Roberto Tamassia, *Algorithm Design,* John Wiley & Sons, 2001

2. Horowitz, Sartaj Sahni, S Rajasekaran, *Computer Algorithms,* 2/e, Silicon Pr., 2007

CS6352 COMPUTER COMMUNICATIONS AND NETWORKING (4–0–0) 4

Network structures – Network Architecture – OSI model – LAN protocols – IEEE standard 802 – Ethernet – Token Bus and Token Ring – Error Detection and Correction – Sliding Window protocols – Routing algorithms – Congestion control algorithms – Internetworking – Network Layer in Internet IP – Transport Layer in Internet – UDP, TCP – Remote Procedure Call – Implementation and semantics of RPC – E-mail Protocol and File Transfer Protocol.

Reading:

1. A. S Tanenbaum, *Computer Networks*, 4/e, PHI, 2003.
2. Larry L Peterson, Bruce S Davis, *Computer Networks*, 5/e, Elsevier, 2012.

CS6353 PRINCIPLES OF DATA WAREHOUSING AND DATA MINING (4–0–0) 4

Data Warehouse vs Databases – KDD Process - Data preprocessing - Data Warehousing and OLAP technologies – Multi Dimensional modeling, data warehouse architecture – Data Mining techniques – Association, Classification, Clustering, Sequential Patterns.

Reading:

1. Jiawei Han and Kamber, M, *Data Mining Concepts and Techniques*, 2/e, Elsevier Publications, 2006.
2. Vipinkumar, Michael Steinbach, *Introduction to Data Mining*, 1/e, Addition-Wesley, 2006.

CS6354 COMPUTER COMMUNICATIONS (0–0–3) 2

AND NETWORKING LAB

Error Correction and Detection – IP address Conversion functions – Client Server example using Pipes, FIFOs, Message Queues, Shared Memory – Connection Oriented Client Server with TCP – Connectionless Client Server with UDP – Concurrent Server – Multi-protocol Server – Internet Super Server – Chat Server – Mail Server.

CS6355 KNOWLEDGE ENGINEERING LAB (0–0–3) 2

This laboratory provides hands on exposure on building of warehouse, analyzing the data using OLAP tools, and implementation of mining techniques using mining tools like SPSS, Weka etc.

CS7301 MOBILE APPLICATIONS DEVELOPMENT (4–0–0) 4

Characteristics of mobile applications, History of mobile application frameworks, Overview of the Android framework, Application models of mobile application frameworks, User-interface design for mobile applications, Managing application data, Integrating with cloud services, Integrating networking, the OS and hardware into mobile, applications, Addressing enterprise requirements in mobile applications: performance, scalability, modifiability, availability and security, Testing methodologies for mobile applications, Publishing, deployment, maintenance, and management

Reading:

1. Valentino Lee, Heather Schneider, and Robbie Schell, *Mobile Applications: Architecture, Design, and Development*, Prentice Hall, 2004
2. Brian Fling, *Mobile Design and Development*, O'Reilly Media,2009.
3. Maximiliano Firtman, "*Programming the Mobile Web*", O'Reilly

Media,2010.

4. Christian Crumlish and Erin Malone, *Designing Social Interfaces*, O'Reilly Media, 2009.
5. Ed Burnett, *Hello, Android. Introducing Google's Mobile Development Platform*, Fourth Edition, Pragmatic Bookshelf, 2015.

CS7302 SOFTWARE TESTING (4–0–0) 4

Introduction, Flow graphs and Path testing, Transaction Flow Testing, Dataflow testing, Domain Testing, Paths, Path products and Regular expressions, Logic Based Testing, Specifications, State, State Graphs and Transition testing ,Graph Matrices and Application

Reading:

1. Baris Beizer, *Software Testing Techniques,* 2/e, Dreamtech, 1990
2. Perry, "*Effective methods of Software Testing"*, John Wiley., 2006

CS7303 MOBILE APPLICATIONS DEVELOPMENT LAB (0-0-3) 2

Configuration of Android Environment and Android Development Tools, Install and Configure Eclipse and SDK, Design and development of User Interfaces, Activity and broadcast life cycle, Implementation of Multimedia, SQLITE database, Telephoning and Messaging, Geocoding and Reverse geocoding, Design and develop mobile applications, Managing mobile applications.

Reading:

1. Jeff McWherter, Scott Gowell, *Professional Mobile Application Development*, John Wiley & Sons, 2012.
2. Muhammad Saif Uddin, Talha Haroon, *IBM Worklight Mobile Application Development Essentials,* Packet Publishing Limited, 2014.

