Master of Technology
COMPUTER SCIENCE AND ENGINEERING

CURRICULUM AND SYLLABUS
(2019)

DEPARTMENT OF COMPUTER SCIENCE ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015, INDIA.

M. Tech. (CSE) – Curriculum (NITTPGCSE19)

Semester-wise Curriculum

M.Tech (CSE)

Semester 1

Course Code	Type	Course name	L	T	P	C
CS601	PC	Mathematical Concepts of Computer Science	3	0	0	3
CS603	PC	Advanced Data Structures and Algorithms	3	0	0	3
CS605	PC	High Performance Computer Architecture	3	0	0	3
E1	PE	Elective 1	3	0	0	3
E2	PE	Elective 2	3	0	0	3
E3	PE	Elective 3	3	0	0	3
CS607	ELR	Advanced Programming lab	0	0	3	2
CS609	ELR	Computer System Design lab	0	0	3	2
Total						22

Semester 2

Course Code	Type	Course name	L	T	P	C
CS602	PC	Service Oriented Architecture & Web Security	3	0	0	3
CS604	PC	Advanced Databases	3	0	0	3
CS606	PC	Advances in Operating Systems	3	0	0	3
E4	PE	Elective 4	3	0	0	3
E5	PE	Elective 5	3	0	0	3
E6	PE	Elective 6	3	0	0	3
CS608	ELR	DBMS lab	0	0	3	2
						20

Semester 3

Course Code	Type	Course name	L	T	P	C
CS639		Project Work- Phase I	0	0	0	12
						12

Semester 4

Course Code	Type	Course name	L	T	P	C
CS640		Project Work- Phase II	0	0	0	12
						12

Programme Electives

Course Code	Course name	L	T	P	C
CS610	Advanced Network Principles and Protocols	3	0	0	3
CS611	Advanced Cryptography	3	0	0	3
CS612	Network Security	3	0	0	3
CS613	Wireless sensor networks	3	0	0	3
CS614	Software Design Architectures	3	0	0	3
CS615	Mobile Network systems	3	0	0	3
CS616	Cloud computing principles	3	0	0	3
CS617	Cloud Security	3	0	0	3
CS618	Design and Analysis of Parallel Algorithms	3	0	0	3
CS619	Statistical Natural language processing	3	0	0	3
CS620	Social network mining and analysis	3	0	0	3
CS621	Computational geometry	3	0	0	3
CS622	Database Tuning and administration	3	0	0	3
CS623	Big Data analytics and mining	3	0	0	3
CS624	Models of Computation	3	0	0	3
CS625	Cognitive Science	3	0	0	3
CS626	Internet of Things	3	0	0	3
CS627	Image and Video Analytics	3	0	0	3
CS628	Information Visualization	3	0	0	3
CS629	Knowledge management	3	0	0	3
CS630	Text Mining	3	0	0	3
CS631	Digital & Cyber Forensics	3	0	0	3
CS632	Principles of Machine Learning & Deep Learning	3	0	0	3
CS633	Multimedia Presentation And Coding Techniques	3	0	0	3
CS634	Principles of Datawarehousing and Datamining	3	0	0	3
CS635	Hardware Security	3	0	0	3
CS636	Advanced Digital Design	3	0	0	3
CS637	Real Time systems	3	0	0	3
CS638	Smart phone Computing	3	0	0	3

First Semester

Course Code	:	**CS601**
Course Title	:	**Mathematical Foundations for Computer Science**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PC**

Course Objectives

- Study the fundamental concepts of logic, abstract algebra, linear algebra, probability and statistics, graph theory etc.

Course Content

Unit I Introduction

Functional Logic: Proposition Logic, Resolution Proof system, Predicate logic. Congruences, Fermat's theorem, Euler function, Chinese remainder theorem.

Unit II Linear Algebra

Groups, homomorphism theorems, cosets and normal subgroups, Lagrange's theorem, Ring. Field. Linear algebra: Vector Space, Basis, Matrices and Linear Transformations, Eigen values, Orthogonality.

Unit III Probability

Counting, Probability, Discrete random variable, Continuous random variable, Moment generating function, Markov's inequality, Chebyshev's inequality, The geometric and binomial distributions, The tail of the binomial distribution.

Unit IV Graph Theory

Graphs, Euler tours, planar graphs, Hamiltonian graphs, Euler's formula, applications of Kuratowski's theorem.

Unit V Graph Applications

Graph colouring, chromatic polynomials, trees, weighted trees, the max-flow min-cut theorem. Matching, halls marriage problem. Independent set, Dominating set, Vertex cover, clique.

Course Outcomes

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

- Be able to comprehend the fundamental methods of logic, number theory and algebra.
- Be able to comprehend the fundamental methods of combinatorics, probability and graph theory. Use basic combinatorics in graph theory and to obtain probabilities.
- Be conversant with the Mathematical Rigor that is necessary for computer science and be able to come up with rigorous arguments.

Text Books

1. *Kenneth H.Rosen, 'Discrete Mathematics and its Applications', McGraw Hill, Seventh Edition, 2012 (Indian Adaptation by Kamala Krithivasan, IIT Madras).*
2. *I.N.Herstein, Topics in Algebra.JOHN Wiley & SONS. 1990.*

Reference Books

1. *Sheldon M. Ross, Introduction to Probability Models, Elsevier.*
2. *G. Chartrand and P. Zhang, Introduction to Graph Theory, McGraw-Hill Companies.*
3. *Linear Algebra 2nd Edition (Paperback) by Kenneth Hoffman, Ray Kunze, PHI Learning, 2009*
4. *Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, second edition, Tata McGraw Hill, 2011*

Course Code	:	**CS603**
Course Title	:	**Advanced Data Structures and Algorithms**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PC**

Course Objectives

- To introduce and practice advanced algorithms and programming techniques necessary for developing sophisticated computer application programs
- To get accustomed with various programming constructs such as divide-and-conquer, backtracking, and dynamic programming.
- To understand and use various data structures in applications
- To learn new techniques for solving specific problems more efficiently and for analyzing space and time requirements.

Course Content

Unit I Analysis Of Algorithms

Review of order of growth of functions, recurrences, probability distributions, Average case analysis of algorithms, Randomized Algorithms – Analysis - NP – Complete and NP – Hard Problems – Amortized Analysis

Unit II Heaps

Min Heap – Min-max Heaps – Deaps – Leftist heaps – Skew leftist heaps – Binomial Heaps – Lazy binomial heaps – Fibonacci Heaps.

Unit III Trees

AVL Trees – Red-Black Trees – Splay Trees - B trees - Multi-way search trees –Tries

Unit IV Advanced Tree Structures

Point – trees – Quad trees - K-d trees – TV- trees – Segment trees – Static and Dynamic

Unit V Geometric Algorithms

Geometric algorithms – line segment intersection – Map overlay detection – Voronoi diagram

Course Outcomes

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

- Familiarize with algorithmic techniques such as brute force, greedy, and divide and conquer.
- Apply advanced abstract data type (ADT) and data structures in solving real world problems.
- Analyze and apply graph data structure to real-life problems
- Effectively combine fundamental data structures and algorithmic techniques in building a complete algorithmic solution to a given problem

Text Books

1. *H. S. Wilf, Algorithms and complexity, Prentice hall.*
2. *T. H. Cormen, C. E. Leiserson, R. L. Rivest, Introduction to Algorithms, Prentice hall.*

Course Code	:	**CS605**
Course Title	:	**High Performance Computer Architecture**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PC**

Course Objectives

- To understand the basics of high performance computer architecture.
- To understand the concept of parallel execution within computer systems through modern parallel architectures.
- To assess the communication and computing possibilities of high performance computing architecture and to predict the performance of parallel applications.
- To understand the concept memory allocation and management in high performance computer.
- To gain knowledge about the real world high performance processors.

Course Content

Unit – I Fundamentals of Computer Design Defining

Computer Architecture – Trends in Technology – Trends in Power in Integrated Circuits – Trends in Cost – Dependability – Measuring, Reporting and Summarizing Performance – Quantitative Principles of Computer Design – Basic and Intermediate concepts of pipelining – Pipeline Hazards – Pipelining Implementation issues.

Unit – II Instruction-Level Parallelism and Its Exploitation Instruction-Level Parallelism:

Concepts and Challenges – Basic Compiler Techniques for Exposing ILP – Reducing Branch Costs with Prediction – Overcoming Data Hazards with Dynamic Scheduling – Dynamic Scheduling: Algorithm and Examples – Hardware-Based Speculation – Exploiting ILP Using Multiple Issue and Static Scheduling – Exploiting ILP Using Dynamic Scheduling, Multiple Issue and Speculation – Studies of the Limitations of ILP – Limitations on ILP for Realizable Processors – Hardware versus Software Speculation – Using ILP Support to Exploit Thread-Level Parallelism

Unit – III Data-Level and Thread-Level Parallelism

Vector Architecture – SIMD Instruction Set Extensions for Multimedia – Graphics Processing Units – Detecting and Enhancing Loop-Level Parallelism – Centralized Shared-Memory Architectures – Performance of Shared-Memory Multiprocessors – Distributed Shared Memory and Directory Based Coherence – Basics of Synchronization – Models of Memory Consistency – Programming Models and Workloads for Warehouse-Scale Computers – Computer Architecture of Warehouse-Scale Computers – Physical Infrastructure and Costs of Warehouse-Scale Computers- Domain- Specific Architecture – Introduction- Guidelines for DSAs - Example Domains - Cross-Cutting Issues- CPUs Versus GPUs Versus DNN Accelerators.

Unit – IV Memory Hierarchy Design Cache

Performance – Six Basic Cache Optimizations – Virtual Memory – Protection and Examples of Virtual Memory – Ten Advanced Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – The Design of Memory Hierarchies

Unit – V Storage Systems & Case Studies

Advanced Topics in Disk Storage – Definition and Examples of Real Faults and Failures – I/O Performance, Reliability Measures and Benchmarks – Designing and Evaluating an I/O System – The Internet Archive Cluster Case Studies / Lab Exercises: INTEL i3, i5, i7 processor cores, NVIDIA GPUs, AMD, ARM processor cores – Simulators – GEM5, CACTI, SIMICS, Multi2sim and INTEL Software development tools.

Course Outcomes

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

- Accustom with the representation of data, addressing modes, and instructions sets.
- Understand parallelism both in terms of a single processor and multiple processors

- Gain Technical knowledge of parallel hardware constructs to include instruction-level parallelism for multi core processor design
- Analyze the way data are stored in memory.
- Understand new architectures of various new generation processors.

Text Books

1. *David.A.Patterson, John L.Hennessy, "Computer Architecture: A Quantitative approach", Elsevier, 6th Edition 2019.*
2. *K.Hwang, NareshJotwani, "Advanced Computer Architecture, Parallelism, Scalability, Programmability", Tata McGraw Hill, 2 nd Edition 2010.*

Reference Books

1. *An Introduction to Parallel Programming, Peter S. Pacheco, 2011, 1st Edition, Morgan Kaufmann Publishers,Print Book ISBN:9780123742605 eBook ISBN:9780080921440*
2. *An Introduction to General-Purpose GPU Programming, Jason Sanders and Edward Kandrot, 2011, 1stEdition, Addison-Wesley Professional, ISBN-13: 9780131387683*

Course Code	:	**CS607**
Course Title	:	**Advanced Programming Laboratory**
Number of Credits	:	**0-0-3-2**
Prerequisites (Course code)	:	
Course Type	:	**ELR**

Course Objectives

- To explore the features of object oriented programming.
- To focus programming rather on programming language.
- To understand the OS internals.

