ACADEMIC CURRICULA

(Course Structure and Detailed Syllabi)

MASTER'S DEGREE PROGRAM

M.TECH

in Computer Science and Engineering

(With all specializations)

2023

School of Computer Engineering

KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY

Deemed to be University U/S 3 of the UGC Act, 1956

BHUBANESWAR, ODISHA, INDIA

SCHOOL OF COMPUTER ENGINEERING

MTECH in Computer Science & Engineering
Specialization in COMPUTER ENGINEERING

SEMESTER-I

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	MA60001	Mathematical Foundations for Computer Science	4	0	0	4	4
2	CS60101	Advanced Data Structures and Algorithms	4	0	0	4	4
3	CS60105	Advanced Database Management Systems	4	0	0	4	4
4	CS60103	High Performance Computer Architecture	3	0	0	3	3
5		Elective I	3	0	0	3	3
Total Credit (Theory Subjects)						**18**	**18**
Practical							
1	CS69101	Advanced Programming Lab	0	0	2	2	1
2	CS69103	Advanced Database Lab	0	0	2	2	1
Sessional							
1	CS68101	Fundamentals of Research Methodology	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**24**	**21**

SEMESTER-II

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	CS60102	Computational Intelligence	4	0	0	4	4
2	CS60104	Advanced Network Principles and Protocols	3	0	0	3	3
3		Elective II	3	0	0	3	3
4		Elective III	3	0	0	3	3
5		Elective IV	3	0	0	3	3
Total Credit (Theory Subjects)						**16**	**16**
Practical							
1	CS69102	Computational Intelligence Lab	0	0	2	2	1
2	CS69104	Network Programming Lab	0	0	2	2	1
Sessional							
1	CS68102	Seminar	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**22**	**19**

SEMESTER-III

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67101	Thesis Part-I	0	0	0		16
Semester Total						**16**

SEMESTER-IV

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67102	Thesis Part-II	0	0	0		20
Semester Total						**20**
Total Course Credit						**76**

LIST OF DEPARTMENT ELECTIVES

ELECTIVE-I						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62201	Data warehousing and Data mining	3	0	0	3	3
CS62105	Internet of Things	3	0	0	3	3
CS62101	Cloud Computing Principles	3	0	0	3	3
CS62109	Wireless Sensor Networks	3	0	0	3	3
CS62103	Image Processing	3	0	0	3	3
ELECTIVE-II						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62104	Principles of Machine Learning & Deep Learning	3	0	0	3	3
CS62106	Statistical Natural language processing	3	0	0	3	3
CS62402	Software Design Architecture	3	0	0	3	3
CS62202	Data Visualization	3	0	0	3	3
CS62208	Text Mining	3	0	0	3	3
ELECTIVE-III/IV						
CS60106	Advanced Digital Design	3	0	0	3	3
CS60114	Design and Analysis of Parallel Algorithms	3	0	0	3	3
CS60108	Artificial Intelligence and Expert Systems	3	0	0	3	3
CS60308	Foundations of Block Chain Technology	3	0	0	3	3
CS60118	Pattern Recognition	3	0	0	3	3
CS60110	Cognitive Science	3	0	0	3	3
CS62107	Real Time systems	3	0	0	3	3
CS60116	Knowledge management	3	0	0	3	3
CS60112	Computational geometry	3	0	0	3	3
CS60120	Smart phone Computing	3	0	0	3	3

SCHOOL OF COMPUTER ENGINEERING

MTECH in Computer Science & Engineering
Specialization in DATA ANALYTICS

SEMESTER-I

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	MA60001	Mathematical Foundations for Computer Science	4	0	0	4	4
2	CS60101	Advanced Data Structures and Algorithms	4	0	0	4	4
3	CS60105	Advanced Database Management Systems	4	0	0	4	4
4	CS60201	Data Science & Analytics	3	0	0	3	3
5		Elective I	3	0	0	3	3
Total Credit (Theory Subjects)						**18**	**18**
Practical							
1	CS69101	Advanced Programming Lab	0	0	2	2	1
2	CS69201	Data Science & Analytics Lab	0	0	2	2	1
Sessional							
1	CS68101	Fundamentals of Research Methodology	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**24**	**21**

SEMESTER-II

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	CS60102	Computational Intelligence	4	0	0	4	4
2	CS60202	Business Analytics & Intelligence	3	0	0	3	3
3		Elective II	3	0	0	3	3
4		Elective III	3	0	0	3	3
5		Elective IV	3	0	0	3	3
Total Credit (Theory Subjects)						**16**	**16**
Practical							
1	CS69102	Computational Intelligence Lab	0	0	2	2	1
2	CS69202	Business Analytics & Intelligence Lab	0	0	2	2	1
Sessional							
1	CS68202	Seminar	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**22**	**19**

SEMESTER-III

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67201	Thesis Part-I	0	0	0		16
Semester Total						**16**

SEMESTER-IV

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67202	Thesis Part-II	0	0	0		20
Semester Total						**20**
Total Course Credit						**76**

LIST OF DEPARTMENT ELECTIVES

ELECTIVE-I						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62105	Internet of Things	3	0	0	3	3
CS62101	Cloud computing principles	3	0	0	3	3
CS62109	Wireless Sensor Networks	3	0	0	3	3
CS62107	Real Time systems	3	0	0	3	3
CS62103	Image Processing	3	0	0	3	3
ELECTIVE-II						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62206	Social Network Analysis	3	0	2	5	4
CS62106	Statistical Natural Language Processing	3	0	2	5	4
CS62204	Exploratory and Interactive Data Analysis	3	0	2	5	4
CS62202	Data Visualization	3	0	2	5	4
CS62102	Deep Learning and its Applications	3	0	2	5	4
ELECTIVE-III/IV						
CS60212	Supply Chain Analytics	3	0	0	3	3
CS60214	Web Analytics	3	0	0	3	3
CS60208	Human Resource Analytics	3	0	0	3	3
CS60110	Cognitive Science	3	0	0	3	3
CS60118	Pattern Recognition	3	0	0	3	3
CS60210	Image and Video Analytics	3	0	0	3	3
CS60122	Web Intelligence	3	0	0	3	3
CS60204	Analytics for Strategic Market Planning	3	0	0	3	3
CS60206	Financial Risk Analytics and Management	3	0	0	3	3
CS60308	Foundations of Block Chain Technology	3	0	0	3	3

SCHOOL OF COMPUTER ENGINEERING

MTECH in Computer Science & Engineering
Specialization in INFORMATION SECURITY

SEMESTER-I

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	MA60001	Mathematical Foundations for Computer Science	4	0	0	4	4
2	CS60101	Advanced Data Structures and Algorithms	4	0	0	4	4
3	CS60105	Advanced Database Management Systems	4	0	0	4	4
4	CS60301	Principles of Cryptography	3	0	0	3	3
5		Elective I	3	0	0	3	3
Total Credit (Theory Subjects)						**18**	**18**
Practical							
1	CS69101	Advanced Programming Lab	0	0	2	2	1
2	CS69301	Cryptography Lab	0	0	2	2	1
Sessional							
1	CS68101	Fundamentals of Research Methodology	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**24**	**21**

SEMESTER-II

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	CS60102	Computational Intelligence	4	0	0	4	4
2	CS60302	Network Security	3	0	0	3	3
3		Elective II	3	0	0	3	3
4		Elective III	3	0	0	3	3
5		Elective IV	3	0	0	3	3
Total Credit (Theory Subjects)						**16**	**16**
Practical							
1	CS69102	Computational Intelligence Lab	0	0	2	2	1
2	CS69302	Network Security Lab	0	0	2	2	1
Sessional							
1	CS68302	Seminar	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**22**	**19**

SEMESTER-III

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67301	Thesis Part-I	0	0	0		16
Semester Total						**16**

SEMESTER-IV

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67302	Thesis Part-II	0	0	0		20
Semester Total						**20**
Total Course Credit						**76**

LIST OF DEPARTMENT ELECTIVES

ELECTIVE-I						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62301	Data Privacy	3	0	0	3	3
CS62307	Secure Cloud Computing	3	0	0	3	3
CS62303	Information Theory & Coding	3	0	0	3	3
CS62305	Intrusion Detection System	3	0	0	3	3
CS62103	Image Processing	3	0	0	3	3
ELECTIVE-II						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62308	Steganography and Digital Water Marking	3	0	0	3	3
CS62310	Web and Database Security	3	0	0	3	3
CS62302	Biometric Security	3	0	0	3	3
CS62306	Digital Forensics	3	0	0	3	3
CS62304	Cyber Security	3	0	0	3	3
ELECTIVE-III/IV						
CS60316	Secure Operating Systems	3	0	0	3	3
CS60306	Design of Secure Protocols	3	0	0	3	3
CS60304	Cyber laws and Intellectual Property Rights	3	0	0	3	3
CS60320	Secure Software Engineering	3	0	0	3	3
CS60312	Mobile Wireless Security	3	0	0	3	3
CS60318	Secure Protocols for Electronic Commerce	3	0	0	3	3
CS60314	Public Key Infrastructure and Trust Management	3	0	0	3	3
CS60308	Foundations of Block Chain Technology	3	0	0	3	3
CS62108	Web Technologies & Services	3	0	0	3	3
CS60310	Information Security and Secure Coding	3	0	0	3	3

SCHOOL OF COMPUTER ENGINEERING

MTECH in Computer Science & Engineering
Specialization in SOFTWARE ENGINEERING

SEMESTER-I

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	MA60001	Mathematical Foundations for Computer Science	4	0	0	4	4
2	CS60101	Advanced Data Structures and Algorithms	4	0	0	4	4
3	CS60105	Advanced Database Management Systems	4	0	0	4	4
4	CS60401	Software Requirement Engineering	3	0	0	3	3
5		Elective I	3	0	0	3	3
Total Credit (Theory Subjects)						**18**	**18**
Practical							
1	CS69101	Advanced Programming Lab	0	0	2	2	1
2	CS69401	Software Engineering Lab	0	0	3	2	1
Sessional							
1	CS68101	Fundamentals of Research Methodology	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**25**	**21**