CS7304 SOFTWARE TESTING LAB (0-0-3) 2

Case studies on Different Testing Tools – Simulate Verification and Validation Environment – Implementing the structured system Techniques – Simulate a software testing Suite which performs the functionalities of different Phase testing of SDLC – Using of Testing Tools to carry out the Functional Testing, Load/Stress Testing – Using any automated testing Tools to Automate Testing – Using of Open Source Testing Tools for databases, Web applications and Networks etc.

CS6361 ARTIFICIAL INTELLIGENCE (3-0-0) 3

INTRODUCTION – Agents and Objects – Evaluation of Agents – Agent Design Philosophies - Multi-agent System – Mobile Agents – Agent Communication – Knowledge query and Manipulation Language – Case Study. What is AI?, The Foundations of Artificial Intelligence; - INTELLIGENT AGENTS – Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents; - SOLVING PROBLEMS BY SEARCH – Problem-Solving Agents, Formulating problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Depth-first search, Searching with Partial Information, Informed (Heuristic) Search Strategies, Greedy best-first search, A* Search: Minimizing the total estimated solution cost, Heuristic Functions, Local Search Algorithms and Optimization Problems, Online Search Agents and Unknown Environments; –ADVERSARIAL SEARCH – Games, The minimax algorithm, Optimal decisions in multiplayer games, Alpha-Beta Pruning, Evaluation functions, Cutting off search, Games that Include an Element of Chance; - LOGICAL AGENTS – Knowledge-Based agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic, Reasoning Patterns in Propositional Logic, Resolution, Forward and Backward chaining; - FIRST ORDER LOGIC – Syntax and Semantics of First-Order Logic,

Using First-Order Logic , Knowledge Engineering in First-Order Logic; - INFERENCE IN FIRST ORDER LOGIC – Propositional vs. First-Order Inference, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution ; - UNCERTAINTY – Acting under Uncertainty, Basic Probability Notation, The Axioms of Probability, Inference Using Full Joint Distributions, Independence, Bayes' Rule and its Use, The Wumpus World Revisited; - PROBABILISTIC REASONING – Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distribution, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks; - STATISTICAL LEARNING METHODS – Statistical Learning, Learning with Complete Data, Learning with Hidden Variables: EM Algorithm.

Reading:

1. Stuart Russell, Peter Norvig, *Artificial Intelligence -A Modern Approach*, 3/e, Pearson, 2003.
2. Nils J Nilsson, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann Publications,2000.

CS6362 INFORMATION SYSTEMS MANAGEMENT (3-0-0) 3

Organization and Information Systems**-** Kinds of information systems- System Analysis and Development and Models- Manufacturing and Service Systems - Information systems- Enterprise System- Enterprise Resources Planning- Choice of IT - Nature of IT decision- Security and Ethical Challenges - Ethical responsibilities of Business Professionals.

Reading:

1. Kenneth J Laudon, Jane P.Laudon, *Management Information Systems*, 10/e, Pearson/PHI, 2007
2. W. S. Jawadekar, *Management Information Systems*, 3/e, TMH, 2004

CS6363 INFORMATION SECURITY (3-0-0) 3

Information Security-Security Problems in Databases – Security Controls – Database Security – Security Models – Secure DBMS Design – Design of Secure Databases – Statistical Database Security – Intrusion Detection – Expert systems-based approach – MIDAS – Security Models for next generation Databases – SORION Model

Reading:

1. Silvana Castano, *Database Security*, Addison Wesley and ACM, 1995.
2. Merkov, *Information Security: Principles and Practices*, 1/e, Pearson, 2007.

CS6364 MODELING AND SIMULATION (3-0-0) 3

Probability theory – Discrete and continuous random variables and distributions - Poisson process - Markov chains – Stochastic process - Building blocks of Simulation - Analysis of Simulation results

Reading:

1. Sheldon M. Ross, *Introduction to Probability Models*, 7/e, Academic Press, 2002.
2. Donald E. Knuth, *The Art of Computer Programming – Volume 2: Semi Numerical Algorithms*, 2/e, Addison Wesley, Reading MA, USA , 2000.
3. Louis G Birta and Gilbert Arbez, *Modelling and Simulation: Exploring Dynamic System Behavior*, Springer Publishers, 2010.