Exercises

1. Exercises using Linux tools – Grep, awk, tr
2. Exercises using system calls
3. Exercises in Python
4. Exercises in C++/ Java

Course Outcomes
Upon completion of this course, the students will be able to:

- develop shell scripts for various applications.
- Gain knowledge about OS internals.
- Understand Object oriented concepts and developing software modules.

Text Books

1. *Arnold Robbins, Nelson H. F. Beebe, Classic Shell Scripting, O'Reilly Media 2005*
2. *H. Schildt Java: The Complete Reference, Eighth Edition, McGraw-Hill Education (India) Pvt. Limited, 2011.*
3. *H. Schildt C++: The Complete Reference, Fourth Edition, McGraw-Hill Education (India) Pvt Limited, 2003.*
4. *Mark Lutz Learning Python, 3rd Edition, O'Reilly Media, 2007*

Course Code		**CS609**
Course Title		**Computer Systems Design Laboratory**
Number of Credits		**0 – 0 – 3 – 2**
Prequisites(Course code)		
Course Type		**ELR**

Course Objective

- To understand the functionality of the various modules of a computer system.
- To build computer systems from components.

Exercises

1. Comparative study of motherboards from INTEL, AMD and ARM with focus on performance.
2. Study of GPUs using NVIDIA boards.
3. Study of memory sub systems with focus on performance.
4. Study of Reconfigurable hardware using FPGA boards.
5. Study of display cards, RAM, Sound cards, disk and I/o interfaces
6. Understanding BIOS and CMOS settings.

MBED

1. Blinking of Onboard LEDS alternatively
2. Blinking of Onboard LED sin specified order
3. Switching between Hexa and Decade counters
4. Hexadecimal counter using Ticker and Time Out
5. Display 0 to 9 in7-Segment Display infinitely
6. Display 0 to 99 in7-Segment Display infinitely
7. Generate a given waveform
8. Generate a given waveform

RASPBERRYPI

1. Install RaspberryPi Osin pen drive and boot successfully.
2. Install apache and PHP packages in RaspberryPi and host a web page using PHP
3. Change the brightness of external LED using GPIO pins of RaspberryPi Board

Zybo

1. Controlling onboard LEDs using DIP switches
2. Implementing hexadecimal counter.

IoT KIT

1. Read and display temperature and humidity using Scientech IoT Kit
2. Controlling on bard LEDs of Scientech IoT depending on room temperature and humidity

Course Outcome

Upon completion of the course, the students will be able to:

- Build computer systems from components for various specifications.
- Gain knowledge on the architecture of the computer systems.

Text Books

1. *R. Kelly Campbell, "Introduction to Computer Hardware Lab Manual" Kendall Hunt, 1st Edition, 2010.*
2. *Michael Meyers, Lloyd Jeffries, "Mike Meyers' A Guide to PC Hardware", McGraw Hill Professional, 2004.*

Second Semester

Course Code	:	**CS602**
Course Title	:	**Service Oriented Architecture And Web Security**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PC**

Course Objectives

- To understand the basic concepts and the foundations of the Web.
- To apply the concept of web services in application development.
- To relate to the cryptography concepts on the web.
- To illustrate various web security concepts.
- To introduce Security solutions in XML and Web Services and to introduce Security standards for Web Services

Course Content

Unit 1: Web Service Architecture

Web Service Architecture, XML Technologies, Service Description: WSDL, Service Discovery: UDDI, Service Transport, Security Considerations

Unit 2: Web Services Technologies

Web Services Technologies - JAX-RPC, JAX-WS. Service Orchestration and Choreography – Composition Standards - Service Oriented Analysis and Design, BPEL

Unit 3: Basics Of Cryptography

Basics of Cryptography, Symmetric key Encipherment, Asymmetric key Encipherment

Unit 4: Integrity And Authentication

Message Integrity and authentication, Cryptographic hash functions, Digital signature, Entity authentication, Key management

Unit 5: Security

Security at the application layer, Transport layer, Network layer, Principles in Practice and System Security

Course Outcomes

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

- Apply Security Concepts for Web applications.
- Develop web applications using web services.
- Interpret Web Security Infrastructure.
- Differentiate between Network and Web Security

TEXTBOOKS

1. *Thomas Erl, " Service Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005*
2. *Cryptography & Network Security, Behrouz A. Forouzan, McGraw-Hill, Inc. New York, NY, USA, 2008.*

REFERENCES

1. *Web Services: An Introduction, B V Kumar, S V Subramanya, Tata McGRAW Hill, 2008*
2. *Web Application Security, By: Bryan Sullivan; Vincent Liu, Publisher: McGraw-Hill, 2011*
3. *Web Services Essentials, By: Ethan Cerami, Publisher: O'Reilly Media, Inc., 2002*
4. *Web Security and Commerce, By: Simson Garfinkel; Gene Spafford, Publisher: O'Reilly Media, Inc., 2001*
5. *Web Commerce Security Design and Development, By: Hadi Nahari; Ronald L. Krutz Publisher: John Wiley & Sons, 2011.*

Course Code	:	**CS604**
Course Title	:	**Advanced Databases**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PC**

Course Objectives

- To understand the basic concepts and terminology related to DBMS and Relational Database Design
- To the design and implement Distributed Databases.
- To understand advanced DBMS techniques like parallel and Main- memory databases
- To understand the concept of transaction management in the database

Course Content

Unit I Introduction

Evaluation of relational algebra expressions, query equivalence, join strategies, query optimization algorithms, Formal review of relational database and FDs Implication, Closure, its correctness

Unit II Locking And Concurrency Control

Correctness of interleaved execution, Locking and management of locks, Two Phase Locking, deadlocks, multiple level granularity, Concurrency Control on B+ trees, Optimistic Concurrency Control

Unit III Timestamp Based Techniques

Timestamp based techniques, Multiversion approaches, Comparison of Concurrency Control methods, dynamic databases, Failure classification, recovery algorithm, XML and relational databases

Unit IV Query Optimization

Query Optimization, Rule-Based Query Optimization using the Volcano Framework, Adaptive Query processing

Unit V Databases

Main-Memory Databases, Parallel and Distributed Databases, Massively Parallel Data Management Systems, Streaming Data and Reactive Applications

Course Outcomes

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

- Write complex queries including full outer joins, self-join, sub queries, and set theoretic queries.
- Know about the file organization, Query Optimization,
- Know about the Transaction management, and database administration techniques
- Work with Main –memory Databases and Data Streams

Text Books

1. *R. Elmasri and S. B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education / Addison Wesley, 2016.*
2. *R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw Hill, 2004*
3. *A. Silberschatz, Henry F. Korth, and S. Sudharshan, "Database System Concepts", 6th Ed., McGraw Hill, 2010.*

Reference Books

1. *K. V. Iyer, Lecture notes available as PDF file for classroom use*

Course Code	:	**CS606**
Course Title	:	**Advances in Operating Systems**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	

Course Objectives

- To study the characteristics of OS for Multiprocessor and Multicomputer.
- To learn the issues related to designing OS for a distributed system.
- To learn the latest trends in building Mobile OS.
- To explore the various issues related to the networks
- To discuss the role of OS in embedded systems

Course Content

UNIT-I Multiprocessor Operating Systems

Multiprocessor Operating Systems: System Architectures- Structures of OS – OS design issues – Process synchronization – Process Scheduling and Allocation- memory management.

UNIT-II Distributed Operating Systems

Distributed Operating Systems: System Architectures- Design issues – Communication models – clock synchronization – mutual exclusion – election algorithms- Distributed Deadlock detection

UNIT-III Distributed Scheduling

Distributed scheduling - Distributed shared memory - Distributed File system – Multimedia file systems - File placement - Caching

UNIT-IV Mobile Operating Systems

Mobile Operating Systems: ARM and Intel architectures - Power Management - Mobile OS Architectures - Underlying OS - Kernel structure and native level programming - Runtime issues- Approaches to power management

UNIT-V Os Issues

OS issues related to the Internet, intranets, Data centers, pervasive computing, embedded systems, Cloud and IoT .

Course Outcomes

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

- Acquire knowledge about advanced concepts in OS
- Develop OS for distributed systems
- Develop modules for mobile devices
- Design and develop OS for networking

Text Books

1. *M Singhal and NG Shivaratri , Advanced Concepts in Operating Systems, Tata McGraw Hill Inc, 2001*

Reference Books

1. A S Tanenbaum, Distributed Operating Systems, Pearson Education Asia, 2001 2. Source Wikipedia, Mobile Operating Systems, General Books LLC, 2010

Course Code	:	**CS608**
Course Title	:	**DBMS Laboratory**
Number of Credits	:	**0-0-3-2**
Co-requisites (Course code)	:	**CS604**
Course Type	:	**ELR**

Course Objectives

- To explore the features of a Database Management Systems
- To interface a database with front end tools
- To understand the database design and normalization techniques
- To understand the internals of a database system
- To implement supervised and unsupervised learning techniques on relational data using Python/R programming language

Exercises

1. Working with Basic SQL
2. Working with Intermediate SQL.
3. Advanced SQL using procedures, functions and Triggers.
4. Database Design and Normalization techniques.
5. Working with XML
6. Accessing Databases from Programs using JDBC
7. Working with PHP and MySQL
8. Indexing and Query Processing
9. Query Evaluation Plans
10. Working with classification algorithms using Python / R programming
11. Working with clustering techniques using Python / R programming
12. Database Design and implementation (Mini Project)

Course Outcomes

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

- Comprehend the internal working of a database system
- Design database and apply normalization techniques
- Design and develop a database using SQL and the mechanism in connecting with a Web based GUI
- Apply Machine learning algorithms to the real time datasets using Python/R programming languages

Text Book

1. *Silberschatz, Henry F. Korth, and S. Sudharshan, "Database System Concepts", 6th Ed., McGraw Hill, 2010.*
2. *RamezElmasri and Shamkant B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education / Addison Wesley, 2016*

PROGRAM ELECTIVES

Course Code	:	**CS610**
Course Title	:	**Advanced Network Principles and Protocols**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the architecture of the Internet protocols as a layered model
- To understand the fundamentals of data transmission, encoding and multiplexing
- To understand how the various components of wide area networks and local area networks work together
- To understand the concept of application layer

Course Content

UNIT-1 Introduction

Introduction to Networks - Application of Networks - Architecture Topology Switching - SLIP, PPP -ALOHA protocols, CSMA/CD, IEEE 802.3, 802.4, 802.5

UNIT-2 Network Layer

Network Layer Issues- Routing, Congestion control- Internetworking - Issues, Address Learning Bridges, Spanning tree, Source routing, Bridges, Routers, Gateway.

UNIT-3 Network Protocol

Network Protocol- IP datagram - hop by hop routing, ARP, RARP, DHCP -Sub net Addressing, Address Masking, ICMP, RIP, RIPV2, OSPF, DNS, LAN and WAN Multicast.

UNIT-4 Transport Layer

Transport Layer- Design issues, Connection Management, Transmission Control Protocol (TCP) User Datagram Protocol (UDP).

UNIT-5 Application Layer

Application Layer Protocol- Telnet - TFTP - FTP - SMTP - Ping Finger, Bootstrap Network Time Protocol- SNMP.