SEMESTER-II

Theory							
Sl. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
1	CS60102	Computational Intelligence	4	0	0	4	4
2	CS60402	Software Testing	3	0	0	3	3
3		Elective II	3	0	0	3	3
4		Elective III	3	0	0	3	3
5		Elective IV	3	0	0	3	3
Total Credit (Theory Subjects)						**16**	**16**
Practical							
1	CS69102	Computational Intelligence Lab	0	0	2	2	1
2	CS69402	Software Testing Laboratory	0	0	2	2	1
Sessional							
1	CS68402	Seminar	0	0	2	2	1
Total Credit (Practical & Sessional Subjects)						**6**	**3**
Total Credit (Semester)						**22**	**19**

SEMESTER-III

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67401	Thesis Part-I	0	0	0		16
Semester Total						**16**

SEMESTER-IV

Subject Code	Subject Name	L	T	P	Total Hours	Credit
CS67402	Thesis Part-II	0	0	0		20
Semester Total						**20**
Total Course Credit						**76**

LIST OF DEPARTMENT ELECTIVES

ELECTIVE-I						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62403	Service Oriented Architecture	3	0	0	3	3
CS62105	Internet of Things	3	0	0	3	3
CS62101	Cloud computing principles	3	0	0	3	3
CS62401	Component Based Software Engineering	3	0	0	3	3
CS62103	Image Processing	3	0	0	3	3
ELECTIVE-II						
Subject Code	**Subject Name**	**L**	**T**	**P**	**Total Hours**	**Credit**
CS62402	Software Design Architecture	3	0	0	3	3
CS62108	Web Technologies & Services	3	0	0	3	3
CS62406	Software Project Management	3	0	0	3	3
CS62404	Software Development Methodologies	3	0	0	3	3
CS62104	Principles of Machine Learning & Deep Learning	3	0	0	3	3
ELECTIVE-III/IV						
CS60408	Software Reliability	3	0	0	3	3
CS60114	Design and Analysis of Parallel Algorithms	3	0	0	3	3
CS60406	Software Maintenance & Configuration Management	3	0	0	3	3
CS60118	Pattern Recognition	3	0	0	3	3
CS60122	Web Intelligence	3	0	0	3	3
CS60112	Computational geometry	3	0	0	3	3
CS60120	Smart phone Computing	3	0	0	3	3
CS60404	Software Engineering Process & Quality	3	0	0	3	3
CS60116	Knowledge management	3	0	0	3	3
CS60210	Image and Video Analytics	3	0	0	3	3

MATHEMATICAL FOUNDATIONS FOR COMPUTERSCIENCE

Subject Code: **MA60001**
Credit: **4-0-0-4**
Prerequisite: **Nil**

Course Objective:

This course enables the students with numerical techniques in finding roots and eigen values, probability and statistical inference, graph theory, and linear algebra which serve as essential tools for applications of computer and information sciences.

Course Outcomes:

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

CO1: Understand the numerical methods to solve and find the roots of the equations and eigenvalues,
CO2: Utilize the statistical tools in multi variable distributions
CO3: Use probability formulations for new predictions with discrete and continuous random variables,
CO4: Analyze quality control chart for the parameters mean, variance, and standard deviation.
CO5: Speculate various graphs in different geometries related to edges,
CO6: Interpret vector spaces and related topics arising in magnification and rotation of images

Course Contents:

Numerical Methods

Significant figures, Error definitions, Approximations and round off errors accuracy and precision, Roots of Equations: Bairstow-Lin's Method, Graeffe's Root Squaring Method. Computation of eigenvalues of real, symmetric matrices: Jacobi and Givens method.

Probability & Statistics

Random Variable, Some Special Distributions: Binomial, Hyper-geometric, Exponential, Weibul distribution, Point and Interval Estimation, Testing of Hypothesis, Bivariate Distribution, Co-relation and Regression Analysis, and Statistical quality control**.**

Graph Theory

Isomorphism, Planar Graphs, Euler's formula,applications of Kuratowski's theorem.Graph Coloring, and Chromatic polynomials.Trees, Weighted trees, and Max-flow min-cut theorem. Matching, and Hallsmarriageproblem. Independentset,Dominatingset, Vertex cover, and Clique.

Linear Algebra

Vector spaces, Subspaces, Linearly Independent and Dependent Vectors, Bases and Dimension, Coordinate Vectors with illustrative examples. Linear Transformations, Representation of Transformations by Matrices, Linear Functional, Non Singular Linear Transformations, and Inverse of a Linear Transformation.

Text Books:

1.M.K.Jain, S.R.K.Iyengar and R.K.Jain: Numerical Methods for Scientific and Engineering Computation. 6th Ed.,New Age Int.Publishers.2012.

2. T.Veerarajan: “Probability, Statistics and Random Process“,3 rd Edition,Tata Mc-Graw Hill Co.,2016.

3.G.Chartrand and P.Zhang,Introduction to Graph Theory,Mc-GrawHill Companies.

4.V Krishnamurthy V.P. Mainra, J.l. Arora, “An Introduction To Linear Algebra”; Published by Affiliated East-West Press Pvt Ltd. New Delhi, 2016.

Reference Books:

1.SheldonM.Ross,Introductionto Probability Models,Elsevier.

2.Linear Algebra 2nd Edition (Paperback) by Kenneth Hoffman, RayKunze, PHI Learning,2009.

FUNDAMENTALS OF RESEARCH METHODOLOGY
Subject Code: CS68101
Credit: 0-0-2-1
Prerequisite: Nil

Course Objectives:

This course addresses the issues inherent in selecting a research problem and discuss the techniques and tools to be employed in completing a research project. This will also enable the students to prepare report writing and framing Research proposals.

Course Outcomes:

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

CO1: Conduct review of literature effectively
CO2: Formulate a viable research problem
CO3: Effectively write a technical paper based on research findings
CO4: Analyze and interpret research data
CO5: Develop awareness on IPR and allied issues
CO6: Follow ethical practices in research

Course Contents:

Introduction:

Types of research, Literature review, Research gap, Motivation, Research objectives and specifications, Formulation of research questions, Research approach, Research hypothesis.

Research Writing:

Methodology to write a technical paper/short communication/research proposal/monograph, Abstract writing, Report or presentation of results, Bibliography.

Data Analysis:

Classification of data, Methods of data collection, Statistical techniques, Design of experiments and choosing an appropriate statistical technique, Introduction to mathematical modeling (regression, model fitting), Hypothesis testing, Statistical inference.

Intellectual Property:

Intellectual property, Patent, Trademark, GI, Copyright and related rights, Research Incentives, PCT and WIPO.

Plagiarism:

Definition, Plagiarism and consequences, IPR Violation and Detection.

Research Ethics:

Professional ethics in research, Ethical issues, Definition and importance, Ethical guidelines, Peer review, Research misconduct, Conflicts of interest.

Reference Books:

1.C. R. Kothari, Research Methodology, New Age International, 2004.

2.Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.

3.J. W. Bames, Statistical Analysis for Engineers and Scientists, Tata McGraw-Hill, New York.

4.Donald Cooper, Business Research Methods, Tata McGraw-Hill, New Delhi.

5.Leedy P. D., Practical Research: Planning and Design, McMillan Publishing Co.

6.Day R. A., How to Write and Publish a Scientific Paper, Cambridge University Press, 1989.

7.Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi, 2012.

8.R. Subramanian, Professional Ethics, Oxford University Press, 2013.

ADVANCED DATA STRUCTURES AND ALGORITHMS
Subject Code: CS60101
Credit: 4-0-0-4
Prerequisite: Nil

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 Outcomes:

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

CO1: Familiarize with algorithmic techniques such as brute force, greedy, and divide and conquer
CO2: Apply advanced abstract data type (ADT) and data structures in solving real world problems.
CO3: Analyze and apply graph data structure to real-life problems

CO4: Effectively combine fundamental data structures and algorithmic techniques in building a complete algorithmic solution to a given problem
CO5: Evaluate different classes of problem:NP,NP Complete and NP hard
CO6: Analyze the given scenario and choose the appropriate Data structure for solving problems

Course Contents:

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

Heaps

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

Trees

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

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

Geometric Algorithms

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

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.

Reference Books:

1.Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars, "Computational Geometry Algorithms and Applications", Third Edition, Springer, 2011.

2.Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, 2008.

Computational Intelligence
Subject Code: CS60102
Credit: 4-0-0-4
Prerequisite: Nil

Course Objectives:

The unit covers rule-based expert systems, fuzzy expert systems, frame-based expert systems, artificial neural networks, evolutionary computation, hybrid intelligent systems and knowledge engineering.

The objective of this course is to acquaint students with intelligent systems and provide them with a working knowledge for building these systems.

Course Outcomes:

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

CO1: Understand the basic concepts and characteristics of soft computing and also its associated methodologies
CO2: Apply various set theoretic operations in fuzzy sets
CO3: Understand and analyze fuzzy rules, fuzzy reasoning and various fuzzy inference systems
CO4: Understand derivative free optimization and apply genetic algorithms to solve optimization problems
CO5: Understand swarm-based optimization and apply swarm-based techniques to solve optimization problems
CO6: Able to understand concepts of artificial neural networks and apply neural networks to various classification problems

Course Contents:

Introduction to Neuro-Fuzzy and Soft Computing

Introduction, Soft Computing constituents and Conventional AI,Neuro-Fuzzy and Soft Computing characteristics.

Fuzzy Set Theory

Fuzzy sets, Basic definitions and terminologies, Set-theoretic operations, Member function formulation and parameterization, More on union, intersection and complement.

Fuzzy Rules, Fuzzy Reasoning and Fuzzy Inference System

Extension principle and fuzzy relations, Fuzzy if-then rules (including linguistic variables), Fuzzy reasoning, Fuzzy inference systems, Mamdani fuzzy model, Sugeno fuzzy model, Tsukamoto fuzzy model.

Genetic Algorithms

Derivative free Optimization, Genetic Algorithms, Concepts of selection, crossover and mutation, Differential Evolution as modified GA.