CS6365 NETWORK PROGRAMMING (3-0-0) 3

Introduction to Network programming - communication protocols -

OSI protocols - Protocol comparisons- Introduction toTCP/IP- Elementary TCP and UDP sockets-Advanced sockets- IPV4,IPv6 and Network Interfaces-Programming with HTTP for the Internet- E-mail Protocols, FTP, and CGI Programming - Screen-scraping and Other Practical Applications - Web Services - Network Security

Reading:

1. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, *UNIX® Network Programming Volume 1*, Addison Wesley, 2004
2. Brandon Rhodes, John Goerzen, *Foundations of Python Nerwork Programming*, Apress, 2010
3. Dr. M. O. Faruque Sarker, *Python network programming cook book*, Packt Publishing, 2014

CS6366 CLOUD COMPUTING (3-0-0) 3

Introduction to cloud computing-cloud provider-Cloud computing platforms-different cloud technologies-web services, AJAX-Databases in cloud-MAP reduce extensions-Cloud computing and security architecture- Implementing real time issues on cloud platform.

Reading:

1. Anothony T Velte, Toby J Velte, Robert Elsenpeter, *Cloud Computing : A Practical Approach*, MGH, 2010.
2. Gautam Shroff, *Enterprise Cloud Computing*, Cambridge, 2010
3. Ronald Krutz and Russell Dean Vines, *Cloud Security*, 1/e, Wiley, 2010

CS6367 DISTRIBUTED OPERATING SYSTEMS (3-0-0) 3

Introduction to distributed systems – Communication models in distributed systems – Synchronization – Processor allocation –

Scheduling algorithms – Distributed file systems – Distributed shared memory – Case Studies of Distributed systems.

Reading:

1. Andrew S. Tanenbaum, *Distributed Operating Systems*, 2/e, Pearson Education Asia Publishers, 2002.
2. Ajay D. Kshemakalyani, Mukesh Singhal, *Distributed Computing*, Cambridge University Press, 2008

CS6368 UBIQUITOUS COMPUTING (3-0-0) 3

Elements of Ubiquitous computing – Architecture – New devices - Overview of Mobile Technologies - Anatomy of a Mobile Device - Application Design Elements - Mobile Web - Development Environments - Objective-C - The Model-View-Controller Model - The Delegate Pattern - The HTML5, iPhone, Android, & Blackberry SDKs- iOS - Windows Mobile - Celluar networks - Wireless (802.11) - TCP/IP in the mobile setting- The iPhone Human Interface Guidelines- Common User Interface Guidelines - Distributed Computing - Security Issues - Upcoming Technologies - Convergence of Media and Communication Devices

Reading:

1. Stefan Poslad, *Ubiquitous Computing: Smart Devices, Environment and Interactions*, John Wiley & Wiley, 2009.
2. Frank Adelstein, Sandeep K S Gupta, Golden G Richard III and Loren Schwiebert, *Fundamentals of Mobile and Pervasive Computing*, MGH, 2005.
3. T. Mikkonen, *Programming Mobile Devices: An Introduction for Practitioners*, Wiley, 2007.
4. S. Hashimi, S. Komatineni, D. MacLean, *Pro Android 2*, Apress, 2010.

CS6369 IMAGE PROCESSING (3-0-0) 3

Introduction to Image Processing, Image Processing Applications, Image Representation and Modeling, Image Acquisition, Image Enhancement, Image Filtering, Edge Detection, Segmentation, Image Compression, different Image Transformations, Object recognition, Color Image Processing, Wavelets, Texture, Feature Extraction.

Reading:

1. Gonzalez and Woods, *Digital Image Processing,* 3/e, Prentice Hall, 2007.
2. M Sonka et. Al., *Image Processing: Analysis and Machine Vision*, 3/e, Cole Pub. Co., 2008

CS6370 PARALLEL COMPUTING (3-0-0) 3

Parallel Programming plat forms – Parallel Algorithm – Basic Communication Operations – Analytical Modeling of Parallel Programs – Programming using MPI – Matrix, graph and sorting algorithms.

Reading:

1. Ananth Grama, Anshul Gupta and Vipin Kumar, *Introduction to Parallel Computing, 2/e,* Pearson Edition 2009.
2. Michael J Quinn, *Parallel Computing Theory and Practice*, 2/e, TMH, 2002.

CS6371 ADVANCED DATABASE SYSTEMS (3-0-0) 3

Distributed Databases: Query processing- query optimization - Concurrency control, Heterogeneity issues. Advanced Transaction Models: Save-points, Sagas, Nested Transactions, Multi Level Transactions. Recovery: Multi-level recovery, Shared disk systems, Distributed systems 2PC, 3PC, replication and hot spares. Recursive query processing: Top-down and bottom-up evaluation, Magic optimization. Parallel Databases: Parallel Architectures, performance

measures, Data partitioning, Intra-operator parallelism, Pipelining, Scheduling, Load balancing, query optimization.