Course Outcomes

Upon completion of the course, the students will be able to:

- Familiarize the different layers of TCP/IP protocol stack
- Understand the working principle of different protocols at different layers
- Apply networking concepts to real life problems

Text Books

1. *Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks", 5th Edition, Pearson, 2011*
2. *William Stallings, "Data and Computer Communications", 9th Edition, Pearson, 2011*

Reference Books

1. W Richard Stevens and G. Gabrani, "TCP/IP Illustrated - Volume I, The protocols", Pearson Education, 2009

2. Eiji Oki, Roberto Rojas-Cessa, Christian Vogt, Advanced Internet Protocols, Services and Applications, John Wiley and Sons Ltd, 2012

Course Code	:	**CS611**
Course Title	:	**Advanced Cryptography**
Number of Credits	:	**3-0-0-3**
Prerequisites(Course code)	:	
Course Type	:	**PE**

Course Objectives

- To study the concepts of applied cryptography
- To understand the application of cryptographic techniques in real world applications
- To comprehend the notion of provable security and its implication with improved security guarantees

Course Content

UNIT-I Number Theory
Review of number theory, group, ring and finite fields, quadratic residues, Legendre symbol, Jacobi symbol, Probability, Probability, Discrete random variable, Continuous random variable, Markov's inequality, Chebyshev's inequality, normal distribution, the geometric and binomial distributions.

UNIT-II Formal Notions Of Attacks
Formal Notions of Attacks: Attacks under Message Indistinguishability: Chosen Plaintext Attack (IND-CPA), Chosen Ciphertext Attacks (IND-CCA1 and IND-CCA2), Attacks under Message Non-malleability: NM-CPA and NM-CCA2, Inter-relations among the attack model.

UNIT-III Public Key Cryptography
Public key cryptography, probabilistic encryption, homomorphic encryption, Elliptic curve cryptosystems, Cryptographic hash functions.

UNIT-IV Digital Signatures
Digital signatures and the notion of existential unforgability under chosen message attacks. Schnorr signature scheme. Zero Knowledge Proofs and Protocols,

UNIT-V Blockchain Technology
Blockchain technology, Consensus algorithm, Incentives and proof of work, Smart contract, Bitcoin.

Course Outcomes

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

- Break cryptosystems that are not provably secure
- Derive simple provable security proofs for cryptographic schemes
- Design and implement cryptographic protocols

Text Books

1. *W. Mao, Modern Cryptography: Theory & Practice, Pearson Education, 2014.*
2. *Introduction to Modern Cryptography (2nd edition): Jonathan Katz and Yehuda Lindell, CRC Press, 2015.*
3. *Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies, 2016.*

Reference Books

1. *Koblitz, N. Course on Number Theory and Cryptography, Springer Verlag, 1986 4.*
2. *Menezes, A, et.al. Handbook of Applied Cryptography, CRC Press, 1996.*
3. *Thomas Koshy, Elementary Number Theory with applications, Elsevier India, 2005.*

Course Code	:	**CS612**
Course Title	:	**Network Security**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objective

- To understand the network security, services, attacks, mechanisms, types of attacks on TCP/IP protocol suite.
- To comprehend and apply authentication services, authentication algorithms
- To comprehend and apply network layer security protocols, Transport layer security protocols, Web security protocols.
- To understand the wireless network security threats.

Course Content

UNIT –I Overview of Network Security
Overview of Network Security, Security services, attacks, Security Issues in TCP/IP suite-Sniffing, spoofing, buffer overflow, ARP poisoning, ICMP Exploits, IP address spoofing, IP fragment attack, routing exploits, UDP exploits, TCP exploits.

UNIT-II Authentication Protocol
Authentication requirements, Authentication functions - Message Authentication Codes - Hash Functions - Security of Hash Functions and MACs - MD5 message Digest algorithm - Secure Hash Algorithm - RIPEMD - HMAC Digital Signatures, Authentication protocols-Kerberos, X.509.

UNIT-III Security
IP Security-AH and ESP, SSL/TLS, SSH, Web Security-HTTPS, DNS Security, Electronic Mail Security (PGP, S/MIME).

UNIT-IV Viruses
Intruders, Viruses, Worms, Trojan horses, Distributed Denial-Of-Service (DDoS), Firewalls, IDS, Honey nets, Honey pots.

UNIT-V Introduction to wireless Network Security
Introduction to wireless network security, Risks and Threats of Wireless networks, Wireless LAN Security (WEP, WPA).

Course Outcomes
Upon completion of this course, the students will be able to:

- Be able to determine appropriate mechanisms for protecting the network.
- Design a security solution for a given application, system with respect to security of the system.
- Find solution to Security Threats
- Understand authentication algorithms

Text Books:

1. *Yang Xiao and Yi Pan, "Security in Distributed and Networking Systems", World Scientific, 2007, Chapter 1.*
2. *W. Stallings, "Cryptography and Network Security: Principles and Practice", 5/E, Prentice Hall, 2013.*

Reference Books:

1. *Aaron E. Earle, "Wireless Security Handbook", Auerbach publications, Taylor & Francis Group, 2006.*
2. *Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill, 2003*.

Course Code	:	**CS613**
Course Title	:	**Wireless Sensor Networks**
Number of Credits	:	**3-0-0-3**
Prerequisites(Course code)	:	
Course Type	:	**PE**

Course Objective

- To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
- To study the various protocols at various layers and its differences with traditional protocols.
- To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Unit 1 Introduction

Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

Unit 2 Introduction to Adhoc/sensor networks

Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.

Unit 3 MAC Protocols

MAC Protocols : Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

Unit 4 Routing Protocols

Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table-driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols

Unit 5 QoS and Energy Management

QoS and Energy Management : Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.

Course Outcomes

Upon completion of the course, the students will be able to:

- Technical know how in building a WSN network.
- Analysis of various critical parameters in deploying a WSN

TEXTBOOKS

1. *C. Siva Ram Murthy, and B. S. Manoj, "AdHoc Wireless networks ", Pearson Education - 2008.*

REFERENCES

1. *Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.*
2. *Jochen Schiller, "Mobile Communications", Pearson Education, 2nd Edition, 2003.*
3. *William Stallings, "Wireless Communications and Networks ", Pearson Education - 2004*

Course Code	:	**CS614**
Course Title	:	**Software Design Architecture**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- Define basics of software architecture and its design
- know the necessity of documentation of the architecture
- Design a UML for software Architecture
- Design a case studies
- Explore modeling tools

Course Content

UNIT-I Software Architecture

Introduction-Software Architecture -The Role of the Architect-Architectural Styles-Quality Attributes(Text2), Why Is Software Architecture Important(Text3), Contexts of Software Architecture: Architecture in a Technical Context-Architecture in a Project Life-Cycle Context-Architecture in a Business Context-Architecture in a Professional Context- Stakeholders- How Is Architecture Influenced - What Do Architectures Influence?

UNIT-II : Architectural Design

Design in General, Design in Software Architecture-Architectural Design-Element Interaction Design- Element Internals Design- Why Is Architectural Design So Important? Architectural Drivers-Design Purpose-Quality Attributes-Primary Functionality- Architectural Concerns- Constraints, Design Concepts: The Building Blocks for Creating Structures-Reference Architectures-Architectural Design Patterns-Deployment Patterns- Tactics-Externally Developed Components, Architecture Design Decisions(Text1)

UNIT-III Design Space for Architecture and models

Software Architecture Design Guidelines, Software Architecture Design Space: Types of software structures-software elements-software connectors-An Agile Approach to software Design, Models of software architecture: overview, UML for software architecture, Architecture View models, Architecture Description Languages

UNIT-IV Software Architecture Process and Documentation

Software Architecture Process: Process Outline, Architecture Design, Validation (Text4), Documenting a Software Architecture: Uses and Audiences for Architecture Documentation, Notations for Architecture Documentation, Views, Choosing the Views, Combining Views, Building the Documentation Package. Documenting Behaviour, Architecture Documentation and Quality Attributes, Documenting Architecture in an Agile Development Project(Text3)

UNIT-V Modeling Tools and Case studies

UML, SysML, AADL, Case studies-FCAPS systems, Big data systems, Banking system(Text1)

Course Outcomes

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

- analyze the abstraction of various architectural styles of a software
- analyze the software architectural design models to make design decisions
- analyze the design, validate and document the software architecture
- Design a algorithms for case studies
- Enforce tools to implement algorithm for case studies

Text Books

1. *Humberto Cervantes, Rick Kazman," Designing Software Architectures: A Practical Approach", Pearson Education 2016.*
2. *Kai Qian, Xiang Fu, Lixin Tao, Chong-wei Xu, "Software Architecture and Design Illuminated", Jones & Bartlett Learning; 1 edition, 2009*

Reference Books

1. *Len Bass, Paul Clements, Rick Kazman," Software Architecture in Practice", 3rd edition, Pearson Education, 2013*
2. *Ian Gorton," Essential Software Architecture", Springer-Verlag Berlin, Heidelberg, 2006*
3. *Paul Clements, Felix Bachmann, Len Bass, David Garlan, James Ivers, Reed Little, Paulo Merson, Robert Nord, Judith Stafford," Documenting Software Architectures: Views and Beyond", 2nd edition, Pearson Education, 2011*
4. *Hofmeister, Christine, Robert Nord, and Dilip Soni. Applied software architecture. Addison-Wesley Professional, 2000.*

Course Code	:	**CS615**
Course Title	:	**Mobile Network Systems**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the fundamentals of Mobile communication systems.
- To understand the different multiplexing scheme.
- To understand the significance of different layers in mobile system.
- To understand how to perform wireless communication

Course Content

Unit 1 Introduction

Introduction to wireless, mobile and cellular mobile systems- cellular mobile telephone systems, analog and digital cellular systems- frequency reuse, co-channel interference.

Unit 2 MAC

MAC - Medium access control - MAC, SDMA, FDMA, TDMA, CDMA, Hand offs and dropped calls-initiation of handoff, power difference, mobile assisted cell-site and Intersystem handoff.

Unit 3 Wireless Network

Communication Systems - Mobile Telecommunication standards, GSM, DECT, TETRA, IMT-2000, CTEO, satellite systems – GEO, LEO and MEO, and broadcast systems –Digital audio and video broadcasting, IEEE 802.11, HIPERLAN, Bluetooth, Wireless ATM, WATM services.

Unit 4 Mobile Network Layer

Mobile Network Layer - Network support for mobile systems – Mobile IP- IP packet delivery- Agent discovery-tunneling and encapsulation, reverse tunneling, IPV6, DHCP.

Unit 5 Mobile Transport Layer

Mobile Transport Layer - Mobile transport and application layer protocol - Review of traditional TCP, fast retransmit/fast recovery, transmission/timeout freezing, file systems, WWW, WAP.

Course Outcomes

Upon completion of the course, the students will be able to:

- Understand the concepts of mobile communication.
- Gain knowledge about wireless communications.
- Implement Mobile Applications.
- Apply the knowledge gained in exploring, application and protocol development.

Text Books

1. Jochen Sciiiller, "Mobile Communications ", Pearson Education India, 2009.

Reference Books

1. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, 2/e, Pearson Education, 2010.
2. William C.Y Lee, "Mobile Cellular Telecommunications ", McGraw Hill International Editions, 1995.

Course Code	:	**CS616**
Course Title		**Cloud Computing Principles**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To provide an in-depth and comprehensive knowledge of the Cloud Computing fundamental issues, technologies, applications and implementations.
- To expose the students to the frontier areas of Cloud Computing
- To motivate students to do programming and experiment with the various cloud computing environments
- To shed light on the Security issues in Cloud Computing
- To introduce about the Cloud Standards.