Swarm-based optimization

Particle Swarm Optimization - PSO Model, Global Best, Local Best, Velocity Update Equations, Position Update Equations; Ant Colony Optimization - Basic Concepts, Ant Behaviour, Applications; Artificial Bee Colony: Basic concepts, Types of Bees and Their Role in the Optimization Process.

Artificial Neural Networks

Introduction to ANN, Perceptrons and MLP, Perceptron learning algorithm, Adaline and Madaline, Backpropagation Multilayer Perceptrons, Some supervised and

unsupervised learning networks, Radial Basis Function Networks (RBF), Kohonen Self-Organizing Networks, Learning Vector Quantization, Hebbian Learning, Hopfield networks.

Text Book:

1. Neuro-Fuzzy and Soft Computing, Jang, Sun, Mizutani, PHI/Pearson Education.

Reference Books:

1.Genetic Algorithms: Search, Optimization and Machine Learning, Davis E. Goldberg, Addison Wesley, N.Y.

2.Neural Network Design, M. T. Hagan, H. B. Demuth, Mark Beale, Cengage Learning.

3.Swarm Intelligence Algorithms: A Tutorial, Adam Slowik, Ed: CRC Press, 2020.

4.Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran and G.A.V. Pai, PHI

5.Neural Networks, Satish Kumar, TMH.

6.Fuzzy Logic with Engineering Applications, Timothy J. Ross, McGraw-Hill.

HIGH PERFORMANCE COMPUTER ARCHITECTURE
Subject Code: CS60103
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To understand the basics of high performance computer architecture.
To understand the concept of parallel execution within computer systems through modern parallelarchitectures.
To assess the communication and computing possibilities of high performance computing architecture andto predict the performance of parallel applications.
To gain knowledge about the real world high performance processors.

Course Outcomes:

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

CO1: To realize the basics of high performance computer architecture
CO2: To analyze the concept of parallel execution within computer systems through modern parallel architectures
CO3: To assess the communication and computing possibilities of high performance computing architecture and to predict the performance of parallel applications
CO4: To apply the concept memory allocation and management in high performance computer
CO5: Can able to discuss the advance storage concepts and interaction with I/O devices
CO6: To gain knowledge about the real world high performance processors

Course Contents:

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.

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

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.

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

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.

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.

Advanced Database Management Systems
Subject Code: CS60104
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To understand the basic concepts and terminology related to DBMS and Relational Database Design
To 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 Outcomes:-

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

CO1: To construct Entity-Relationship models from specifications and conversion into logical data models
CO2: To apply data normalization principles for getting good database design
CO3: To analyze query processing & evaluations
CO4: To distinguish between parallel and distributed databases
CO5: To develop an idea on data warehousing concepts and data mining techniques
CO6: Evaluate basic database storage structure and access techniques: file organizations and indexing techniques

Course Contents:

Database Fundamentals

DBMS, Data Abstraction, Constraints, Relational Algebra, SQL, Aggregate Functions, Join, Subquery, E/R Diagrams, Normalization: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF, Denormalization.

Query Evaluation

Operator Evaluation, Query Optimization, Alternative Plans, Translation of SQL Queries into Algebra, Cost Estimation of Query Plans, Relational Algebra Equivalences, Enumeration of Alternative Plans, Nested subqueries, The System R Optimizer

Physical Database Design & Tuning

File Organization & Indexing, Index Data Structures, Comparison of File Organizations, Indexes & Performance Tuning, Introduction to Physical Database Design, Clustering & Indexes, Overview of Database Tuning, Tuning in Conceptual Schema, Tuning Queries & Views

Parallel & Distributed Database

Architectures for Parallel Databases, Parallel Query Evaluation, Parallel Query Optimization, Introduction to Distributed Databases, Distributed DBMS Architectures,

Distributed Catalog Management, Distributed Query Processing, Distributed Transactions & Concurrency Control, Distributed Recovery

Data Warehousing & Data Mining
Decision Support, OLAP, Multidimensional Aggregation Queries, Data Warehousing, Views & Decision Support, View Materialization, Introduction to Data Mining, Mining for Rules, Tree-Structured Rules, Clustering.

Text Book:

1.Database Management Systems by RamaKrishna & Gehrke, 3rd Edition, 2018, McGraw-Hill Education.

Reference Books:

1.Fundamentals of Database System By Elmasari & Navathe, 7th Edition, 2018, Pearson Education.

2.Database System Concepts by Silberschatz, Korth & Sudarshan, 6th Edition, 2019, McGraw-Hill Education.

ADVANCED NETWORK PRINCIPLES AND PROTOCOLS
Subject Code: CS60105
Credit: 4-0-0-4
Prerequisite: Nil

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 Outcomes:

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

CO1: Understand the protocol stack model for network engineering
CO2: Utilize the architecture of network routing in the Internet
CO3: Inspect TCP connection management and problem handling
CO4: Analyze the necessity of Quality of Service in a network
CO5: Survey the Next Generation IP
CO6: Compare the overview of VLAN and MPLS for packet switching

Course Contents:

Protocols, Layers, Devices

Networking Fundamentals, Standards and Organizations, Overview of Network Layers and its protocols, Network Devices

Transport Layer Protocols

TCP/IP multiplexing and demultiplexing using ports, TCP Transmission Control Block(TCB), TCP connection management and problem handling. TCP window managament, TCP timers

Network Layer Routing

Network routing and overview, Internet Routing Architecture, IP Address lookup algorithm, IP QoS

Next Generation IP

Overview, Transition from Ipv4 to Ipv6, Ipv6 addressing, Datagram format, Fragmentation, and Reassembly. Ipv6 support protocols (ICMPv6, Ipv6 Neighbor Discovery)

Link Layer Protocols

Link Layer Switching, VLANs, MPLS

Text Book:

1. The Illustrated Network: How TCP/IP Works in a Modern Network, Walter Goralski, Morgan Kaufmann, 2nd edition, 2017

Reference Books:

1.The TCP/IP Guide: A comprehensive, illustrated Internet Protocols reference, Charles M. Kozierok, No Startch Press, 1st edition, 2005.

2.Network Routing: Algorithms, Protocols, and Architectures, Deepankar Medhi and Karthikeyan Ramasamy, Morgan Kaufmann, 2007.

3.Computer Networking: A Top-Down Approach, Kurose and Ross, Pearson, 6rd edition, 2019.

4.TCP/IP Protocol Suite, Behrouz A. Forouzan, McGraw-Hill, 4th edition, 2016.

5.Computer Networking : Principles, Protocols and Practice, Olivier Bonaventure, The Saylor Foundation, 2011.

ADVANCED DIGITAL DESIGN

Subject Code: **CS60106**
Credit: **3-0-0-3**
Prerequisite: **Nil**

Course Objectives:

To understand the basic building blocks, logic gates, adders.
To apply logic minimization techniques, including Karnaugh Maps
To learn techniques and tools for programmable logic design

Course Outcome:

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

CO1: Able to utilize the basic building blocks, logic gates, adders, multipliers, shifters and other digital devices
CO2: Able to apply logic minimization techniques, including Karnaugh Maps
CO3: Able to learn techniques and tools for programmable logic design
CO4: Able to design various functional units for different arithmaticand logic operations
CO5: Able to design various sequential and combinational circuits
CO6: Able to analyze various Postsynthesis Design Validation

Course Contents:

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

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.

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.

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.

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

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.

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Subject Code: **CS60108**
Credit: **3-0-0-3**
Prerequisite: **Nil**

Course Objectives:

To study the idea of intelligent agents and search methods.
To study about representing knowledge.
To study the reasoning and decision making in uncertain world.
To construct plans and methods for generating knowledge.
To study the concepts of expert systems.

Course Outcomes:

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

CO1: Understand basic concepts of AI
CO2: Compare various search strategies
CO3: Compare various heuristic and game search algorithms
CO4: Experiment with various knowledge representation schemes
CO5: Compile various Expert Systems tools
CO6: Analyze various AI applications

Course Contents:

Introduction

AI problem; AI techniques, problem as a state space search, Production Systems, Issues in design of search programs.

Search Strategies

Hill climbing - Backtracking - Graph search - Properties of A* algorithm - Monotone restriction - Specialized production systems - AO* algorithm.

Searching Game Trees

Minimax procedure - Alpha-beta pruning - Introduction to predicate calculus.

Knowledge Representation

Knowledge representation issues, Ontological commitments. Predicate logic, knowledge representation using rules, weak slot-and-Filler structure.STRIPS - Structured representation of knowledge - Dealing with uncertainty.

Introduction to Expert Systems

Representation using domain knowledge, Expert System shell, Inference - Forward chaining - Backward chaining - Languages and tools - Explanation facilities - Knowledge acquisition.

Natural Language Processing

Introduction - Understanding - Perception - Machine learning, Syntactic processing, semantic analysis, Discourse and pragmatic processing.

Text Books:

1. Artificial Intelligence : E. Rich & K. Knight : Tata McGraw Hill.

2. G. Luger, W. A. Stubblefield, "Artificial Intelligence", Third Edition, Addison-Wesley Longman, 1998.

Reference Books:

1. N. J. Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, 1980.

COGNITIVE SCIENCE
Subject Code: CS60110
Credit: 3-0-0-3
Prerequisite: Nil

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 Outcomes:

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

CO1: Know Introduction to Cognitive Science, Psychology, Nervous system and brain
CO2: Understand Brain and sensory motor information, Representation of sensory information
CO3: Analyze from Sensation to Cognition; Roots of Cognitive Science
CO4: Develop Language and Embodiment
CO5: Implement Affordances in biological and artificial systems, Cognitive Development
CO6: Make Attention, Learning, Memory, Reasoning, Social Cognition

Course Contents:

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.

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.

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.

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.

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.

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.

COMPUTATIONAL GEOMETRY
Subject Code: CS60112
Credit: 3-0-0-3
Prerequisite: Nil

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 Outcomes:

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

CO1: Able to utilize to geometric algorithms and related research issues

CO2: Able to implement algorithms and data structures for geometric problems
CO3: Able to apply geometric techniques for addressing degenerate cases
CO4: Able to utilize randomization as a tool for developing geometric algorithms
CO5: Able to apply combinational geometry to solve different design problems
CO6: Able to apply sweep techniques to resolve various computational geometry problems

Course Contents:

Convex Hulls

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

Delaunay triangulations

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

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;

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;

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.