Readings:

1. M. Stonebraker, *Readings in Database Systems*, 2/e, Morgan Kauffman, 1993.
2. M T Ozsu, Patrick Valduriez, *Principles of Distributed Database Systems*, Prentice Hall, 1999
3. S. Ceri and G. Pelaggati, *Distributed Database System Principles and Systems*, MGH, 1985.

CS6372 E-COMMERCE TECHNOLOGIES AND MANAGEMENT (3-0-0) 3

Overview – E-commerce Infrastructure – Wireless Technology – Web Architecture – Data interchange – Web content delivery – Access Security – Public Key Encryption – Electronic Payment System – Mass Personalization – Search Engines – Data Mining and Privacy – Intelligent Agents – Auction Models

Reading:

1. Kenneth C Louden, *E-Commerce: Business, Technology, Society,* 7/e, PHI, 2011.
2. Turban, *Electronic Commerce 2010: A Managerial Perspective*, 6/e, Pearson, 2010

CS6373 ADVANCED WEB TECHNOLOGIES (3-0-0) 3

HTML5- XML (Extensible Markup Language)- DTDs, Customized Markup Languages, XML parsers- XSL- Web2.0- JQuery, CSS3- Responsive Web Design- Java Server Faces Technologies- RESTFUL Web services- JSON- AJAX- NodeJS- Secure Web Application Development-3D Web Design- Search Engines- Web3.0- Next Generation Web Technologies.

Reading:

1. Eric Van der Vlist, Danny Ayers, Eric Bruchez, Joe Fawcett and Alessandro Vernet, *Professional Web 2.0 Programming*, Wrox Professional, 2006.
2. Deitel, Deitel & Nieto, *Internet and Worldwide Web - How to Program*, 5th Edition, PHI, 2011.
3. Kogent Sol inc, *HTML5 Black Book*, Dreamtech Press. 2010.
4. Andreas Anyuru, *Professional WebGL Programming: Developing 3D Graphics for the Web*, Wrox Professional, 2012.

CS6374 ADVANCED DATA STRUCTURES (3-0-0) 3

Height Balanced Trees - Priority Queues - Amortized Analysis - Binomial Queues - Top down Splay Trees - Red-black Trees - Skip Lists -overview of greedy, divide and conquer, dynamic programming methods, sorting, graph algorithms - Algorithms for parallel computers - Number theory and cryptographic algorithms - String matching - Network flow and routing Algorithms - Internet Algorithms.

Reading:

1. Mark Allen Weiss, *Data Structures and Algorithm Analysis in C++*, 2nd Edition, Pearson, 2004.
2. M T Goodrich, Roberto Tamassia, *Algorithm Design*, John Wiley, 2002.

CS6375 MACHINE LEARNING (3-0-0) 3

Introduction – Well defined learning problems, Designing a Learning System, Issues in Machine Learning; - the concept learning task - General-to-specific ordering of hypotheses, Find-S, List then eliminate algorithm, Candidate elimination algorithm, Inductive bias - decision tree learning - Decision tree learning algorithm-Inductive bias- Issues in Decision tree learning; - artificial neural networks –

Perceptrons, Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of backpropagation rule-Backpropagation Algorithm- Convergence, Generalization; – evaluating hypotheses – Estimating Hypotheses Accuracy, Basics of sampling Theory, Comparing Learning Algorithms; - bayesian learning – Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm; - computational learning theory – Sample Complexity for Finite Hypothesis spaces, Sample Complexity for Infinite Hypothesis spaces, The Mistake Bound Model of Learning; - instance-based learning – k-Nearest Neighbor Learning, Locally Weighted Regression, Kernel Methods - Dual Representations, Constructing Kernels, Radial basis function networks, Gaussian Processes for Regression and Classification; Case-based learning - genetic algorithms – an illustrative example, Hypothesis space search, Genetic Programming, Models of Evolution and Learning; Sparse Kernel Machines- Maximum Margin Classifiers, Multi class svms, reinforcement learning - The Learning Task, Q Learning, Nondeterministic rewards and actions, Temporal difference learning, Generalizing from examples, relationship to Dynamic Programming.

Reading:

1. Tom Mitchell, *Machine Learning*, McGraw Hill International; Edition.
2. Christopher M.Bishop, *Pattern Recognition and Machine Learning*, Springer Publishing.