Course Content

UNIT - I

History of Centralized and Distributed Computing - Overview of Distributed Computing, Cluster computing, Grid computing. Technologies for Network based systems- SOA – Hardware- MultiCore Systems – GPGPU- Data Storage

UNIT - II

Cloud issues and challenges - Properties - Characteristics - Service models, Deployment models- Virtualization – Virtual Machines – Hypervisor Types – Resource Virtualization: Server, Storage, Network

UNIT - III

Service models - Infrastructure as a Service (IaaS) - Platform as a Service (PaaS) - Software as a Service (SaaS) - Anything as a service (XaaS) – Service Management

UNIT - IV

Cloud Access: authentication, authorization and accounting - Cloud Provenance and meta-data - Cloud Reliability and fault-tolerance - Cloud Security, privacy, policy and compliance- Cloud federation, interoperability and standards.

UNIT - V

Cloud Programming and Software Environments –Programming on Amazon AWS and Microsoft Azure – Programming support of Google App Engine – Docker Architecture and Components –Docker Interfaces – Docker Orchestration - Emerging Cloud Software Environment.

Course Outcomes

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

- Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
- Identify the architecture and infrastructure of cloud computing, including saas, paas, iaas, public cloud, private cloud, hybrid cloud
- Design a cloud with security, privacy, and interoperability.
- Provide the appropriate cloud computing solutions and recommendations according to the applications used.

Text Book

1. *Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, "Distributed and cloud computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier – 2012.*

Reference Books

1. *Barrie Sosinsky, " Cloud Computing Bible" John Wiley & Sons, 2010*
2. *Tim Mather, Subra Kumaraswamy, and Shahed Latif, Cloud Security and Privacy An Enterprise Perspective on Risks and Compliance, O'Reilly 2009 James Turnbull , **The Docker Book: Containerization Is the New Virtualization**" , e-book 2015.*

Course Code	:	**CS617**
Course Title	:	**Cloud Security**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

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

Course Content

Unit I: Introduction to cryptography

Secret Key Cryptography, Public Key Cryptography, Secret Key Cryptography, Advanced Encryption Standard (AES), Hashes and Message Digests: MD2;MD4;MD5, Public Key Algorithms: RSA

Unit II: Introduction to Cloud Security and Securing Cloud Architecture

Cloud Security, Cloud Security Threats, Risks and Concerns, Cloud Security Controls, Identity and Access Management, Data Security and Privacy, Incident Response, Challenges to Cloud Security. Securing the Cloud: Architecture: Security Requirements for the Architecture Security Patterns and Architectural Elements, Cloud Security Architecture, Planning Key Strategies for Secure Operation.

Unit III : Infrastructure Security and Data Security

The network level: ensuring data confidentiality and integrity, ensuring proper access control, ensuring the availability of internet facing resources replacing the established model of network zones and tiers with domains, network level mitigation. *The host level:* SaaS and PaaS host security; IaaS host security, virtualization software security, virtual server security. *The application level:* DoS and EDoS, end user security, SaaS application security, PaaS application security, customer deployed application security, IaaS application security, aspects of data security**,** Data security mitigation and provider data and its security, data encryption, cloud data security, cloud data storage, cloud lock-in.

Unit IV : Security criteria, Evaluating Cloud Security and security management

Security control, best practices, security Monitoring, building an internal cloud security, selecting an external cloud provider, evaluating cloud security and checklists for evaluating cloud security, metrics for the checklists. Standards, availability management, SaaS availability management, PaaS availability management, IaaS availability management, security vulnerability, patch and configuration management.

Unit V : Operating Cloud Security

Operating a Cloud, From Architecture to Efficient and Secure Operations, The Scope of Planning, Physical Access, Security, and Ongoing Costs Logical and Virtual Access, Personnel Security, From the Physical Environment to the Logical, Bootstrapping Secure Operations, The Refinement of Procedures and Processes over Time, Efficiency and Cost, Security Operations Activities, Server Builds, Business Continuity, Backup, and Recovery, Managing Changes in Operational Environments, Information Security Management, Vulnerability and Penetration Testing, Security Monitoring and Response, Best Practices, Resilience in Operations**.**

Course Outcomes

1. Understanding network security and cloud security.
2. Design the cloud security architecture that assures secure isolation of computer network and storage infrastructure comprehensive data protection.
3. Gaining knowledge about monitoring and auditing processes.
4. Evaluate cloud security and cloud security management

References

1. Vic (J.R) Winkler, “Securing the cloud: cloud computer security Techniques and Tactics” Technical editor Bill Meine, 2011.

2. Tim Mather, Subra Kumaraswamy, and Shahed Latif,"Cloud security and privacy- an Enterprise Perspective on Risks and Compliance", Published by O'Reilly Media, Inc., 2009.
3. Ronald L. Krutz Russell Dean Vines," Cloud Security A Comprehensive Guide to Secure Cloud Computing", Published by Wiley Publishing, Inc.2010.
4. Charlie Kaufman, Radia Perlman, Mike Speciner,"Network Security: Private communication in a Public world" second edition, Prentice Hall on 2002.

Course Code	:	**CS618**
Course Title	:	**Design and Analysis Parallel Algorithms**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand different array processors and parallel algorithms for multiprocessor.
- To perform the various operations on PRAM model.
- To perform merging and sorting operations on different models
- To solve linear equations using parallel algorithms for basic problems.
- To study graph Algorithms

Course Content

UNIT I

Structures and algorithms for array processors: SIMD Array Processors, Interconnection networks, Parallel algorithms for Array processors. Multiprocessor architecture-and Interconnection networks-multiprocessor control algorithms- parallel algorithms for multiprocessors.

UNIT II

Selection – broadcast- all sums- parallel selection. Searching a random sequence, sorted sequence on PRAM models, Tree and Mesh.

UNIT III

Merging – A network for merging – merging on PRAM models. Sorting on a linear array, EREW, CREW and CRCW SIMD models, MIMD Enumeration sort.

UNIT IV

Matrix operations- Transposition, Matrix by matrix multiplication, matrix by vector multiplication. Numerical problems- solving systems of linear equations, finding roots of non linear equations on PRAM models.

UNIT V

Graphs – Connected components- dense graphs- sparse graphs. Minimum spanning tree- Solli's algorithm, Biconnected components, Ear decomposition, Directed graphs.

Course Outcomes

Upon completion of the course, the students will be able to:

- Describe the algorithms for array processors
- Develop searching algorithms for various kinds of models.
- Perform efficient sorting operation on different models.
- Solve linear and nonlinear equations using PRAM models.
- Construct graph and find solutions to real world problems.

Text book:

1. Kai Wang and Briggs, "Computer Architecture and Parallel Processing", McGraw Hill, 1985.
2. S. G. Akl, "Designa and Analysis of Parallel Algorithms", Prentice Hall Inc., 1992.
3. Joseph Jaja, " An Introduction to parallel Algorithms", Addison Wesley, 1992.

Course Code	:	**CS619**
Course Title	:	**Statistical Natural Language Processing**
Number of Credits	:	**3-0-0-3**
Prerequisites(Course code)	:	
Course Type	:	**PE**

COURSE OBJECTIVES

- To understand the need for morphological processing and their representation
- To know about the various techniques used for speech synthesis and recognition
- To appreciate the syntax analysis and parsing that is essential for natural language processing
- To learn about the various representations of semantics and discourse
- To have knowledge about the applications of natural language processing

UNIT I Morphology And Part-Of-Speech Processing

Introduction –Regular Expressions and Automata-Non-Deterministic FSAs. Transducers –English Morphology -Finite-State Morphological Parsing -Porter Stemmer -Tokenization-Detection and Correction of Spelling Errors. N-grams –Perplexity -Smoothing -Interpolation -Backoff . Part-of-Speech Tagging –English Word Classes -Tagsets -Rule-Based -HMM -Transformation-Based Tagging -Evaluation and Error Analysis. Hidden Markov and Maximum Entropy Models

UNIT II Speech Processing

Phonetics –Articulatory Phonetics -Phonological Categories -Acoustic Phonetics and Signals -Speech Synthesis –Text Normalization –Phonetic and Acoustic Analysis -Diphone Waveform synthesis –Evaluation-Automatic Speech Recognition –Architecture -Hidden Markov Model to Speech -MFCC vectors -Acoustic Likelihood Computation -Evaluation. Triphones –Discriminative Training -Modeling Variation. Computational Phonology-Finite-State Phonology –Computational Optimality Theory -Syllabification -Learning Phonology and Morphology

UNIT III Syntax Analysis

Finite-State and Context-Free Grammars -Dependency Grammars. Syntactic Parsing – Ambiguity -Dynamic Programming Parsing Methods –CKY-Earley and Chart Parsing-Partial Parsing-Evaluation. Statistical Parsing – Probabilistic Context-Free Grammars –Probabilistic CKY Parsing of PCFGs –Probabilistic Lexicalized CFGs – Collins Parser – Shallow parsers – Dependency parsing

UNIT IV Semantic and Pragmatic Interpretation

Representation of Meaning –Desirable Properties -Computational Semantics -Word Senses -Relations Between Senses –WordNet -Event Participants-Proposition Bank -Frame Net -–Metaphor. Computational Lexical Semantics –Word Sense Disambiguation-Supervised Word Sense Disambiguation -Dictionary and Thesaurus Methods-Word Similarity -Minimally Supervised WSD -Hyponymy and Other Word Relations -Semantic Role Labeling -Unsupervised Sense Disambiguation. Computational Discourse -Discourse Segmentation -Unsupervised Discourse -Segmentation -Text Coherence -Reference Resolution –Phenomena –Features and algorithms -Pronominal Anaphora Resolution

UNIT V Applications

Information Extraction –Named Entity Recognition -Relation Detection and Classification –Temporal and Event Processing -Template-Filling -Biomedical Information Extraction. Question Answering and Summarization -Information Retrieval -Factoid Question Answering -Summarization -Single and Multi-Document Summarization -Focused Summarization -Evaluation. Dialog and Conversational Agents –Properties of Human Conversations -Basic Dialogue Systems

COURSE OUTCOMES

Upon completion of this course, the student should be able to:

- Identify the different linguistic components of natural language
- Design a morphological analyser for a given natural language
- Decide on the appropriate parsing techniques necessary for a given language and application
- Design new tagset and a tagger for a given natural language
- Design applications involving natural language

TEXT BOOKS

1. *Jurafsky and Martin, "Speech and Language Processing", Pearson Prentice Hall, Second Edition, 2008.*
2. *Christopher D. Manning and Hinrich Schütze, "Foundations of Statistical Natural Language Processing", MIT Press, 1999.*

REFERENCE BOOKS

1. *Stevan Bird, "Natural Language Processing with Python", Shroff, 2009.*
2. *James Allen, "Natural Language Understanding", Addison Wesley, Second Edition, 2007.*
3. *Nitin Indurkhya, Fred J. Damerau, "Handbook of Natural Language Processing", (Chapman & Hall/CRC Machine Learning & Pattern Recognition), Second Edition, 2010.*
4. *Alexander Clark, Chris Fox, Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", Wiley-Blackwell, 2012.*

Course Code	:	**CS620**
Course Title	:	**Social Network Mining and Analysis**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- Describe about the current web development and emergence of social web
- Design modeling, aggregating and knowledge representation of semantic web
- Summarize knowledge on extraction and analyzing of social web
- Describe Association rule mining algorithms
- Recognize the evolution of social networks

Course Content

UNIT-I Introduction:
Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web . Social Network analysis: Development of Social Network Analysis – Key concepts and measures in network analysis

UNIT-II Modelling, Aggregating And Knowledge Representation:
Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: State-of-the-art in network data representation – Ontological representation of social individuals – Ontological representation of social relationships – Aggregating and reasoning with social network data – Advanced representations.