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.R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge Univ. Press, 1995.

DESIGN AND ANALYSIS PARALLEL ALGORITHMS
Subject Code: CS60114
Credit: 3-0-0-3
Prerequisite: Nil

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 Outcomes:

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

CO1: Describe the algorithms for array processors
CO2: Develop searching algorithms for various kinds of models
CO3: Perform efficient sorting operation on different models
CO4: Solve linear and nonlinear equations using PRAM models
CO5: Construct graph and find solutions to real world problems
CO6: Estimate various matrix operations through Matrix by matrix multiplication, matrix by vector multiplication

Course Contents:

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.

Selection – Broadcast- All Sums- Parallel Selection

Searching a random sequence, sorted sequence on PRAM models, Tree and Mesh.

Merging – A Network for Merging – Merging on PRAM Models

Sorting on a linear array, EREW, CREW and CRCW SIMD models, MIMD Enumeration sort.

Matrix Operations

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

Graphs

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

Text Books:

1.Wang and Briggs, “Computer Architecture and Parallel Processing”, McGraw Hill, 1985.

2.Kai S. G. Akl, “Designa and Analysis of Parallel Algorithms”, Prentice Hall Inc., 1992.

3.Joseph Jaja, “An Introduction to parallel Algorithms”, Addison Wesley, 1992.

KNOWLEDGE MANAGEMENT
Subject Code: CS60116
Credit: 3-0-0-3
Prerequisite: Nil

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 Outcomes:

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

CO1: To give an overview of Knowledge management, its evolution and the challenges it faces
CO2: To acquire the knowledge about building the learning organization and how knowledge markets are managed
CO3: To apply the various Knowledge management tools
CO4: To learn in-depth details about various knowledge management applications
CO5: To expose the future trends and challenges in knowledge management
CO6: To apply telecommunications and networks in knowledge management

Course Contents:

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

Organization and Knowledge Management

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

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.

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).

Advanced Topics and Case Studies in Knowledge Management

Advanced topics and case studies in knowledge management - Development of a knowledge management 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.

Text Books:

1.Srikantaiah.T. K., Koenig, M., "Knowledge Management for the Information Professional "InformationToday, Inc., 2000.

2.Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create theDynamics 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, OxfordUniversity Press.

PATTERN RECOGNITION
Subject Code: CS60118
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

Introduce basic concepts and major techniques in statistical pattern recognition.
Include concepts and techniques for data classification, feature selection, and dimensionality reduction.
Introduce research development ability in pattern recognition through technical survey and presentation.
To develop the mathematical tools required for the pattern recognition.

Course Outcomes:

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

CO1: Apply their knowledge on Real World Problems while converting these problems to computer compatible problems for Pattern Recognition

CO2: Solve Decision-making model using Statistical and Mathematical Decision Theory
CO3: Design clusters for various Pattern using classical and Modern clustering techniques
CO4: Analyzing various Techniques for Pattern Classification and Clustering
CO5: Develop Model for Pattern classification through Probabilistic or fuzzy
CO6: Analyze feature selection algorithms in pattern recognition

Course Contents:

Basics of Probability, Random Processes and Linear Algebra

Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra.

Basic concepts Pattern Recognition

Definitions, data sets for Pattern Recognition, Structure of a typical pattern recognition system. Different Paradigms of Pattern Recognition. Representations of Patterns and Classes. Metric and non-metric proximity measures

Features Selection & Extraction

Feature vectors - Feature spaces - Different approaches to Feature Selection-Branch and Bound Schemes. Sequential Feature Selection, Feature Extraction and classification stages, Principal Component Analysis (PCA), Kernel PCA, Different approaches to pattern recognition.

Statistical Pattern Recognition

Hypothesis testing, Linear classifiers, Parametric and nonparametric classification techniques, Unsupervised learning and clustering, Syntactic pattern recognition, Fuzzy set.

Applications of PR

Theoretic approach to PR, Speech and speaker recognition. Character recognition, Scene analysis.

Text Books:

1.Pattern Classification., Richard, Duda, Peter Hart and David Stork, Wiley Interscience, 2000, ISBN: 9780471056690.

2.Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.

Reference Books:

1.Neural Networks for Pattern Recognition., Christopher, Bishop, Oxford University Press, 1995, ISBN: 9780198538646.

2.The Elements of Statistical Learning: Data Mining, Inference and prediction., Hastie, T., R. Tibshirani and J.H Friedman . , NY. Springer, ISBN: 9780387952840, 2009.

3.Information Theory, Interference and learning algorithms., MacKay, David, Cambridge , UK, Cambridge University Press,. ISBN: 9780521642989, 2003.

SMART PHONE COMPUTING
Subject Code: CS60120
Credit: 3-0-0-3
Prerequisite: Nil

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 Outcomes:

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

CO1: Able to recognize the different challenges in mobile computing
CO2: Able to estimate the measurement and management of energy for wireless devices
CO3: Able to create and enhance the localization and tracking systems
CO4: Able to categorize about the different interface design issues
CO5: Able to identify Gesture Recognition
CO6: Able to apply privacy and Security in mobile computing

Course Contents:

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, Differences with the classical programming practices, Introduction to mobile operating systems, iOS, Android, Windows, Mobile application development.

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.

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)

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.

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 .

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. 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.

WEB INTELLIGENCE

Subject Code: **CS60122**
Credit: **3-0-0-3**
Prerequisite: **Nil**

Course Objectives:

To introduce the fundamental concepts as well as practical applications of Web Intelligence (WI) which combines contemporary Artificial Intelligence and advanced Information Technology in the context of Web-empowered systems, environments, and activities.
To introduce some advanced topics of Web Intelligence as well as their possible impact to different sectors of the society.

Course Outcomes:

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

CO1: Outline the various web terminologies related to web analytics
CO2: Know the principles, tools and methods of web intelligence
CO3: Apply analytics for business situations
CO4: Use of various parameters used for web analytics and their impact
CO5: Explore the use of tools and techniques of web analytics
CO6: Discuss the goals and funnels of web analytics

Course Contents:

Web Analytics

Basics – Traditional Ways – Expectations – Data Collection – Clickstream Data – Weblogs – Beacons – JavaScript Tags – Packet Sniffing – Outcomes data – Competitive data – Search Engine Data.

Qualitative Analysis

Customer Centricity – Site Visits – Surveys – Questionnaires – Website Surveys – Post visits – Creating and Running- Benefits of surveys – Critical components of successful strategy.

Web Analytic concepts

URLS – Cookies – Time on site – Page views – Understand standard reports – Website content quality – Navigation reports (top pages, top destinations, site overlay). – Search Analytics – Internal search, SEO and PPC – Measuring Email and Multichannel Marketing - Competitive intelligence and Web 2.0 Analytics – Segmentation – Connectable reports.

Google Analytics

Analytics - Cookies - Accounts vs Property - Tracking Code - Tracking Unique Visitors - Demographics - Page Views & Bounce Rate Acquisitions - Custom Reporting.

Goals & Funnels

Filters - Ecommerce Tracking - Real Time Reports - Customer Data Alert - Adwords Linking - Adsense Linking -Attribution Modeling - Segmentation - Campaign Tracking - Multi-Channel Attribution.

Text Books:

1.Avinash Kaushik, “Web Analytics 2.0: The Art of Online Accountability and Science Of Customer Centricity “, 1st edition, Sybex, 2009.

2.Michael Beasley, “Practical Web Analytics for User Experience: How Analytics can help you Understand your Users”, Morgan Kaufmann, 2013.

Reference Books:

1.Magy Seif El-Nasr, Anders Drachen, Alessandro Canossa, eds., "Game Analytics: Maximizing the Value of Player Data", Springer, 2013.

2.Bing Liu, "Web Data Mining: Exploring Hyperlinks, Content, and Usage Data", 2nd Edition, Springer, 2011.

3.Justin Cutroni, "Google Analytics", O'Reilly, 2010.

DATA SCIENCE & ANALYTICS
Subject Code: CS60201
Credit: 3-0-0 3
Prerequisite: Nil

Course Objectives:

Building the fundamentals of data science.
Understand the strategies of data collection and pre-processing.
Gaining practical experience in programming tools for data sciences
Empowering students with tools and techniques used in data science
Use appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues

Course Outcomes:

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

CO1: Work with data science platform and explore the big data analytics techniques business applications
CO2: Design efficient algorithms for mining the data from large volumes
CO3: Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making
CO4: Use the different approaches towards recommendation
CO5: Analyze the HADOOP and Map Reduce technologies associated with big data analytics
CO6: Think critically in making decisions based on data and deep analytics

Course Contents:

Introduction to Data Science

Introduction to Data Science Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting. Descriptive Statistics, Probability Distributions.

Mining Data Streams

Introduction to Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis- Stock Market Predictions.

Decision Analysis

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.
Recommendation Systems: Building a User-Facing Data Product - Algorithmic ingredients of a Recommendation Engine - Dimensionality Reduction - Singular Value Decomposition - Principal Component Analysis

Predictive Analytics

Simple linear regression- Multiple linear regression- Interpretation of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications
Presecriptive Analytics: Creating data for analytics through designed experiments, creating data for analytics through Active learning, creating data for analytics through Reinforcement learning

Understanding Hadoop Fundamentals and Frameworks

The MapReduce Framework; Techniques to Optimize MapReduce Jobs; Uses of MapReduce; Role of HBase in Big Data Processing; Storing Data in Hadoop : Introduction of HDFS, Architecture, HDFC Files, Introducing HBase, Architecture, Storing Big Data with HBase , Interacting with the Hadoop Ecosystem; HBase in Operations Programming with HBase; Installation, Combining HBase and HDFS. Frameworks: Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphere BigInsights and Streams.

Text Books:

1.Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.

2.Cathy O’Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O’Reilly. 2014.

3.BIG DATA and ANALYTICS, Seema Acharya, Subhasinin Chellappan, Wiley publications.

Reference Books

1.“Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill Publishing, 2012.

2.Anand Rajaraman and Jeffrey David Ullman, “Mining of Massive Datasets”, CUP, 2012.