CS6376 SOFTWARE ARCHITECTURE (3-0-0) 3

Introduction and architectural drivers**,** Introduction –Architecture Standard Definitions – Architectural structures – Influence of software architecture on organization-both business and technical – Architecture Business Cycle- Introduction – Functional requirements – Technical constraints – Quality

Quality Attribute Workshop – Documenting Quality Attributes – Six

part scenarios – Case studies.
Architectural views - 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
Architectural styles - Introduction – Data flow styles – Call-return styles – Shared Information styles – Event styles – Case studies for each style.
Documenting the architecture 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

Reading:

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.
3. 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.
4. Paul Clements, Rick Kazman, and Mark Klein, *Evaluating software architectures: Methods and case studies*, Addison-Wesley, 2001.
5. Rajkumar Buyya, James Broberg, and Andrzej Goscinski, *Cloud Computing. Principles and Paradigms*, John Wiley & Sons, 2011

CS6377 RANDOMIZED ALGORITHMS (3-0-0) 3

Las Vegas and Monte Carlo Algorithms, Computational Model and Complexity Classes, Game Tree Evaluation, The Markov and

Chebyshev's Inequality, The Stable Marriage Problem, The Coupon Collectors Problem, The Chernoff Bound, Routing in a Parallel Computer, The Probabilistic Method: Overview, probablistic analysis, use of indicator random variables, Randomly permuting arrays, Birthday paradox, analysis using indicator random variables, Balls and bins, Streaks, Online hiring problem, Maximum Satisfiability, Expanding Graphs, The Lovasz Local Lemma, Markov Chains, Random Walks on Graphs, Graph Connectivity, Expanders and Rapidly Mixing Random Walks, Pattern Matching, Random Treaps, Skip Lists, Hash Tables, Linear Programming, The Min-Cut Problem, Minimum Spanning Trees, The DNF Counting Problem, The Online approximations paging Problem, Adversary Models and Paging against an Oblivious Adversary, Randomized number theoretic and algebraic algorithms

Reading:

1. Rajeev Motwani and Prabhakar Raghavan, *Randomized Algorithms*, Cambridge University Press, 1995.
2. J. Hromkovic, *Design and Analysis of Randomized Algorithms*, Springer, 2005.

CS6378 USER INTERFACE DESIGN (3-0-0) 3

The Importance of the User Interface, Usability of Interactive Systems: Guidelines, Principles, and Theories, Characteristics of Graphical and Web User Interfaces: The Graphical User Interface, The Web User Interface, Development Processes: Managing Design Processes, Evaluating Interface Designs, Software Tools, Interaction Styles: Direct Manipulation and Virtual Environments, Menu Selection, Form Filling, and Dialog Boxes, Command and Natural Languages, Interaction Devices, Collaboration.
Design Issues: Quality of Service, Balancing Function and Fashion, User Manuals, Online Help, and Tutorials, Information Search and Visualization

Reading:

1. Ben Sheiderman, *Design The User Interface*, Pearson Education, 1998.
2. Wilbent. O. Galitz ,*The Essential Guide To User Interface Design*, John Wiley& Sons, 2001.

CS7371 DIGITAL FORENSICS (3-0-0) 3

Introduction to computer forensics, Legal systems, Types of computer forensics evidence, Acquiring evidence in computer forensics, Website evidence, online crime, capturing online communications, crime scene examinations, Network analyzer, Expert witness, Evidence admissibility, Network forensics, Advanced persistent threats, Investigating a network attack, Mobile forensics, Digital photography, Cloud forensics and legal concerns.

Reading:

1. John Sammons, *The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics*, Second Edition, Elsevier, 2015.
2. Darren R. Hayes, *A Practical Guide to Computer Forensics Investigations*, Pearson Education, Inc., 2015.
3. Edward Wilding, *Computer Evidence: a Forensic Investigations Handbook*, Sweet & Maxwell, 1996.

CS7372 INTERNET OF THINGS (3-0-0) 3

Internet of Things (IoT) frameworks and applications, IoT Standards, Smart Environments, Communication capabilities and Device Intelligence, Sensor and RFID Technology, Wireless Technologies for IoT, Zigbee/IEEE 802.15.4, IEEE 802.15.6 WBANs, Comparison of WPAN technologies, Mobile IPv6 for IoT, Machine-to-Mechine communication models, Service Discovery in IoT, Service oriented Middleware, Resource management in IoT, Web of Things, Sensor Web, Crowd sourcing, Securing Internet of Things: vulnerabilities and

attacks.