UNIT-III Algorithms And Techniques :
Association Rule Mining, Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Markov models, K-Nearest Neighbouring, Content-based Recommendation, Collaborative Filtering Recommendation, Social Network Analysis, Detecting Community Structure in Networks, the Evolution of Social Networks

UNIT-IV Extracting And Analyzing Web Social Networks:
Extracting Evolution of Web Community from a Series of Web Archive, Temporal Analysis on Semantic Graph using Three-Way Tensor, Decomposition, Analysis of Communities and Their Evolutions in Dynamic Networks.

UNIT-V Web Mining And Recommendation Systems:
User-based and Item-based Collaborative Filtering Recommender Systems, Hybrid User-based and Item-based Web Recommendation System, User Profiling for Web Recommendation Based on PLSA and LDA Model, Combing Long-Term Web Achieves and Logs for Web Query Recommendation

Course Outcomes

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

- Design a model for social network data
- apply general mining algorithms for social media data
- design algorithms for handling social media data
- interpret the semantic content of social media data
- analyze the patterns involved in social media data

Text Books

1. *Peter Mika, "Social networks and the Semantic Web", Springer, 2007.*
2. *Guandong Xu,Yanchun Zhang, and Lin Li, "Web Mining and Social Networking Techniques and Applications", Springer.*

Reference Books

1. *Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.*
2. *Guandong Xu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", First Edition Springer, 2011.*
3. *Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, "Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling", IGI Global Snippet, 2009.*
4. *Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2011.*

Course Code	:	**CS621**
Course Title	:	**Computational Geometry**
Number of Credits	:	**3-0-0-3**
Prerequisites(Course code)	:	
Course Type	:	**PE**

Course Objectives

- To introduction to geometric algorithms and related research issues.
- To exposure algorithms and data structures for geometric problems.
- To exposure to techniques for addressing degenerate cases.
- To exposure to randomization as a tool for developing geometric algorithms.

Course Content

UNIT - I Convex hulls

Convex hulls: construction in 2d and 3d, lower bounds; Triangulations: polygon triangulations, representations, point-set triangulations, planar graphs; Voronoi diagrams: construction and applications, variants;

UNIT - II Delaunay triangulations

Delaunay triangulations: divide-and-conquer, flip and incremental algorithms, duality of Voronoi diagrams, min-max angle properties;

UNIT - III Geometric searching

Geometric searching: point location, fractional cascading, linear programming with prune and search, finger trees, concatenable queues, segment trees, interval trees; Visibility: algorithms for weak and strong visibility, visibility with reflections, art-gallery problems;Arrangements of lines: arrangements of hyperplanes, zone theorems, many-faces complexity and algorithms;

UNIT - IV Combinatorial geometry

Combinatorial geometry: Ham-sandwich cuts, Helly's theorems, k-sets, polytopes and hierarchies, polytopes and linear programming in d-dimensions, complexity of the union of convex sets, simply connected sets and visible regions;

UNIT - V Sweep techniques

Sweep techniques: plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, topological sweep for line arrangements; Randomization in computational geometry: algorithms, techniques for counting; Robust geometric computing; Applications of computational geometry.

Course Outcomes

Upon completion of the course, the students will be able to:

- Introduce a variety of algorithmic techniques that apply to geometric problems
- Aim for diversity at the expense of getting the fastest known algorithms, which are typically obtained with amortized analysis
- Use Geometric algorithms in Computer Graphics, Databases, Wireless Networks (and the combined GIS systems), and Natural Sciences.

Text Books

1. *Mark de Berg, Otfried Schwarzkopf, Marc van Kreveld and Mark Overmars, Computational Geometry: Algorithms and Applications, Springer.*
2. *F. P. Preparata and Michael I. Shamos, Computational Geometry: An Introduction, Springer.*

Reference Books

1. *Joseph O' Rourke, Computational Geometry in C, Cambridge University Press.*
2. *Lecture Notes by David Mount.*
3. *K. Mulmuley, Computational Geometry: An Introduction Through Randomized Algorithms, Prentice Hall, 1994.*
4. *R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge Univ. Press, 1995.*

Course Code	:	**CS622**
Course Title	:	**Database Tuning and Administration**
Number of Credits	:	**3-0-0-3**
Prerequisites(Course code)	:	
Course Type	:	**PE**

Course Objectives

- To learn various types of File Systems and Database Architectures
- To understand the internal storage structures in a physical DB design.
- To know the fundamental concepts of transaction processing techniques.
- To understand the concept of ASM Instance.
- To know the manipulation of SQL Queries for transaction and concurrency control.
- To learn about Database Security and Database Maintenance.

Course Content

UNIT – I File systems and databases

Data, information, databases, database management systems, data redundancy, database systems, DBMS functions, and connecting a client to the Oracle DBMS, Data models: entities, attributes, relationships, business rules. Data abstraction, conceptual, internal, and external models. Hands on: Installing and connecting to a database management system; introduction to SQL. Advanced Database Programming, Modeling and Normalization Performance Tuning, Security, Administration, and Ethical Issues, Transactions, Distributed, Clustered, Tiered and Mobile Databases Object-Oriented and Object-Relational Databases, The Web, XML, and Database Administration Business Intelligence: Data warehousing and Data Mining

UNIT - II Exploring the Oracle Database Architecture

Introduction Exploring the Oracle Database Architecture, Connecting to a server, Oracle Database Server Architecture Instance: Database Configurations, Memory structures- Shared Pool, MS – Buffer Cache, MS-Redo Log Buffer, MS- Large Pool MS- Java Pool/Streams Pool, MS-PGA, Transactions, Properties (ACID Rules), Life Cycle.

Concurrency control- Types of concurrency control mechanisms, Crash Recovery Components, Undo and Redo operations, Examples for different component behaviors,

Deadlocks, Process Structures - Background processes -Database Writer Process (DBWn), BP- Log Writer Process(LWR), BP-Checkpoint Process (CKPT), BP-System Monitor Process(SMON) - BP-Process Monitor Process(PMON), BP-Recoverer Process, BP-Archiever Process(ARCn), Process Startup Sequence, Database Storage Architecture, Logical and physical storage structures, Segments, Extents and Blocks, Table spaces and Data files, SYSTEM and SYSAUX Table spaces, ASM storage components, Interacting with an Oracle Database.

Managing the Database instance - Database initialization parameters modification, Stages of database startup, Database shutdown modes and options, Alert log, Using Trace Files, Dynamic performance views, Data Dictionary views, Data dictionary from SQL Expert.

UNIT – III Managing the ASM instance

Benefits of using ASM, ASM instance processes and parameters, Interaction between database instances and ASM, ASM instance dynamic performance views, ASM system privileges, ASM disk groups, ASM disks, Allocation units, ASM files, Extent Maps, Striping granularity, Fine-Grained Striping, ASM Failure groups, Stripe and mirror example, Failure example, Managing disk groups, Adding disk to disk groups, Alter commands, ASM disk group compatibility, Disk Group Attributes, ASM Fast Mirror Resync Overview. Configuring the Oracle Network environment: Creating additional listeners ,Creating Oracle Net Service aliases, Configuring connect-time failover, Controlling the Oracle Net Listener, Using TNSPING to test Oracle Net connectivity, Shared servers versus dedicated servers, Managing Database Storage Structures:• Storage of table row data in blocks, Oracle-Managed Files (OMF), Enlarging the database ,Managing Data Concurrency: Locking mechanism, Oracle data concurrency management, Enqueue mechanism, Monitoring and resolving locking conflict

UNIT – IV **Administering User security**

Create and manage database user accounts: Authenticate users, Assign default storage areas (table spaces) , Administer authentication,• Grant and revoke privileges (system & object privileges) Create and manage roles, Predefined roles, Create and manage profiles, Supplied password verification Function, Assigning quotas to users, Principle of least privilege, Protect privileged Accounts Managing Undo Data: DML and undo data generation, Monitor and administer undo data, Difference between undo data and redo data, Configuring undo retention, Undo retention guarantee, Undo Advisor ,Implementing Oracle Database Auditing: DBA responsibilities for security and auditing, Standard database auditing, DBA responsibilities for security and auditing, Standard database auditing, Specifying audit options, Audit information, Value-based auditing, Fine-Grained Auditing, FGA Guidelines, SYSDBA Auditing, Maintaining the audit trail, Oracle Audit Vault.

UNIT - V **Database Maintenance**

Database Maintenance: Managing optimizer statistics, Preferences for Gathering Statistics, Managing the Automatic workload Repository (AWR), Statistic Levels, Automatic Database Diagnostic Monitor (ADDM), Advisory framework , Automated Maintenance Tasks, Server-generated alerts, Setting alert thresholds, Reacting to alerts, Alert types and clearing Alerts, Performance Management : Use Enterprise Manager to monitor performance ,Use Automatic Memory Management (AMM),Use the Memory Advisor to size memory buffers, View performance-related dynamic views, Troubleshoot invalid and unusable objects, Backup and Recovery Concepts: Types of failure that can occur in an Oracle database (statement/user process/ network/ User/ Instance failures) ,Flashback Technology, Ways to tune instance recovery (Redo Log files/Log Writer) , Using MTTR Advisor, Media failure, Configuring recoverability, Configuring the fast recovery area, Checkpoints, redo log files, and archive log files, Achiever process, Configuring ARCHIVELOG mode, Performing Database Backups: Consistent database backups, Oracle Secure Backup, User Managed Backup, Recovery Manager (RMAN) ,Backing Up the Control File to a Trace File, Performing Database Recovery: Opening a Database, Keeping a Database Open, Data Recovery Advisor, Loss of Control file/Redo Log file/data file /noncritical data file /system _critical data file, Data failure examples, Data recovery advisor, Recovery.

Course Outcomes

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

- design and develop a effective Database Architecture.
- maintain and manage user accounts in the Database
- administering the user Security.
- manage ASM instance.

Text book

1. *Oracle Database 11g: Administration Workshop1 (Volume 1 and 2).*

Reference Books

1. *Lightstone, Teorey, Nadeau," Physical Database Design", Morgan Kaufman,2007.*
2. *Edward Sciore, "Database Design and Implementation", Wiley,2008.*
3. *Bernstein, Hadzilacos, Goodman "Concurrency Control and Recovery in Database Systems", Addison-Wesley, 1987.*

Course Code	:	**CS623**
Course Title	:	**Big Data Analytics and Mining**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand big data and data analytics lifecycle
- To learn Basic Data analytic methods using R
- To Get a knowledge on advanced analytical methods, technology and tools

Course Content

UNIT-I Big data overview
State of the practice in Analytics-Key roles for new big data ecosystem Data Analytics Lifecycle-Data analytics lifecycle overview- Discovery- Data Preparation-Model Planning-Model Building-Communicate Results-operationalize

UNIT-II Introduction to R
Exploratory Data Analytics-Statistical methods for evaluation Hadoop & Map Reduce framework for R, R with Relational Database Management Systems, R with Non-Relational (NoSQL) DBs

UNIT-III Clustering
Overview of Clustering-K-means, Association Rules-Overview-Apriori Algorithm-Evaluation of candidate rules-An Example: Transactions in grocery Store-Validation and Testing-Diagnostics, Regression-Linear Regression-Logistic Regression-Reason to choose and Cautions-Additional Regression Models

UNIT-IV Classification
Decision Trees-Naïve Bayes-Diagnostics of Classifiers-Additional classification methods, Time series Analysis-Overview of Time series analysis-ARIMA Model-Additional methods, Text Analysis-Text analysis steps-A text analysis Example-Collecting raw Text-Representing Text-Term Frequency—Inverse document frequency(TFIDF)-Categorizing documents by Topics-Determining Sentiments-Gaining insights

UNIT-V Analytics for Unstructured data
The Hadoop Ecosystem-NoSQL, In-Database Analytics-SQL Essentials-In-Database Text Analysis-Advanced SQL

Course Outcomes
Upon completion of this course, the students will be able to:

- Understand the big data concepts
- Utilize and apply the Analytical methods, Technology and tools in the industry.
- Understand hadoop ecosystem and apply to solve real-life problems

Text Books

1. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
2. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016

Reference Books

1. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.
2. Kim H. Pries and Robert Dunnigan, “Big Data Analytics: A Practical Guide for Managers” CRC Press, 2015.