3.Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.

BUSINESS ANALYTICS & INTELLIGENCE
Subject Code: CS60202
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

Understand the emergence of business analytics as a competitive strategy.
Analyse data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.Learn data visualization and storytelling through data.

Learning decision-making tools& managing business processes using analytical and management tools.
Understand sources of Big Data and the technologies and algorithms for analyzing big data for inferences. Ability to analyze unstructured data such as social media data and machine-generated data.

Course Outcomes:

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

CO1: Understand the essentials and fundamentals of business analytics, business intelligence and the corresponding terminologies
CO2: Familiar with the steps involved in the business analytics process
CO3: Interact competently on the topic of business analytics & Intelligence
CO4: Develop specific skills, competencies, and points of view needed by professionals in the field most closely related to this course
CO5: Implement the different prediction and classification techniques
CO6: Develop mining relationship among records

Course Contents:

Introduction and overview of Data Mining Process

What Is Business Analytics?, What Is Data Mining?, Data Mining and Related Terms, Big Data, Data Science, Other Terminology and Notation, Core Ideas in Data Mining, The Steps in Data Mining, Predictive Power and Over fitting, Building a Predictive Model.

Data Exploration and Dimension Reduction: Data Visualization

Uses of Data Visualization, Basic Charts, Multidimensional Visualization, Specialized Visualizations.

Dimension Reduction

Introduction, Curse of Dimensionality, Correlation Analysis, Reducing the Number of Categories in Categorical Variables, Converting a Categorical Variable to a Numerical Variable, Principal Components Analysis.

Prediction and Classification Methods

Logistic Regression, Multiple Linear Regression, k-Nearest Neighbours (k-NN), The Naive Bayes Classifier, Classification and Regression Trees, Dimension Reduction Using Regression Models, Dimension Reduction Using Classification and Regression Trees, Neural Network.

Mining Relationships among Records

Association Rules: Discovering Association Rules in Transaction Databases, The Apriori Algorithm, The Process of Rule Selection, Cluster Analysis: Introduction, Measuring Distance Between Two Records, Measuring Distance Between Two Clusters, Hierarchical (Agglomerative) Clustering, Non-Hierarchical Clustering: The k-Means Algorithm.

Text Books:

1.Data Mining For Business Analytics: Concepts, Techniques, and Applications in R, Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, and Kenneth C. Lichtendahl Jr., Wiley publication, ISBN: 978-1-118-87936-8.

2.Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner, Galit Shmueli, Wiley publication, ISBN: 9788126517589.

Reference Books:

1. How to Measure Anything: Finding the Value of Intangibles in Business, by Douglas W. Hubbard, Wiley 3rd Edition, and ISBN: 9781118539279.

2. Analytics at Work: Smarter Decisions, Better Results, by Thomas H. Davenport, Jeanne G. Harris, Robert Morison, Harvard Business Press, ISBN: 9781422177693.

3. Data Science for Business by F. Provost and T. Fawcett, ISBN: 978-1-4493-6132-7.

ANALYTICS FOR STRATEGIC MARKET PLANNING
Subject Code: CS60204
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

The focus of this course is strategic marketing analysis for making marketing decisions and marketing planning.
It,therefore, integrates knowledge acquired in other subjects in marketing (e.g., analysis of consumer behavior, brand management, market research) and business administration subjects (management, finance, and accounting).
Students develop analytical skills, acquire a strategic perspective of marketing and learn to comprehend it as an integral part of the overall strategy of a company.
The course emphasizes the role of the strategic marketing plan as the framework for the internal organization of the company's marketing activities and decisions.

Course Outcomes:

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

CO1: Take data empowered strategic marketing decisions by using analytical techniques
CO2: Make use of segmentation process to handle customer heterogeneity
CO3: Conduct the multi dimensional positioning of perceptual maps
CO4: Perform strategic market analysis
CO5: Develop models for Strategic Decision Making
CO6: Sharpen their analytical skills by getting exposure to computer-based marketing models and tools for decision making

Course Contents:

Marketing Analytics

Basics of marketing analytics - marketing decisions models – characteristics - types and benefits of marketing decisions models - Response models - types - calibration -

objectives - interactions effects - dynamic effects - competitive effects - models in individual levels - shared experience and qualitative models.

Segmentation and Targeting

The segmentation process and defining the market with models - Segmentation research - methods using factors analysis and cluster analysis - behaviour-based segmentation: cross classification - regression and choice-based segmentation - customerheterogeneity- issues and challenges.

Positioning

Differentiation and positioning - perceptual maps: developing perceptual map – multi dimensional scaling - techniques – attribute based and similarity based - joint space mapping.

Strategic Market Analysis

Strategic marketing decisions - market demand and trend analysis - product life cycle - cost dynamics: scale and experience effects.

Models for Strategic Decision Making

Market entry and exit decisions - PIMS: shared experience models - product portfolio models: BCG - GE etc. - financial models - analytical hierarchy process.

Reference Book:

1. Lilien, Gary L. and Arvind Rangaswamy, Marketing Engineering: Computer-Assisted Marketing Analysis and Planning. Revised Second Edition, Trafford Publishing, 2004.

FINANCIAL RISK ANALYTICS AND MANAGEMENT

Subject Code: **CS60206**
Credit: **3-0-0-3**
Prerequisite: **Nil**

Course Objectives:

This course aims to provide an overview of data analytics applicationsin financial, insurance and risk management context
In particular, it provides a holistic view of how data analytics affects the insurance and risk management decision making procedures
Will gain deeper understandings on data analytic framework, be able to perform data modellings and calibrate appropriate model to serve specific financial planning and risk management tasks
To use different simulation methods and generate scenarios for stress testing and risk analysis

Course Outcomes:

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

CO1: Categorize the various risks faced by an organization
CO2: List different types of approaches for management of credit,operational and market risk
CO3: Explore the tools and practices needed to assess and evaluate financial risks

CO4: Analyze risk management practices in an industry
CO5: Discuss accounting and tax issues for integrated risk management
CO6: Solve legal issues that impact financial and other risks affecting business

Course Contents:

Introduction to Risk

Understanding Risk - Nature of Risk - Source of Risk - Need for risk management - Benefits of Risk Management - Risk Management approaches - Risk Classification

Credit risk - Market risk - Operational Risk and Other Risk

Risk Measurements

Measurement of Risk – Credit Risk Measurement - Market Risk Measurement - Interest Rate Risk Measurement - Asset Liability Management - Measurement of Operational Risk

Risk Management

Managing Credit Risk - Managing Operational Risk - Managing Market Risk.

Risk in Instruments

Tools for Risk Management – Derivatives - Combinations of Derivative Instruments - Neutral and Volatile Strategies - Credit Derivatives - Credit Ratings - Swaps.

Regulation and Other Issues

Other Issues in Risk Management - Regulatory Framework - Basel Committee - Legal Issues - Accounting Issues - Tax Issues - MIS and Reporting - Integrated Risk Management.

Reference Books:

1.Dun, Bradstreet, “Financial Risk Management”, TMH, 2006.

2.John C Hull, “Risk Management and Financial Institutions”, Pearson, 2015.

3.Aswath Damodharan, “Strategic Risk Taking”, Pearson, 2008.

HUMAN RESOURCE ANALYTICS
Subject Code: CS60208
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

Understand the importance of HR Analytics& learn the metrics measured by HR analytics. Helps to develop students’ abilities to analyse people management issues and systems from an analytics perspective. After completing the course, students should be familiar with key analytics concepts and approaches and be able to demonstrate the skill sets that are required to implement them. Provide better employee development plans leading to higher engagement & productivity

COURSE OUTCOMES:

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

CO1: Identify necessary skills to carry out the personnel roles in the domain of HR
CO2: Develop metrics to improve employer-employee relationship and improve employee retention.
CO3: Use skilled personnel and job tasks to achieve mission-critical goals
CO4: Align organization's mission and goals with key metrics and benchmarks
CO5: Apply HR analytics to improve organizational performance by providing better insights on human resources data
CO6: Construct predictive and prescriptive models for HR analytics

Course Contents:

Introduction to HR Analytics

Overview of HR Process - HR Analytics – An overview - Role of analytics in HR – HRM in changing context - Transition from transaction orientation to analytics orientation - HR Analytics Framework – People Capability Maturity Model – LAMP framework – HCM 21 framework – Talent analytics maturity model.

Organization-Wide Alignment Analytics

Alignment Analytics – link HR process and organization process - identify alignment opportunities; Human Capital Strategy - HR Alignment Inventory - workforce planning - Measurement Map – Lead and Lag indicators.

HR Metrics and Audits

Formulation of key performance indicators and key result areas; HR Metrics – Recruitment metrics – Training and development metrics - Talent retention metrics –HR cost benefit metrics – Career Progression Metrics - Performance metrics – Diversity and Inclusion Metrics - Human capital ROI - Designing and Implementing HR Scorecard - Conducting HR Practice Audits

Descriptive Analytics

Descriptive Analytics – Exploring the people data – slice and dice of data

HR Dashboards - Segmentation - Business Insights - KPI Catalogue Creation.

Predictive and Prescriptive Analytics

Predicting future performance - Techniques to capture the fallouts of HR Practices – Data driven decision making - Organization change and improvement.

Reference Book:

1.Bassi, Laurie Jo, Rob Carpenter, and Dan McMurrer. HR analytics handbook. ReedBusiness. 2010.

2.Fitz-Enz, Jac. The New HR Analytic. Predicting the Economic Value of Your Company’s Human Capital Investments. American Management Association. 2010.

IMAGE AND VIDEO ANALYTICS

Subject Code: **CS60210**

Credit: **3-0-0-3**

Prerequisite: **Nil**

Course Objectives:

Teach the fundamentals of digital image processing, image and video analysis. In particular, it will present the mathematics and algorithms that underlie image analysis techniques such as filtering, denoising, edge detection, feature detection, tracking and 3D reconstruction. It will also present how these tools are used in algorithms image and video segmentation, motion estimation, stereo reconstruction, video denoising andvideo analysis, object detection and recognition, and standards for video compression and communication.