Reading:

1. Daniel Minoli, *Building The Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications*, John Wiley & Sons, 2013.
2. Dieter Uckelmann, Mark Harrison and Florian Michahelles, *Architecting the Internet of Things*, Springer, 2011.
3. Nik Bessis and Ciprian Dobre, *Big Data and Internet of Things: A Roadmap for Smart Environments*, Springer, 2014.
4. Giancarlo Fortino and Paolo Trunfio, *Internet of Things Based on Smart Objects-Technology, Middleware and Applications*, Springer, 2014.

CS7373 HUMAN COMPUTER INTERACTION (3-0-0) 3

HCI foundations- Input–output channels, Human memory, Thinking: reasoning and problem solving, Emotion, Individual differences, Psychology and the design of interactive systems, Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning Designing- Programming Interactive systems- Models of interaction, Frameworks and HCI, Ergonomics, Interaction styles, Elements of the WIMP interface, The context of the interaction, Experience, engagement and fun, Paradigms for interaction, Cantered design and testing- Interaction design basics-The process of design, User focus, Scenarios, Navigation design, Screen design and layout, Iteration and prototyping, Design for non-Mouse interfaces, HCI in the software process, Iterative design and prototyping, Design rules, Principles to support usability, Standards and Guidelines, Golden rules and heuristics, HCI patterns Implementation support - Elements of windowing systems, Programming the application, Using toolkits. User interface management systems, Evaluation techniques,

Evaluation through expert analysis, Evaluation through user participation, Universal design, User support Models and Theories - Cognitive models, Goal and task hierarchies, Linguistic models, The challenge of display-based systems, Physical and device models, Cognitive architectures. Collaboration and communication - Face-to-face communication, Conversation, Text-based communication, Group working, Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design Human factors and security - Groupware, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware Implementing synchronous groupware, Mixed, Augmented and Virtual Reality.

Reading:

1. A Dix, Janet Finlay, G D Abowd, R Beale., *Human-Computer Interaction*, 3rd Edition, Pearson Publishers,2008.
2. Shneiderman, Plaisant, Cohen and Jacobs, *Designing the User Interface: Strategies for Effective Human Computer Interaction*, 5th Edition, Pearson Publishers, 2010.

CS7374 DESIGN PATTERNS (3-0-0) 3

Introduction to Patterns and UML, Software Design Patterns from GoF, Creational Patterns, Structural Patterns, Behavioral Patterns, Software Architectural Patterns, Layer, Pipe and Filters and Black Board, Broker, Reflection and Microkernel.

Reading:

1. Erich Gamma*, Design Patterns,* Addison-Wesley, 1994
2. Frank Buschmann, Regine Meunier, Hans Rohnert, Peter Sommerlad, Michael Stal, *Pattern-Oriented Software Architecture: A System of Pattern,* John Wiley & Sons; 1996.

CS7375 BIG DATA TECHNOLOGIES (3-0-0) 3

Overview of Big Data, Stages of analytical evolution, State of the Practice in Analytics, The Data Scientist, Big Data Analytics in Industry Verticals, Data Analytics Lifecycle, Operationalizing Basic Data Analytic Methods Using R, Advanced Analytics - Analytics for Unstructured Data - Map Reduce and Hadoop, The Hadoop Ecosystem, In - database Analytics, Data Visualization Techniques, Stream Computing Challenges, Systems architecture, Main memory data management techniques, Energy - efficient data processing, Benchmarking, Security and Privacy, Failover and reliability.

Reading:

1. Bill Franks, *Taming The Big Data Tidal Wave*, 1st Edition, Wiley, 2012.
2. Frank J. Ohlhorst, *Big Data Analytics*,1st Edition, Wiley, 2012.

CS7376 BIOINFORMATICS (3-0-0) 3

Introduction to Bioinformatics: What is a Data Base?, Types of Databases, Biological Databases, Pitfalls of Biological Databases, Information Retrieval from Biological Databases, Pair wise Sequence Alignment: Evolutionary Basics, Sequence homology versus similarity, Sequence similarity versus Identity, Scoring Matrices, Statistical Significance of Sequence alignment, Database similarity searching: Unique requirement of Database searching, Heuristic Database searching. Basic alignment search tool: Comparison of FASTA and BLAST, Multiple Sequence Alignment, Scoring Function, Exhaustive Algorithms, Heuristic Algorithms, Gene Prediction, Categories of gene prediction programs, Gene prediction in prokaryotes and Eukaryotes, Phylogenetics Basics Molecular phylogenetics and molecular basics Gene phylogeny versus species phylogeny, Forms of tree representation, Why finding a true tree is difficult, Phylogenetic tree construction methods and programs Protein structure basics: Amino acid, peptide formation, Dihedral Angles, Hierarchy, Secondary structures, Tertiary

structure, Determination of protein 3-D structure, Protein structure data base, Genome mapping, assembly and comparison, Genome mapping, Genome sequencing, Genome sequence assembly, Genome Annotation, Comparative genomics, Functional Genomics, Sequence based approaches, Microarray based approaches, Comparisons of SAGE and DNA microarray.