Course Code	:	**CS624**
Course Title	:	**Models of Computation**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand computation and computability concepts.
- To study different approaches to facilitate computing
- To learn the abstractions of computation and their implementations

UNIT I Turing Machine Model 9

Turing Machine Logic, Proof, Computability.

UNIT II Quantum Computation

Quantum Computing History, Postulates of Quantum Theory, Dirac Notation, the Quantum Circuit Model, Teleportation, Superdense Coding, Foundation Algorithms

UNIT III Nature Inspired Computing

Nature-Inspired Computing Optimization and Decision Support Techniques, Evolutionary Algori Benchmarks and Testing

UNIT IV Social Computing

Social Computing Online communities, Online discussions, Twitter, Social Networking Systems. Crowdsourcing, Facebook, blogs, wikis, social recommendations, Collective intelligence

UNIT V Evolutionary Computing

Evolutionary Computing Introduction to Genetic Algorithms, Genetic Operators and Parameters, Gen Solving, Theoretical Foundations of Genetic Algorithms, Implementation Issues

OUTCOMES:

Upon completion of this course, the student should be able to

- Identify the terminology of the theory of computing
- Predict the major results in computability and complexity theory.
- Prepare the major models of computations

Text books

1. *Danah Boyd, "It's Complicated: The Social Lives of Networked Teens", Yale University Press, 2015*
2. *John E. Savage, "Models Of Computation - Exploring the Power of Computing", Addison-Wesley, 2008*

References books:

1. *Margaret M. Fleck, "Building Blocks for Theoretical Computer Science", University of Illinois, Urbana-Champaign, 2013.*
2. *Michael A. Nielsen & Isaac L. Chuang, "Quantum Computation and Quantum Information" 2010*
3. *M. Mitchell, "An Introduction to Genetic Algorithms", Prentice-Hall, 1996.*
4. *G.Rozenberg, T.Back, J.Kok, Editors, "Handbook of Natural Computing", Springer Verlag, 2012.*

Course Code	:	**CS625**
Course Title	:	**Cognitive Science**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To know concepts, approaches and issues in the field of cognitive science
- to increase the awareness of the students to the questions raised in the disciplines of computer science, linguistics, philosophy and psychology
- to focus on the interaction of these disciplines in approaching the study of the mind
- To make specialization on topics central to cognitive science such as the nature of mental representation, reasoning, perception, language use
- To learn other cognitive processes of humans and other intelligent systems.

Course Content

UNIT - I Introduction

Introduction to the study of cognitive sciences. A brief history of cognitive science. Methodological concerns in philosophy, artificial intelligence and psychology. Structure and constituents of the brain; Brief history of neuroscience; Mathematical models; Looking at brain signals; Processing of sensory information in the brain.

UNIT - II Neural Network Models

Neural Network Models; Processing of sensory information in the brain; motor and sensory areas; Brain Imaging, fMRI, MEG, PET, EEG; Multisensory integration in cortex; information fusion; from sensation to cognition, cybernetics; From physics to meaning; Analog vs. Digital: Code duality.

UNIT - III Linguistic Knowledge

What is language?; Linguistic knowledge: Syntax, semantics, (and pragmatics); Generative linguistics; Brain and language; Language disorders; Lateralization; The great past tense debate; Cognitivist and emergent standpoints ; A robotic perspective.

UNIT - IV Robotics

Affordances, direct perception, Ecological Psychology, affordance learning in robotics; Development, child and robotic development; Attention and related concepts; Human visual attention; Computational models of attention; Applications of computational models of attentional.

UNIT - V Machine Learning

Categories and concepts; Concept learning; Logic ; Machine learning; Constructing memories; Explicit vs. implicit memory; Information processing (three-boxes) model of
memory; Sensory memory; Short term memory; Long term memory; Rationality; Bounded rationality; Prospect theory ; Heuristics and biases; Reasoning in computers; Key points in social cognition; Context and social judgment; Schemas; Social signals.

Course Outcomes

Upon completion of the course, the students will be able to:

- Know Introduction to Cognitive Science, Psychology, Nervous system and brain
- Understand Brain and sensory motor information, Representation of sensory information
- Analyse From Sensation to Cognition; Roots of Cognitive Science
- Develop Language and Embodiment
- Implement Affordances in biological and artificial systems, Cognitive Development
- Make Attention, Learning, Memory, Reasoning, Social Cognition.

Text Books

1. *Gardner, Howard E. The mind's new science: A history of the cognitive revolution. 2nd Edition.*
2. *Bermúdez, José Luis. Cognitive science: An introduction to the science of the mind. Cambridge University Press, 2014.*

Reference Books

1. *McCulloch, Warren S., and Walter Pitts. "A logical calculus of the ideas immanent in nervous activity." The bulletin of mathematical biophysics 5.4 (1943): 115-133.*
2. *Imaging: Brain Mapping Methods, John C. Mazziotta, Richard S. J. Frackowiak, Elsevier Science Publication.*
3. *Fromkin, Rodman, and Hyams. An Introduction to Language, Boston, MA: Thomson Wadsworth, 9th edition, 2011.*

Course Code	:	**CS626**
Course Title	:	**Internet of Things (IoT)**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

Course Content

UNIT-I Fundamentals Of Iot

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

UNIT-II Iot Protocols

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT

UNIT-III Design And Development

Design Methodology – Embedded computing logic – Microcontroller, System on Chips – IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming.

UNIT-IV Data Analytics And Supporting Services

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

UNIT-V Case Studies/Industrial Applications

Cisco IoT system – IBM Watson IoT platform – Manufacturing – Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model – Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

Course Outcomes

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

- Explain the concept of IoT.
- Analyze various protocols for IoT.
- Design a PoC of an IoT system using Rasperry Pi/Arduino
- Apply data analytics and use cloud offerings related to IoT.
- Analyze applications of IoT in real time scenario

Text Books

1. *David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017*
2. *Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach, Universities Press, 2015*

Reference Books

1. *Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012*
2. *Jan Ho¨ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.*
3. *Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things, Springer, 2011.*
4. *Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.*

Course Code	:	**CS627**
Course Title	:	**Image And Video Analytics**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the fundamentals of digital image processing
- To have an knowledge on image and video analysis.
- To understand the real time use of image and video analytics.
- T understand the processing of images and videos
- To demonstrate real time image and video analytics applications.

Course Content

Unit 1 Introduction

Digital Image Processing – Characteristics of Digital Image - Basic relationship between pixels – Fundamental operations on image - Image sampling and quantization – Image transformations - Color models.

Unit 2 Basic Techniques of image processing

Fundamentals of spatial filtering: spatial correlation and convolution-smoothing blurring- sharpening - Basics of filtering in the frequency domain: smoothing-blurring - sharpening-- Histograms and basic statistical models of image.

Unit 3 Transformations and Segmentations

Colour models and Transformations – Image and Video Segmentation-Image and video demonising- Image and Video enhancement- Image and Video compression.

Unit 4 Detection and Classification

Object detection and recognition in image and video-Texture models Image and Video classification models-Object tracking in Video.

Unit 5 Applications and Case studies

Industrial- Transportation & Travel- Remote Sensing-Video Analytics in WSN: IoT Video Analytics Architectures.

Course Outcomes

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

- Describe the fundamental principles of image analysis
- Have an idea of various image processing techniques.
- Apply pattern recognition techniques.
- Apply image analysis in real world problem
- Extent the technologies for analyzing and processing of videos.

Text Books

1. *Rafael C Gonzalez, Richard E Woods, Digital Image Processing, Pearson Education, 4th edition, 2018.*
2. *A.K. Jain, Fundamentals of Digital Image Processing, PHI, New Delhi, 1995*

Reference Books

1. *Rick Szelisk, "Computer Vision: Algorithms and Applications", Springer 2011.*
2. *Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.*

Course Code	:	**CS628**
Course Title	:	**Information Visualization**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To introduce visual perception and core skills for visual analysis
- To understand visualization for time-series analysis
- To understand visualization for ranking analysis AND 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

Course Content

UNIT I Introduction

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.

UNIT II Time Analysis And Ranking Pattern

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.

UNIT III Distribution And Correlation 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.

UNIT IV Introduction To Dashboard

Information dashboard – categorizing dashboards – typical dashboard data – dashboard design issues and best practices – visual perception – limits of short-term memory – visually encoding data – Gestalt principles – principles of visual perception for dashboard design.

UNIT V Analysis And Designing Of Dashboard

Characteristics of dashboards – key goals in visual design process – dashboard display media – designing dashboards for usability – meaningful organization – maintaining consistency – aesthetics of dashboards – testing for usability – case studies: sales dashboard, CIO dashboard, Telesales dashboard, marketing analysis dashboard.

Course Outcomes

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

- Explain principles of visual perception
- Apply core skills for visual analysis
- Apply visualization techniques for various data analysis tasks
- Design information dashboard

Text Books

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.*

Reference Books

1. *Edward R. Tufte, "The visual display of quantitative information", Second Edition, Graphics Press, 2001.*
2. *Nathan Yau, "Data Points: Visualization that means something", Wiley, 2013.*
3. *Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.*
4. *Gert H. N. Laursen and Jesper Thorlund, "Business Analytics for Managers: Taking business intelligence beyond reporting", Wiley, 2010.*

Course Code	:	**CS629**
Course Title	:	**Knowledge Management**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To give an overview of Knowledge management, its evolution and the challenges it faces.
- To acquire the knowledge about building the learning organization and how knowledge markets are managed.
- To know the use of Knowledge management tools.
- To learn in-depth details about various knowledge management applications.
- To expose the future trends and challenges in knowledge management.

Course Content

Unit 1 Introduction

An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management**:** From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management

Unit 2 Organization And Knowledge Management

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets:Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

Unit 3 Telecommunications And Networks In Knowledge Management

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management -Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval -Information Coding in the Internet Environment - Repackaging Information.

Unit 4 Components Of A Knowledge Strategy

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).

Unit 5 Advanced Topics And Case Studies In Knowledge Management

Advanced topics and case studies in knowledge management - Development of a knowledgemanagement map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

Course Outcomes

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

- Ability to understand the fundamental concepts in knowledge management.
- Ability to understand the importance of knowledge sharing.
- Ability to know usage of knowledge management tools for various applications.
- Ability to develop knowledge management applications.
- Ability to design and develop enterprise knowledge management applications

Text Books

1. *Srikantaiah.T. K., Koenig, M., "Knowledge Management for the Information Professional"Information Today, Inc., 2000..*
2. *Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995*

Reference Books

1. *Kimiz Dalkir,Jay Liebowitz, "Knowledge Management in theory & practices",2011,2nd edition.*
2. ***Donald Hislop,"** Knowledge Management in Organizations -A critical introduction", 3rd edition, Oxford University Press.*

Course Code	:	**CS630**
Course Title	:	**Text Mining**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- Describe text extraction techniques.
- Differentiate clustering and classification techniques on text.
- Analyze visualization methodologies.
- Illustrate about event detection methods and embedding semantics in models.
- Compare feature extraction methods

Course Content

Unit-I: Text Extraction

Text Extraction: Introduction, Rapid automatic keyword extraction: candidate keywords, keyword scores, adjoining keywords, extracted keywords, Benchmark evaluation: precision and recall, efficiency, stoplist generation, Evaluation on new articles.