Course Outcomes:

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

CO1: Understand fundamentals of digital image processing, image and video analysis
CO2: Understand the real time use of image and video analytics
CO3: Demonstrate real time image and video analytics applications and others
CO4: Understand the fundamental principles of image and video analysis and have an idea of their application.
CO5: Apply image and video analysis in real world problems
CO6: Discuss various applications and case studies of Video Analytics in WSN

Course Contents:

Fundamentals of spatial filtering

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

Colour models and Transformations

Image and Video segmentation-Image and video demonising- Image and Video enhancement- Image and Video compression.Object detection and recognition in image and video-Texture models Image and Video classification models- Object tracking in Video

Image and Video Analysis

Image representation and image models, Image and Video classification and segmentation, multiband stechniques for texture classification and segmentation, adaptive and neural methods for image segmentation, edge and boundary detection, Algorithms for image processing.

Applications and Case studies

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

Text Books:

1.C. Gonzalez and R.E. Woods.” Digital Image Processing”. 3rd Edition. Addison Wesley, 2007.

2.Alan C Bovik, Handbook of Image and Video Processing, 2nd Edition, Academic Press, 2005.

Reference Books:

1.W. Härdle, M. Müller, S. Sperlich, A. Werwatz, "Nonparametric and Semi parametric Models", Springer, 2004.

2.Rick Szelisk, "Computer Vision: Algorithms and Applications", Springer 2011.

3.Jean-Yves Dufour, "Intelligent Video Surveillance Systems", Wiley, 2013.

4.Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, "Video Analytics for Business Intelligence", Springer, 2012.

SUPPLY CHAIN ANALYTICS
Subject Code: CS60212
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To provide a strong foundation in supply chain analytics in order to handle complex data bases, build advanced analytical models and deliver effective visualization product and comprehensive reports.Articulate the philosophy and approach in data-driven Supply Chain Management.Understand the important role of change management, develop key skills to implement new business solutions and processes.Evaluate a variety of business constraints and inputs in Supply Planning, and develop a realistic constrained model to optimize Master Production Schedule

Course Outcomes:

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

CO1: Develop the concepts of supply chain analytics
CO2: Categorize various procurement and strategic sourcing for procurement analysis
CO3: Apply various supply chain management concepts
CO4: Elaborate various integrated supply chain methods for computation of transfer prices and revenue and yield management
CO5: Improve an existing supply chain and design an efficient supply chain in alignment with the strategic goals of the company
CO6: Build project with industrial support for validation of model and review the data analytics techniques

Course Contents:

Demand Planning

Demand Planning- Review of Forecasting and planning concepts - Defining KPIs- Forecasting Model Building - Discrete and continuous manufacturing

Supply planning

Supply planning - Procurement and Strategic Sourcing - Inventory Modelling – aggregate planning and resource allocation decisions - Procurement Analytics - Productionmodelling

Demand Fulfilment

Demand Fulfilment - DC location and network design - optimizing inventory levels in distribution network - Logistics & Network Modelling - Transportation modelling - delayed differentiation - mass customization

Integrated supply chain

Advanced and business supply chain related topics like CPFR - DDSN - Make/Buy Case Study - Total Supply Chain Cost - computation of transfer prices - revenue management-yield management - product changes/economies of scale

Project Development

Undertaking projects with industry inputs- validation of models – frameworks – Review of data analytics techniques - choice of tools and designing solution approach to specific applications

Reference Books:

1.Raman, A & Fisher, M., How Analytics Are Transforming the Supply Chain and Improving Performance, HBS Press. 2010.

2.Tayur,S.Ganeshan, R.& Michael, M.(editors).Quantitative Models for Supply Chain Management. Kluwer Academic Publishers. 1999.

WEB ANALYTICS
Subject Code: CS60214
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To Assess how website visitors view and interact with a site's pages and features, and business intelligence, which would allow using data on customer purchasing patterns, demographics, and demanding trends to make effective strategic decisions.Gain the skill of using web analytics for the two aspects of web marketing (driving in traffic and taking care of traffic). Become familiar with the vocabulary of web analytics. Experience creating reports and making pertinent interpretations based on the reports.

Course Outcomes:

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

CO1: Analyze the factors influencing the business through the web site data
CO2: Realise various types of analysis involved in web site data (users, business data, etc.)
CO3: Practice applying Google Analytics APIs to improve the business process
CO4: Proficient in digital measurement and analytics and complete a full website audit
CO5: Increase awareness regarding customer behavior and intent
CO6: Create a well-thought web experience for users, including an easily discoverable web presence

Course Contents:

Web Analytics Approach

Know about web site – Gather Data – Transform – Balancing Time and the Need for Certainty – Context; How Web Analytics Works – Log File Analysis – Page Tagging – Cookies – Accuracy – Accounts and Profiles – Click Analytics – Metrics and Dimensions – Interacting With Data In Google Analytics – Goals and Conversions – Conversion Rate – Goal Reports – Performance Indicators.

Learning about Users – Visitor Analysis – Demographics – Behavior –

Technology – Mobile – Custom based – Traffic Analysis – Source and Medium (Dimensions)

– Organic Search – Search Query Analysis – Referral and Direct Traffic – Content Usage Analysis – Website Content Reports – Pageviews – Low and High Time – Pageviews Ratio Bounce rate – Page Value – Click – Path Analysis – Relationships between Pages – Navigation Summary – Visitors Flow – Examples.

Segmentation

Google Analytics' Advanced Segments – AND – OR – and Sequence of Filters – Metrics – Dimensions – Based on Page – User Traits – Information need – User's Goal Completion – Page Related Landing and Viewing – Pairing Analytics Data with UX Methods – Personas – Usability Testing and Inspection – Measuring Effects of Changes – Reframe as a Rate – Types of Changes – Conversion Rate – Redirect Traffic – Page Time – Other Continuous Metrics – Reporting.

Measuring Behavior within pages

Google In – Page Analytics – Measurable Clicks – Analytics Tools – Event Data Analysis – Virtual Page Views – A/B Testing – Analytics Profiles – Filters – Reporting Culture – Making Case for Usability Activities – Design Changes – User Research – Mobile Application Analytics – Cross – Device Measurement.– On Page Behavior – Connecting to other data sources – Google Analytics – E – Commerce Tracking – Online Campaign Tracking – Event Tracking – Customizing GATC – Hacks – Methodologies.

Google Tag Managers

Building blocks – Enhancing websites with Tag Manager – Using Google Analytics with BigQuery – Tag Manager and Analytics APIs.

Reference Books:

1.Michael Beasley, "Practical Web Analytics for User Experience", Elsevier, 2013.

2.Beatriz Plaza "Advanced Web Metrics with Google Analytics", Koros Press, 2017.

3.Todd Kelsey, "Introduction to Google Analytics: A Guide for Absolute Beginners", Apress, 2017.

4.Jonathan Weber et al., "Practical Google Analytics and Google Tag Manager for Developers", Apress, 2015.

PRINCIPLES OF CRYPTOGRAPHY
Subject Code: CS60301
Credit: 3-0-0-3

Prerequisite: Nil

Course Objectives:

To make the student learn different encryption techniques along with hash functions, MAC, digital signatures and their use in various protocols for network security and system security.Investigate the security of encrypted data in communication and information systems. Explore the role of hackers and code breakers influenced cryptography in modern secure communication. To get an opportunity to try encrypting data yourself by completing cryptography challenge.

Course Outcomes:

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

CO1: Understand the knowledge of mathematics of symmetric and asymmetric key cryptography
CO2: Apply fundamentals of symmetric key cryptosystems and algorithms
CO3: Apply fundamentals of asymmetric key cryptosystems and algorithms
CO4: Compare the message digest and digital signature mechanisms
CO5: Analyze the requirements of key management and entity authentication
CO6: Combine the advanced techniques like ECC, DNA cryptography & Quantum cryptography

Course Contents:

Introduction

Basic objective of cryptography, secret-key and public key cryptography, classical cryptography, one-way and trapdoor functions, attack models, modular arithmetics, gcd, primality testing, Chinese remainder theorem, modular square roots.

Symmetric-key Ciphers

Modes of operations, DES & its variants, RC5, IDEA, Blowfish, AES, Cryptanalysis.
Asymmetric-key Ciphers: RSA, Rabin & ElGamal schemes, Diffie-Hellman Key exchange.

Message Digest, Digital Signatures

Properties of Hash functions, MD5, SHA-1, keyed hash functions, MAC, attacks on hash functions, Digital Signatures, RSA and DSA signature schemes

Key Management & Entity Authentication

KDC, Kerberos, Passwords, Challenge Response Algorithms, Zero-knowledge Protocols.

Advanced Topics

Elliptic curve cryptography, Quantum cryptography, DNA cryptography.

Text Books:

1.Cryptography and Network Security, by Behrouz A Forouzan and Debdeep Mukhopadhyay, McGraw Hill Education, 3rd edition 2018.

2.Cryptography: Theory and Practice, by Douglas Robert Stinson, Maura Paterson, RCR Press, 4th edition, 2018.

Reference Books:

1.Cryptography and Network security: Principles and Practice, by William Stallings, Pearson Education, 5th edition, 2011.

2.Cryptography and Network Security, by Atul Kahate, Tata McGraw Hill Education, 3rd edition, 2013.

3.Information Security: Principles and Practice, by Mark Stamp, Willey, 2nd edition, 2011.

NETWORK SECURITY
Subject Code: CS60302
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

Students will identify some of the factors driving the need for network security, identify and classify particular examples of attacks and define the terms vulnerability, threat and attack. Also, can identify physical points of vulnerability in simple networks, compare and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Design adversary models and protocols
CO2: Design of secure communication protocols in Internet applications
CO3: Analyze cryptographic algorithms
CO4: Identify security threats in Mobile Applications
CO5: Design of secure protocols for wireless ad-hoc and sensor networks
CO6: Design of Firewalls, Intrusion Detection Systems and Malware detection methods

Course Contents:

Module-I

Cryptographic algorithms, Pseudorandom Generators, Hash functions, Block ciphers, Stream Ciphers, Access Control Methods, Message Authentication and Digital Signatures, Design of secure Internet protocols, Key distributions, Design of Access control methods, Network Anomaly Detection methods, Mobile IPv6, https protocol.