Reading:

1. Jin Xiong, *Essential Bioinformatics*, 1st Edition, Cambridge University Press, 2011.
2. Arthur M Lesk, *Introduction to Bioinformatics*, 2nd Edition, Oxford University Press, 2007.

CS7377 ERP AND SUPPLY CHAIN MANAGEMENT (3-0-0) 3

Strategizing ERP - Customer Relationship Management - ERP implementation - Product life cycle management- Introduction to Supply Chain Management - Supply chain process management - policy management - quality and deployment - modeling the strategic supply chain - Decision science models for supply chain excellence.

Reading:

1. Christian N Madu, *ERP and Supply Chain Management,* Chi Publishers, 2005.
2. Marianne Bradford, *Modern ERP: Select, Implement and Use Today's Advanced Business Systems*, Lulu Press Inc., 2/e, 2010.

CS7378 WEB ANALYTICS (3-0-0) 3

Web Analytics Fundamentals - Capturing Data - Monitoring Web Usability - Clickstream Analysis - Website Traffic Analysis- Search and Keyword Analysis- Audience Identification and Segmentation Analysis- Web Analytics Tools.

Reading:

1. Avinash Koushik, *Web Analytics: An Hour A Day*, Wiley Publications, 2007.
2. Avinash Koushik, *Web Analytics 2.0: The art of online accountability& Science of Customer Centricity*, Wiley Publications, 2010.
3. Justin Curtroni, *Google Analytics*, O'reilly Media, 1st Edition, 2010.
4. Pedro Sostre and Jennifer LeClaire, *Web Analytics for Dummies*, Wiley, 1st Edition 2007.

CS7379 ALGORITHMIC GRAPH THEORY (3-0-0) 3

Introduction, Degree sequences, Havel–Hakimi algorithm, Erdös-Gallai theorem, Cheriton-Tarjan algorithm for minimum spanning tree, Connectivity, Blocks, Algorithms for finding the blocks of a graph, Matching, Hungarian algorithm for maximum matching, Perfect matchings and 1-factorizations, Network flows, Ford-Fulkerson algorithm, Matchings and flows, Hamiltonian cycle, Euler cycle, Chinese postman problem, Strong components, Tournaments, 2-Satisfiability, Perfect graphs, Greedy graph coloring algorithm, Some special classes of graphs, Algorithms for recognition of chordal graphs, Unit disk graphs, Dominating sets, Complexity of dominating and connected dominating sets, Algorithms for dominating sets, Hardness of some graph problems, Algorithms for independent sets and cliques, Random graphs, Social network models.

Reading:

1. Martin Charles Golumbic, *Algorithmic Graph Theory and Perfect Graphs*, Academic Press, 1980.
2. M.E.J. Newman, *Networks: An Introduction*, Oxford University Press, 2010.
3. Teresa W. Haynes, Stephen T. Hedetniemi and Peter J. Slater, *Fundamentals of Domination in Graphs*, Marcel

Dekker, Inc., 1998.
4. William Kocay and Donald L. Kreher, *Graphs, Algorithms, and Optimization*, CRC Press, 2005.

CS7380 FOUNDATIONS OF CRYPTOGRAPHY (3-0-0) 3

Number Theory – Divisibility, Congruences, Quadratic residues and residuacity, Abstract Algebra – Groups, rings, fields, construction of finite fields, cryptography, Stream Ciphers – One-time Pad (OTP), Perfect secrecy, Pesudo-random generators (PRG), Attacks on stream ciphers and OTP, Real world stream ciphers, Semantic security, Block ciphers- DES, attacks, AES, Block ciphers from PRG, Modes of operation – one-time key and many-time keys, CBC, CTR modes, Message Integrity – MAC, MAC based on PRF, NMAC, PMAC, Collision resistance – Birthday attack, Merkele-Damgard construction, HMC, Case study:SHA-256, Authenticated encryption, Key exchange algorithms, Public key cryptosystems – RSA, ElGamal, Rabin, Elliptic curve cryptosystems – PKC, key exchange, IBE, Lattice based cryptosystem.