Unit-II: Clustering

Clustering: Multilingual document clustering: Multilingual LSA, Tucker1 method, PARAFAC2 method, LSA with term alignments, LMSA, LMSA with term alignments.

Unit-III: Classification

Classification: Content-based spam email classification using machine-learning algorithms, Utilizing nonnegative matrix factorization for email classification problems, Constrained clustering with k-means type algorithms.

Unit-IV: Anomaly and trend detection

Anomaly and trend detection: Text Visualization techniques such as tag clouds, authorship and change tracking, Data Exploration and the search for noval patterns, sentiment tracking, visual analytics and FutureLens, scenario discovery, adaptive threshold settting for novelty mining.

Unit-V: Text streams

Text streams: Introduction, Text streams, Feature extraction and data reduction, Event detection, Trend detection, Event and trend descriptions, Embedding semantics in LDA topic models: Introduction, vector space modeling, latent semantic analysis, probabilistic latent semantic analysis, Latent Dirichlet allocation, embedding external semantics from Wikipedia, data-driven semantic embedding.

Course Outcomes

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

- Design text extraction techniques.
- Design clustering techniques for text.
- Design classification techniques for text
- Practice visualization methodologies using tools.
- Practice feature extraction using tools

Text Books

1. *Michael W. Berry & Jacob Kogan ,"Text Mining Applications and Theory", Wiley publications.*
2. *Aggarwal, Charu C., and ChengXiang Zhai, eds. Mining text data. Springer Science & Business Media, 2012.*

Reference Books

1. *Miner, Gary, et al. Practical text mining and statistical analysis for non-structured text data applications. Academic Press, 2012.*
2. *Srivastava, Ashok N., and Mehran Sahami. Text mining: Classification, clustering, and applications. Chapman and Hall/CRC, 2009.*
3. *Buitelaar, Paul, Philipp Cimiano, and Bernardo Magnini, eds. Ontology learning from text: methods, evaluation and applications. Vol. 123. IOS press, 2005*.

Course Code	:	**CS631**
Course Title	:	**Digital And Cyber Forensics**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the basic digital forensics and techniques for conducting the forensic examination on different digital devices.
- To understand how to examine digital evidences such as the data acquisition, identification analysis.
- To understand the basics of mobile phone forensics.
- To understand the network based cyber security intrusion detection.
- To know the various forensics tool.

Course Content

UNIT- I Introduction

Computer forensics fundamentals, computer crimes, Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

UNIT-II Data Acquisition

Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.

UNIT-III Network Forensic

Collecting and analyzing network-based evidence, reconstructing web browsing, email activity, and windows registry changes, intrusion detection, tracking offenders. E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

UNIT-IV Mobile Network Forensic

Introduction, Mobile Network Technology, Investigations, Collecting Evidence, Where to seek Digital Data for further Investigations, Interpretation of Digital Evidence on Mobile Network.

UNIT-V Processing Crime

Processing crimes and incident scenes, securing a computer incident or crime, seizing and storing digital evidence at scene, obtaining digital hash, reviewing case, current computer forensics tools - software, hardware tools, validating and testing forensic software, addressing data-hiding techniques.

Course Outcomes

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

- Know how to apply forensic analysis tools to recover important evidence for identifying computer crime.
- train as next-generation computer crime investigators.
- identify the background of various forensic techniques.
- use correct tool for the particular case.
- classify the different kind of data.

Text Books

1. *Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.*
2. *Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations", 2nd edition, Thomson Course Technology, 2006, ISBN: 0-619-21706-5.*

Reference Books

1. *Network Forensics: Tracking Hackers Through Cyberspace, Sherri Davidoff, Jonathan Ham Prentice Hall, 2012*
2. *Iosif I. Androulidakis, " Mobile phone security and forensics: A practical approach", Springer publications, 2012*
3. *Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2nd Edition, Charles River Media, 2005, ISBN: 1-58450-389*

Course Code	:	**CS632**
Course Title	:	**Principles of Machine Learning And Deep Learning**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the basic building blocks and general principles that allow one to design machine learning algorithms
- To become familiar with specific, widely used machine learning algorithms
- To introduce building blocks of deep neural network architecture
- To understand representation and transfer of knowledge using deep learning
- To learn to use deep learning tools and framework for solving real-life problems

Course Content

UNIT-I Introduction

Basic Concepts, Introduction to Machine Learning, Applications of ML, Design Perspective and Issues in ML, Supervised, Unsupervised, Semi-supervised learning with applications and issues.

UNIT-II Supervised and Unsupervised Learning

Decision Tree - Representation, hypothesis, issues in Decision Tree Learning, Pruning, Rule extraction from Tree, Learning rules from Data, Probabilistic classifier: Bayes rule, Nearest Neighbor, Clustering: Unsupervised learning technique, Similarity and Distance Measures, k-means and k-medoids algorithm.

UNIT-III Deep Networks

Deep Networks – Introduction to Neural Networks, Feed-forward Networks, Deep Feed-forward Networks - Learning XOR, Gradient Based learning, Hidden Units, Back-propagation and other Differential Algorithms, Regularization for Deep Learning, Optimization for training Deep Models.

UNIT-IV Convolutional Networks

Convolution operation, Motivation, Pooling, Convolution and Pooling as strong prior, Efficient convolution algorithms, Unsupervised features, Sequence Modeling: Recurrent and Recursive Nets, LSTM Networks, Applications - Computer Vision, Speech Recognition, Natural Language Processing.

UNIT-V Deep Learning Frameworks

Introduction to Keras and Tensorflow, Deep Learning for computer vision - convnets, Deep Learning for Text and Sequences, Generative Deep Learning - Text Generation with LSTM, Deep Dream, Neural Style Transfer, Generating images with variational autoencoders, Generative Adversarial Networks (GAN).

Course Outcomes

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

- Ability to implement and apply machine learning algorithms to real-world applications.
- Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains
- Incorporate transfer of knowledge in machine learning algorithms
- Implement deep learning algorithms and solve real-world problems

Text Books

1. *Ethem Alpaydin, Introduction to Machine Learning, PHI, 2005*
2. *Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", The MIT Press, 2016.*

Reference Books

1. *Tom Mitchell, Machine Learning, McGraw-Hill, 1997*
2. *Francois Chollet, "Deep Learning with Python", Manning Publications, 2017*
3. *Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", O'Reilly Media; 1 edition (April 9, 2017)*
4. *Josh Patterson, "Deep Learning: A Practitioner's Approach", O'Reilly Media; 1 edition (August 19, 2017)*

Course Code		**CS633**
Course Title		**Multimedia Presentation And Coding Techniques**
Number of Credits		**3-0-0-3**
Prerequisites(Course code)		
Course Type		**PE**

Course Objectives

- To Understand how Text, Audio, Image and Video information can be represented digitally in aComputer
- To Learn the basic audio coding techniques
- To Understand the bi-level Image lossless coding techniques, grayscale and colour image coding techniques.
- To Understand lossy Image, video Coding techniques

Course Content

UNIT -I Multimedia Representation

Multimedia Representation - Text, Audio, Image and Video Representation - -Human Vision and Audio Systems and their Limitations - Sampling, Quantization, Coding, Companding. Multimedia Communication Systems – Database Systems – Synchronization issues – Presentation requirements – Applications – Video conferencing – Virtual reality – Interactive Video – Media on Demand.

UNIT- II Coding Techniques

Basic Coding Techniques-Introduction to Data Compression - Information Theory -Statistical Coding - Dictionary Based Coding – Audio Coding.

UNIT-III Lossless Image Coding

Lossless Image Coding-Bi-Level -Reflected Gray Codes - Predictive Coding –GIF-Lossless JPEG

UNIT- IV Lossy Image Coding

Lossy Image Coding-Distortion Measures -Transform Coding -JPEG -Wavelet Coding -Sub-Band Coding - JPEG2000 - Progressive Image Coding.

UNIT- V Video Coding

Video Coding (Lossy)-Video Coding Concepts - The Hybrid DPCM/DCT Algorithm-Motion Compensated Prediction- Motion Estimation-Standards: H.261, MPEG-1,2,4,7.

Course Outcomes

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

- Study representation of different multimedia formats.
- Develop new algorithms for multimedia compression
- Explore new techniques in the areas of Multimedia applications
- Explore the possibility of applying Multimedia concepts in various domains

Text Books

1. *Ze-Nian Li & Mark Drew, "Fundamentals of Multimedia", Prentice Hall, 2004.*
2. *Yun Q. Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering:Fundamentals, Algorithms, and Standards*", CRC Press, Second edition, 2008

Reference Books

1. *B.Prabhakaran, "Multimedia Database Management Systems", Springer International Edition,2007.*
2. *Tay Vaughan, "Multimedia: Making it Work", McGraw Hill Publication, Eighth Edition,* 2010.

Course Code	:	**CS634**
Course Title	:	**Principles of Datawarehousing and Data Mining**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the principles of Data warehousing and Data Mining.
- To be familiar with the Data warehouse architecture and its Implementation.
- To know the Architecture of a Data Mining system.
- To understand the various Data Pre-processing Methods.
- To understand the various classification and clustering techniques
- To get an introduction to spatial, multimedia and text mining

Course Content

UNIT-I Data Warehousing

Data Warehousing and Business Analysis: - Data Warehousing Components –Building a Data warehouse –Data Warehouse Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata – reporting – Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

UNIT-II Data Mining

Data Mining Functionalities – Data Pre-processing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems. Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods – Mining Various Kinds of Association Rules – Association Mining to Correlation Analysis – Constraint-Based Association Mining.

UNIT-III Classification and Prediction

Issues Regarding Classification and Prediction – Classification by Decision Tree Introduction – Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor – Ensemble Methods – Model Section.

UNIT-IV Cluster Analysis

Types of Data in Cluster Analysis – Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model Based Clustering Methods – Clustering High-Dimensional Data – Constraint-Based Cluster Analysis – Outlier Analysis.

UNIT-V Advanced Mining Techniques

Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web Introduction to big data, big data analytics, NoSQL systems, Hadoop, PIG and HIVE

Course Outcomes

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

- Technical knowhow of the Data Mining principles and techniques for real time applications.
- Apply the knowledge of data classification to classify any real time data
- Measure the performance of any classification algorithm
- Select and apply proper clustering techniques to build analytical applications
- Discover the knowledge from the high dimensional system

Text Books

1. *Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2011.*
2. *Edward Capriolo, Dean Wampler, Jason Rutherglen "Programming Hive: Data Warehouse and Query Language for Hadoop" 1st Edition, O'reilly, 2012*

Reference Books

1. *Pramod J. Sadalage, Martin Fowler , "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", first edition, Addison-Wesley Professional, 2012*
2. *Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.*
3. *K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data Mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.*
4. *G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.*

Course Code	:	**CS635**
Course Title	:	**Hardware Security**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the different issues in hardware security
- To introduce the side channel attacks and counter measures to avoid it.
- To study on the detection and prevention of Hardware Trojan.
- To know the legal, ethical and professional issues in Information Security.
- To know the aspects of risk management.