Module-II

Design of Firewalls and Intrusion Detection Systems, Malware detection methods, Mobile application security models, Mobile threats and malware, Trust based protocols, Mobile app security, Vulnerabilities and Security Challenges in Wireless networks, Trust Assumptions.

Module-III

Adversarymodels and Protocols, Attacks against naming and addressing in the Internet, Security protocols for address resolution and address auto configuration, IP Security (IP Sec) protocol, Key Establishment and Revocation Protocols,

Module-IV

Secure Neighbor Discovery, Secure routing protocols in multi-hop wireless networks, Provable Security for Ad-hoc Network routing protocols, Privacy preserving routing in Ad-hoc Networks, Location privacy in vehicular Ad-hoc networks.

Text Books/Reference Books:

1.John R. Vacca, Computer and Information Security Handbook, Elsevier, 2009.

2.L. Buttyan, J. P. Hubaux, Security and Cooperation in Wireless Networks, CambridgeUniversity Press, 2008.

3.W. Trappe, L. C. Washington, Introduction to Cryptography with Coding Theory, Prentice-Hall 2005.

4.NoureddineBoudriga, Security of Mobile Communications, Auerbach Publications, Taylorand Francis Group, 2010.

CYBER LAWS AND INTELLECTUAL PROPERTY RIGHTS
Subject Code: CS60304
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To enable the students to obtain the basic knowledge about Intellectual Property Right (IP) and Cyber Law. Develop Competencies For Dealing With Frauds And Deceptions (Confidence Tricks, Scams) And Other Cyber Crimes For Example, Child Pornography Etc. That Are Taking Place Via The Internet.To recognize the importance of IP and to educate the pupils on basic concepts of Intellectual Property Rights.

Course Outcomes:

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

CO1: Understand cyberspace, issues there in and need for a cyber law
CO2: Understand facets of India IT act n addressing e-trade and e-governance
CO3: Understanding of issues and problems arising out of online transactions
CO4: Understanding crimes with case law
CO5: Categorize crimes with case law
CO6: Discuss intellectual property issues and development of the law in this regard

Course Contents:

Cyber Space- Fundamental definitions -Interface of Technology and Law – Jurisprudence and-Jurisdiction in Cyber Space - Indian Context of Jurisdiction - Enforcement agencies – Need for IT act - UNCITRAL – E- Commerce basics; Information Technology Act, 2000 - Aims and Objects — Overview of the Act – Jurisdiction - Electronic; Governance – Legal Recognition of Electronic Records and Electronic Evidence - Digital Signature Certificates - Securing Electronic records and secure digital signatures - Duties of Subscribers - Role of Certifying Authorities - Regulators under the Act -The Cyber Regulations Appellate Tribunal

Internet Service Providers and their Liability– Powers of Police under the Act – Impact of the Act on other Laws; Cyber Crimes -Meaning of Cyber Crimes –Different Kinds of Cyber crimes – Cyber crimes under IPC; Cr.P.C and Indian Evidence Law -

Cyber crimes under the Information Technology Act,2000 - Cyber crimes under International Law - Hacking Child Pornography, Cyber Stalking, Denial of service Attack, Virus Dissemination, Software Piracy, Internet Relay Chat (IRC) Crime, Credit Card Fraud, Net Extortion, Phishing etc - Cyber

Terrorism- Violation of Privacy on Internet - Data Protection and Privacy – Indian Court cases;Intellectual Property Rights – Copyrights- Software – Copyrights vs Patents debate - Authorship and Assignment Issues - Copyright in Internet - Multimedia and Copyright issues

Software Piracy - Trademarks - Trademarks in Internet – Copyright and Trademark cases, Patents - Understanding Patents - European Position on Computer related Patents, Legal position on Computer related Patents - Indian Position on Patents – Case Law, Domain names -registration - Domain Name Disputes-Cyber Squatting-IPR cases

Text Books/Reference Books:

1.Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co., New Delhi, 2010.

2.Farooq Ahmed, Cyber Law in India, New Era publications, New Delhi, 2005.

3.S.R.Myneni, Information Technology Law(Cyber Laws), Asia Law House, Hyderabad,2014.

4.Chris Reed, Internet Law-Text and Materials, Cambridge University Press, 2004.

5.Pavan Duggal, Cyber Law- the Indian perspective, Universal Law Publishing Co., NewDelhi, 2004.

DESIGN OF SECURE PROTOCOLS
Subject Code: CS60306
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

This is a project-oriented course intended to give students hands-on experience in using a variety of analysis techniques to evaluate cryptographic protocols and other security mechanisms. The main objective of this course is to explore various protocols and the design of various protocols with deeper security.Gain knowledge of various secure mechanisms through a set of protocols.

Course Outcomes:

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

CO1: Design adversary models and protocols
CO2: Analyze Secure protocols for global IP mobility
CO3: Develop cryptographic algorithms
CO4: Identify security threats in Advanced Wireless networks
CO5: Elaborate security protocols for address resolution and address auto configuration
CO6: Design secure routing protocols in wireless ad-hoc networks

Course Contents:

Module-I

One-Way Functions, Pseudorandom Generators, Hash functions, Block ciphers, Stream Ciphers, Access Control Methods, Message Authentication and Digital Signatures, Vulnerabilities and Security Challenges of Wireless networks, Trust Assumptions.

Module-II

Adversary models and Protocols, Attacks against naming and addressing in the Internet, Security protocols for address resolution and address auto configuration.

Module-III

Security for global IP mobility, IP Security (IP Sec) protocol, Key Establishment and Revocation Protocols in Sensor Networks, Secure Neighbor Discovery, Secure routing protocols in multi-hop wirelessnetworks.

Module-IV

Provable Security for Ad-hoc Network routing protocols, Privacy preserving routingin Ad-hoc Networks, Location privacy in vehicular Ad-hoc networks, Secure protocols for behavior enforcement Game theoretic model of packet forwarding

Text Books/Reference Books:

1.L. Buttyan, J. P. Hubaux, "Security and Cooperation in Wireless Networks", CambridgeUniversity Press, 2008.

2.O. Goldrich, "Foundation of Cryptography-Vol. 1 and Vol. 2", Cambridge University Press,2001.

3.James Kempf, ―Wireless Internet Security: Architecture and Protocols‖, Cambridge University Press, 2008.

Foundations of Block Chain Technology
Subject Code: CS60308
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

This course aims to provide a conceptual understanding on the function of Blockchains as a method of securing distributed ledgers, how consensus on their contents is achieved, and the new applications that they enable. It covers the technological underpinnings of blockchain operations as distributed data structures and decision making systems, their functionality, and different architecture types. It provides a critical evaluation of existing Smart Contract (SM) capabilities and platforms, and examines their future directions, opportunities, risks and challenges

Course Outcomes:

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

CO1: Understand how blockchain work, including private and public platforms
CO2: Understand the technical underpinnings of blockchain technology to perform analysis
CO3: Apply various blockchain concepts to analyse examples, proposals, case studies,and preliminary blockchain system design discussions
CO4: Know and be able to apply the concepts, tools, and frameworks for buildingblockchain decentralized applications
CO5: Design secure smart contract applications on blockchain
CO6: Integrate Blockchain to IoT and other applications

Course Contents:

Blockchain technology Introduction

Blockchain technology Introduction, Concepts of Blockchain Systems, Key Problem Challenges and Solutions, Bitcoin Concept- Merkle Tree - hardness of mining - transaction verifiability - anonymity.

Attacks on Bitcoin

Double-spend attacks, Selfish mining, Security of Transactions in Bitcoin, Privacy in Bitcoin, Cryptographic Primitives in Blockchain- Cryptosystems in practice, Cryptographic Hash Functions, Digital Signatures-Aggregate Signature, Threshold Signature.

Blockchain Platforms

Blockchain-Ethereum, Smart Contracts - Attacks on smart contracts, Permissioned Blockchain – Hyperledger, Blockchain Applications & Use Cases, Consensus Protocols-

The consensus problem

Byzantine Generals problem, Asynchronous Byzantine Agreement, Consensus mechanisms used in Bitcoin Blockchain, Ethereum Blockchain and Hyperledger Blockchain, Blockchain (BoT)- Advantages of integrating

Blockchain to IoT

Trust Building, Cost Reduction, Accelerate DataExchanges, Scaled Security for IoT.

Text Books/Reference Books:

1.Arvind Narayanan, “Bitcoin and Cryptocurrency Technologies- A Comprehensive Introduction”, Princeton University Press, 2016.

2.William Magnuson, “Blockchain Democracy- Technology, Law and the Rule of the Crowd”, Cambridge University Press, 2020.

3.Pethuru Raj, Kavita Saini, Chellammal Surianarayanan, “Blockchain Technology andApplications”, CRC Press, 2021.

4.Chandramouli Subramanian, “Blockchain Technology”, Universities Press, 2020.

Relevant Research Paper and While Papers.

INFORMATION SECURITY AND SECURE CODING

Subject Code: **CS60310**
Credit: **3-0-0-3**
Prerequisite: **Nil**

Course Objectives:

The goal of this course is to enable learners to develop safe, reliable, and secure software systems by incorporating secure coding practices in the software lifecycle.Apply their knowledge of secure coding to create software systems that are safe, reliable, and secure as measured by objective criteria.

Course Outcomes:

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

CO1: Understand Information Security basics along with the design policies, standards, procedures and guidelines
CO2: Compare different authentication and authorization principles
CO3: Design more secure applications and softwares
CO4: Analyze various J2EE vulnerabilities
CO5: Analyze the facets of Security Operations Management
CO6: Compare the different disaster recovery and backup mechanisms

Course Contents:

Information Security Basics

Introduction to Information Security – Risk Analysis – Legal Issues – Secure Design – Policy, Standards, Procedures and Guidelines – Security Organization structure.

Information Security Policy and Compliance

Authentication and Authorization principles -Securing unstructured data – Information Rights Management – Storage security – Data basesecurity.

Secure Application

Secure application design – Writing Secure Software – J2EE vulnerabilities

Secure Infrastructure Management

Security Operations Management – Disaster Recoveryand Backups – Physical Security.