Reading:

1. N. Koblitz, *Number Theory and Cryptography*, Springer, 2001
2. J. Katz and Y. Lindell, *Introduction to Modern Cryptography*, CRC press, 2008.
3. Menezes, et.al, *Handbook of Applied Cryptography*, CRC Press, 2004.
4. Golreich O, *Foundations of Cryptography*, Vol. 2, Cambridge University Press, 2004.

CS7381 FOUNDATIONS OF DATA SCIENCE (3-0-0) 3

Overview of Random variables and distributions, Statistical learning, Assessing Model Accuracy, Descriptive statistics, Dependent and

independent events.
Linear Regression: Simple and multiple linear regressions, Comparison of Linear regression with K-nearest neighbors.
Simple Hypothesis Testing, Student's t-test, paired t and U test, correlation and covariance, tests for association
Classification: Linear and Logistic Regression, LDA and comparison of classification methods
Graphical Analysis: Histograms and frequency polygons, Box-plots, Quartiles, Scatter Plots, Heat Maps
Programming for basic computational methods such as Eigen values and Eigen vectors, sparse matrices, QR and SVD, Interpolation by divided differences.
Data Wrangling: Data Acquisition, Data Formats, Imputation, The split-apply-combine paradigm.
Descriptive Analytics: Data Warehousing and OLAP, Data Summarization, Data de-duplication, Data Visualization using CUBEs

Reading:

1. Gareth James Daniela Witten Trevor Hastie, Robert Tibshirani, *An Introduction to Statistical Learning with Applications in R*, February 11, 2013, web link: www.statlearning.com (1 to 4 chapters)
2. Mark Gardener, *Beginning R The statistical Programming Language*, Wiley, 2015.
3. Han, Kamber, and J Pei, *Data Mining Concepts and Techniques*, 3rd edition, Morgan Kaufman, 2012. (Chapter 2 and Chapter 4)

CS7382 NETWORK SECURITY (3-0-0) 3

Introduction to network security and associated techniques- Cryptography - Security issues in Internet protocols: TCP, DNS, and routing - Network defense tools: Firewalls, VPNs, Intrusion detection, and filters - Standards : Kerboros v4 Kerboros v5, PKI, IPsec AH ESP ,IPsec IKE, SSL/TLS, S/MIME and PGP

Reading:

1. Charlie Kaufman, Radia Perlman, Mike Speciner, *Network Security: Private Communication in a Public World*, Prentice Hall, 2002

CS7383 GAMES OF STRATEGY (3-0-0) 3

Noncooperative Game Theory: Games in Normal Form - Preferences and utility, examples of normal-form, Analyzing games: Pareto optimality, Nash equilibrium, Maxmin and minmax strategies, dominated strategies, Rationalizability, Correlated equilibrium

Computing Solution Concepts of Normal-Form Games: Computing Nash equilibria of two-player, zero-sum games, Computing Nash equilibria of two-player, general-sum games, Complexity of computing Nash equilibrium, Lemke–Howson algorithm, Searching the space of supports, Computing Nash equilibria of n-player, general-sum games, Computing maxmin and minmax strategies for two-player, general-sum games, Computing correlated equilibria

Games with the Extensive Form: Perfect-information extensive-form games, Subgame-perfect equilibrium, Computing equilibria, Imperfect-information extensive-form games, Sequential equilibrium

Other Representations: Repeated games: Finitely repeated games, Infinitely repeated games, automata, Stochastic gamesBayesian games: Computing equilibria

Coalitional Game Theory: Transferable Utility, Analyzing Coalitional Games, The Shapley Value, The Core

Mechanism Design: strategic voting, unrestricted preferences, Implementation, quasilinear setting, Efficient mechanisms,

Computational applications of mechanism design, Task scheduling, Bandwidth allocation in computer networks
Auctions: Single-good auctions, Canonical auction families, Bayesian mechanisms, Multiunit auctions, Combinatorial auctions,

Readings:

1. Nisan, N., T. Roughgarden, E. Tardos, and V. Vazirani (Eds.), *Algorithmic Game Theory*, Cambridge University Press, 2007.
2. Shoham, Y. and Leyton–Brown, K., *Multiagent Systems: Algorithmic, Game Theoretic, and Logical Foundations*, Cambridge University Press, 2008.
3. Osborne, M. J., and Rubinstein, A., *A Course in Game Theory*, Cambridge, MA: MIT Press, 1994.