Course Content

UNIT - I Preliminaries

Algebra of Finite Fields, Basics of the Mathematical Theory of Public Key Cryptography, Basics of Digital Design on Field-programmable Gate Array (FPGA), Classification using Support Vector Machines (SVMs).

Useful Hardware Security Primitives: Cryptographic Hardware and their Implementation, Optimization of Cryptographic Hardware on FPGA, Physically Unclonable Functions (PUFs), PUF Implementations, PUF Quality Evaluation, Design Techniques to Increase PUF Response Quality.

UNIT- II Side-channel Attacks on Cryptographic Hardware

Basic Idea, Current-measurement based Side-channel Attacks (Case Study: Kochers Attack on DES), Design Techniques to Prevent Side-channel Attacks, Improved Side-channel Attack Algorithms (Template Attack, etc.), Cache Attacks

UNIT – III Testability and Verification of Cryptographic Hardware

Fault-tolerance of Cryptographic Hardware, Fault Attacks, Verification of Finite-field Arithmetic Circuits. Modern IC Design and Manufacturing Practices and Their Implications:Hardware Intellectual Property (IP) Piracy and IC Piracy, Design Techniques to Prevent IP and IC Piracy, Using PUFs to prevent Hardware Piracy, Model Building Attacks on PUFs (Case Study: SVM Modeling of Arbiter PUFs, Genetic Programming based Modeling of Ring Oscillator PUF)

UNIT – IV Hardware Trojans and Their Detection

Hardware Trojan Nomenclature and Operating Modes, Countermeasures Such as Design and Manufacturing Techniques to Prevent/Detect Hardware Trojans, Logic Testing and Side-channel Analysis based Techniques for Trojan Detection, Techniques to Increase Testing Sensitivity.

UNIT – V Infrastructure Security

Impact of Hardware Security Compromise on Public Infrastructure, Defense Techniques (Case Study: Smart-Grid Security)

Course Outcomes:

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

- Develop algorithms to eliminate side channel attacks.
- Design new techniques that will increase puff response quality.
- Model new arbiter puffs.
- Become aware of various standards in the Information Security System.
- Illustrate the legal, ethical and professional issues in information security.

Text Books

1. *DebdeepMukhopadhyay and RajatSubhra Chakraborty: Hardware Security: Design, Threats and Safeguards, CRC Press, 2014.*

2. *Ahmad-Reza Sadeghi and David Naccache (eds.): Towards Hardware-intrinsic Security: Theory and Practice, Springer, 2010.*

Reference Books

1. *Ted Huffmire et al: Handbook of FPGA Design Security, Springer.*
2. *Stefan Mangard, Elisabeth Oswald, Thomas Popp: Power analysis attacks - revealing the secrets of smart cards, Springer, 2010.*
3. *Mark Joye and Michael Tunstall: Fault Analysis in Cryptography, Springer, 2012*
4. *Abijit Das and C. E. VeniMadhavan: Public-Key Cryptography: Theory and Practice, Pearson Education Asia, 2009.*

Course Code	:	**CS636**
Course Title	:	**Advanced Digital Design**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To understand the basic building blocks, logic gates, adders, multipliers, shifters and other digital devices
- To apply logic minimization techniques, including Karnaugh Maps
- To learn techniques and tools for programmable logic design

Course Content

UNIT-I Combinational and Sequential logic design

Review of Combinational and Sequential logic design – Structural models of combinational logic – Propagation delay – Behavioral Modeling – Boolean equation based behavioral models of combinational logic – Cyclic behavioral model of flip-flop and latches – A comparison of styles for behavioral modeling – Design documentation with functions and tasks

UNIT-II Synthesis of Combinational and Sequential logic

Synthesis of Combinational and Sequential logic – Introduction to synthesis – Synthesis of combinational logic – Synthesis of sequential logic with latches – Synthesis of three-state devices and bus interfaces – Synthesis of sequential logic with flip-flops – Registered logic – State encoding – Synthesis of gated clocks and clock enables – Anticipating the results of synthesis – Resets – Synthesis of loops – Design traps to avoid – Divide and Conquer: partitioning a design.

UNIT-III Design and Synthesis of Datapath Controllers

Design and Synthesis of Datapath Controllers – Partitioned sequential machines – Design example: Binary counter – Design and synthesis of a RISC stored-program machine – Processor, ALU, Controller, Instruction Set, Controller Design and Program Execution – UART – Operation, Transmitter, Receiver.

UNIT-IV Programmable devices

Programmable logic devices – Storage devices – Programmable Logic Array (PLA) – Programmable Array Logic (PAL) – Programmability of PLDs – Complex PLDs – Introduction to Altera and Xilinx FPGAs – Algorithms – Nested loop programs and data flow graphs – Design Example of Pipelined Adder, Pipelined FIR Filter – Circular buffers – FIFOs and Synchronization across clock domains – Functional units for addition, subtraction, multiplication and division – Multiplication of signed binary numbers and fractions.

UNIT-V Postsynthesis Design Validation

Postsynthesis Design Validation – Postsynthesis Timing Verification – Elimination of ASIC Timing Violations – False Paths – Dynamically Sensitized Paths – System Tasks for Timing Verificaion – Fault Simulation and Testing – Fault Simulation – Fault Simulation with Verifault-XL, lab exercises using Xilinx and Bluespec

Course Outcome

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

- Understand the use standard digital memory devices as components in complex subsystems
- Obtain technical knowhow to design simple combinational logic circuits and logic
- Acquire skill set to develop the necessary software for basic digital systems

Text Book

1. *Michael D. Ciletti, "Advanced Digital Design with the VERILOG HDL, 2nd Edition, Pearson Education, 2010.*

Reference Books

1. *Samir Palnitkar "Verilog HDL", 2nd Edition, Pearson Education, 2003.*
2. *Stephenbrown, "Fundamentals of Digital Logic with Verilog", M*

Course Code	:	**CS637**
Course Title	:	**Real Time Systems**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- To study issues related to the design and analysis of systems with real-time constraints.
- To learn the features of Real time OS.
- To learn about computer control and hardware requirements for Real time systems.
- To study the methods of developing Real time applications.
- To study the difference between different Real time system development methodologies.

Course Content

UNIT-I Introduction to real–time computing

Elements of Control System – Structure of a real–time system – Classification of Real-time Systems, Time Constraints, Classification of Programs, Concepts of Computer Control: Introduction, Sequence Control, Loop Control, Supervisory Control, Centralized Computer Control, Hierarchical Systems.

UNIT-II Hardware Requirements for Real-Time Applications

Introduction – General Purpose Computer – Single Chip Microcomputers and Microcontrollers – Specialized Processors – Process-Related Interfaces – Data Transfer Techniques – Communications – Standard Interface.

UNIT-III Languages for Real-Time Applications

Introduction – Syntax Layout and Readability – Declaration and Initialization of Variables and Constants – Modularity and Variables – Compilation of Modular Programs – Data types – Control Structures – Exception Handling – Low-level facilities – Co–routines – Interrupts and Device Handling – Concurrency –Real-Time Support – Overview of Real-Time Languages.

UNIT-IV Real Time Operating Systems

Introduction – Real-Time Multi-Tasking OS – Scheduling Strategies – Priority Structures – Task Management – Scheduler and Real-Time Clock Interrupt Handler – Memory Management – Code Sharing – Resource Control – Task Co-Operation and Communication – Mutual Exclusion.

UNIT-V RTS Development Methodologies

Introduction – Yourdon Methodology – Ward and Mellor Method – Hately and Pirbhai Method.

Course Outcomes

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

- Understand classifications of Real time systems.
- Comprehend Real-time programming environments
- Schedule jobs in Real time systems
- Develop real time systems.

Text Books

1. *Stuart Bennet, "Real–Time Computer Control", 2nd Edn., Pearson Education, 2008.*

Reference Books

1. Rajib Mall, "Real–Time Systems: Theory and Practice", 1st edition, Pearson Education, 2012

Course Code	:	**CS638**
Course Title	:	**Smart phone computing**
Number of Credits	:	**3-0-0-3**
Prerequisites (Course code)	:	
Course Type	:	**PE**

Course Objectives

- Recognize the different challenges in mobile computing
- Estimate the measurement and management of energy for wireless devices
- Categorize about the different interface design issues
- Identify Gesture Recognition
- Privacy and Security in mobile computing

Course Content

UNIT-I Introduction & Programming platforms:

Introduction: Challenges in mobile computing, convergence of sensing, computing, and communications, Introduction to smartphones, tablet, PDA, or other digital mobile devices, Introduction to smartphone system architecture.

Programming platforms: Overview of different mobile programming environments, Difference with the classical programming practices, Introduction to mobile operating systems, iOS, Android, Windows, Mobile application development.

UNIT-II Wireless Energy Management & Localization

Wireless Energy Management: Measurement of energy consumption, WiFi Power Save Mode (PSM), Constant Awake Mode (CAM), Different Sleep States, WiFi Energy management.

Localization: User location and tracking system, Cell tower localization, Spot localization, Logical location, Ambience fingerprinting, War-driving, Localization without war-driving, Indoor localization, Crowd sourcing forlocalization.

UNIT-III Location Privacy & Context Sensing

Location Privacy: Different approaches, K-anonymity, CliqueCloak, Location Privacy, Applications with location proof.

Context Sensing: Context-Aware system, Automatic Image Tagging, Safety critical applications (case study: determining driver phone use), Energy-efficient Context Sensing, Contextual Ads and Mobile Apps.

Lab Component: (if applicable)

UNIT-IV Activity and Gesture Recognition

Activity and Gesture Recognition: Machine Recognition of Human Activities, Mobile Phones to Write in Air, Personalized Gesture Recognition, Content Rating, Recognizing Human without Face Recognition, Phone-to-Phone Action Games, Interface design issues, Touchscreen, Gesture-based Input.

UNIT-V Mobility & Privacy and Security & Miscellany

Mobility: Overview of Mobility models, Automatic Transit Tracking, Mapping, Arrival Time Prediction, Augmenting Mobile 3G with WiFi, Vehicular WiFiHotspots, Code Offload

Privacy and Security: Authentication on Mobile Phones, Activity based Password, Finger Taps usage as Fingerprints

Miscellany: Cloud-based services, Peer-to-peer applications, Delay-tolerance, Mobile social networking .

Course Outcomes

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

- Create and enhance the localization and tracking systems.
- Assess and improve services available for mobile social networking.
- Design secure critical applications on mobile.
- Develop an algorithm for Gesture Recognition
- Develop an algorithm for Security in mobile computinng

Text Books

1. *Smart Phone and Next Generation Mobile Computing (Morgan Kaufmann Series in Networking), PeiZheng, Lionel Ni, 2005*
2. *Principles Of Mobile Computing, Hansmann, LotharMerk, Martin Niclous, Stober, 2006*
3. *Mobile Computing*, Tomasz Imielinski, Springer, 1996

Reference Books

1. *Zheng, Pei, and Lionel Ni. Smart phone and next generation mobile computing. Elsevier, 2010.*
2. *Mayes, Keith E., and Konstantinos Markantonakis, eds. Smart cards, tokens, security and applications. Vol. 1. New York: Springer, 2008.*
3. *Bolt, Richard A. "Put-that-there": Voice and gesture at the graphics interface. Vol. 14. No. 3. ACM, 1980.*
4. *Kazmierski, Tom J., and Steve Beeby*. *Energy harvesting systems*. New York: Springer, 2014.