Text Books/Reference Books:

1. Information Security – The complete reference; Chapters: 1-9, 11-12, 26-28, 31, 32, and 34 Author: Mark Rhodes – Ousley; McGraw Hill, 2013;ISBN Number: 978-0-07-178436-8.

MOBILE WIRELESS SECURITY

Subject Code: **CS60312**
Credit: **3-0-0-3**
Prerequisite: **Nil**

Course Objectives:

Familiarize with the issues and technologies involved in designing a wireless and mobile system that is robust against various attacks. Gain knowledge and understanding of the various ways in which wireless networks can be attacked and tradeoffs in protecting networks. Have a broad knowledge of the state-of-the-art and open problems in wireless and mobile security, thus enhancing their potential to do research or pursue a career in this rapidly developing area.

Course Outcomes:

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

CO1: Understand Wireless Fundamentals - Hardware, Protocols, Programming and Security
CO2: Compare several policy solutions and VPNs
CO3: Analyze Pocket PC hacking and other auditing tools
CO4: Compare several authentication, authorization and access control mechanisms
CO5: Identify targets, attacks and vulnerabilities for proper mitigations and protection
CO6: Categorize Mobile Commerce Security, its enabling technologies and several payment methods

Course Contents:

Wireless Fundamentals

Wireless Hardware- Wireless Network Protocols- Wireless Programming WEP Security. Wireless Cellular Technologies : concepts – Wireless reality – Security essentials – Information classification standards. Wireless Threats : Cracking WEP - Hacking Techniques- Wireless Attacks – Airborne Viruses.

Standards and Policy Solutions

Network Solutions – Software Solutions – Physical Hardware Security- Wireless Security – Securing WLAN – Virtual Private Networks – Intrusion Detection System – Wireless Public Key infrastructure.

Tools

Auditing tools – Pocket PC hacking – wireless hack walkthrough.

Security Principles

Authentication – Access control and Authorization – Non-repudation- privacy and Confidentiality – Integrity and Auditing –Security analysis process.

Privacy in Wireless World

Legislation and Policy – Identify targets and roles analysis – Attacks and vulnerabilities – Analyze mitigations and protection.

WLAN Configuration : IEEE 802.11 – Physical layer – media access frame format – systematic exploitation of 802.11b WLAN – WEP – WEP Decryption script – overview of WEP attack – Implementation - Analyses of WEP attacks.

Mobile Commerce Security and Payment Methods

Reputation and Thrust – Intrusion detection - Vulnerabilities analysis of mobile commerce platform – Secure authentication for mobile users – Mobile Commerce

security – Payment methods – Mobile Coalition key evolving Digital Signatures scheme for wireless mobile networks.

Text Books:

1.Anurag Kumar, D. Manjunath, Joy Kuri "Wireless Networking" Morgan Kaufmann Publihsers, First Edition – 2009.

Reference Books:

1.Russel Dean Vines,"Wireless Security Essentials: Defending Mobile from Data Piracy", John Wiley & Sons, First Edition – 2002.

2.Cyrus, Peikari, Seth Fogie, "Maximum Wireless Security", SAMS Publishing 2002.

3.Wen Chen hu, Chang Wiu Lee, Weidong kou, "Advances in Security and Payment Methods for Mobile Commerce", Idea Group Inc-2004.

PUBLIC KEY INFRASTRUCTURE AND TRUST MANAGEMENT
Subject Code: CS60314
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

The goal of this course is to enable the student to understand the foundational elements and complexity of a public key infrastructure. Introduce students to concepts of public key infrastructures.Introduce students to the need for Identity Management Process and its importance in public key infrastructure.Introduce students to the basics of Trust Management.Understand implementation of a public key infrastructure, including the technology, policy, standards, and long-term maintenance considerations.

Course Outcomes:

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

CO1: Analyze Core PKI services: Authentication, Integrity, and confidentiality
CO2: Design Certificates using Trust Models , PKI Considerations and Electronic Legislation
CO3: Identify PKIX standardization Requirements
CO4: Distinguish Public key certificate management models
CO5: Analyze different access control mechanisms
CO6: Compare several trust management systems

Course Contents:

Introduction – services offered by PKI- components of a fully functional PKI

Certification authority, Certificate repository, Certificate revocation, Key backup and recovery, Automatic key update, Key history management, Cross-certification, Support for non-repudiation, Time stamping, Client software

PKI architectures

Single CA, Hierarchial PKI, Mesh PKI, Trust Lists, Bridge CAs

PKI standards

X.509: Components of X.509: Tamper evident envelope, Basic certificate contents, certificate extensions.; PGP: Web of Trust; Simple PKI (SPKI) / Simple Distributed Security Infrastructure (SDSI): Representing certificates in terms of S-Expressions-Certificate

Chain Discovery - Distinct Advantages of SPKI/SDSI over X.509. PKI application : Smart cardintegration with PKI's

Access Control Mechanisms

Discretionary Access Control (DAC) – Mandatory Access Control (MAC) – Role Based Access Control (RBAC).Issues : Revocation- Anonymity-Privacyissues

Trust Management

Policy based Trust Management System- Social network based Trust Management System- Reputation based Trust Management System (DMRep, EigenRep, P2Prep)-Framework for Trust Establishment. Risks Impact on E-Commerce and E- Business: Information Risk – Technology Business Risk

Text Books/Reference Books:

1.Desmedt, Yvo G. (Ed.), Secure Public Key Infrastructure Standards, PGP and Beyond,Springer, 2012.

2. J. Camenisch and C. Lambrinoudakis, Public Key Infrastructures, Services andApplications, EuroPKI 2010.

SECURE OPERATING SYSTEMS
Subject Code: CS60316
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To introduce students to a broad range of operating system security topics including: network and system security plans, security design, security threats and risks, system and application security tools, implementation of security plan, network monitoring and audit logs and resolution of any security breach. Studentswill learn computer operating systems by demonstrating server support skills and designing and implementing OS security systems, identifying security threats, vulnerabilities, and monitoring network security implementations. Such a course should give skills to the students to implement industry standard secure servers side managed operations as well as clients.

Course Outcomes:

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

CO1: Identify the security goals,models and fundamentals of access control techniques
CO2: Classify various security features in ordinary operating systems
CO3: Analyze for the vulnerabilities in a given system
CO4: Evaluate Information flow secrecy models, integrity models and trust models
CO5: Identify the system level security features incorporated in Multics, SELinux, Solaris etc
CO6: Assess the security parameters of secure capability systems and secure virtual machines

Course Contents:

Introduction:

Security Goals, Trust Model, Threat Model; Access Control Fundamentals: Protection System, Reference Monitor, Secure Operating System Definition, Assessment Criteria;

Multics:

Multics History, Multics Security Fundamentals, Multics Protection System Models, Multics Security, Multics Vulnerability Analysis; Security in Ordinary

Operating Systems:

UNIX Security, UNIX Protection System, UNIX Authorization, UNIX Security Analysis, UNIX Vulnerabilities, Windows Security, Windows Protection System, Windows Authorization, Windows Security Analysis, Windows Vulnerabilities;

Verifiable Security Goals:

Information Flow, Information Flow Secrecy Models, Denning's Lattice Model, Bell-LaPadula Model, Information Flow Integrity Models, Biba Integrity Model, Low-Water Mark Integrity, Clark-Wilson Integrity, The Challenge of Trusted Processes, Covert Channels, Channel Types, Noninterference;

Building a Secure Operating System for Linux:

Linux Security Modules, LSM History, LSM Implementation, Security-Enhanced Linux, SELinux Reference Monitor, SELinux Protection State, ELinux Labeling State, SELinux Transition State, SELinux Administration, SELinux Trusted Programs, SELinux Security Evaluation;

Secure Capability Systems:

Capability System Fundamentals, Capability Security, Challenges in Secure Capability Systems, Building Secure Capability Systems; Secure Virtual Machine Systems: Separation Kernels, VAX VMM Security Kernel, Security in Other Virtual Machine Systems

Text Books/Reference Books:

1.Trent Jaeger, Operating System Security, Morgan & Claypool, 2008.

2.P.G Neumann (PI), A Provably Secure Operating System, Final Report published by Stanford Research Institute, California, US., 1975.

3.Morrie Gasser, Building A Secure Computer System, Van Nostrand Reinhold, 1988.

4.Michael Palmer, Operating Systems Security, Thomaon Course Technology, 2004.

SECURE PROTOCOLS FOR ELECTRONIC COMMERCE
Subject Code: CS60318
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To implement and defend against canonical attacks on web security, and rapidly read technical descriptions of attacks, determine their severity and applicability, and identify suitable countermeasures. Understand, implement and defend against canonical attacks on payment systems, and explain the architecture of cryptocurrencies. Study popular e-business models, including those of Amazon, eBay, CyberCash and VeriSign and will understand the issues of billing, credit and cash transfers on the Internet. Learning the Internet security technologies such as public-key/private-key cryptography, digital signatures and digital certificates.

Course Outcomes:

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

CO1: Identify algorithms and architecture for security
CO2: Discuss the access control,DOS,Nonrepudiation, for Secure Management of Cryptographic Keys
CO3: Classify security for Business-to-Business electronic commerce
CO4: Measure the performance of SSL/TLS, Implementation Pitfalls
CO5: Apply the SET Protocol
CO6: Evaluate the Secure Payments systems

Course Contents:

Overview of Electronic Commerce

Electronic Commerce and Mobile Commerce, Effects of the Internet and Mobile Networks, Network Access, Barcodes, Smart Cards, Parties in Electronic Commerce, Security;

Money and Payment Systems

Mechanisms of Classical Money, Payment Instruments, Types of Dematerialized Monies, Purses, Holders, and Wallets; Transactional Properties of Dematerialized Currencies, Overall Comparison of the Means of Payment, Practice of Dematerialized Money, Clearance and Settlement in Payment Systems, Drivers of Innovation in Banking and Payment Systems;

Algorithms and Architectures for Security

Security of Open Financial Networks, OSI Model for Cryptographic Security, Security Services at the Link Layer, Security Services at the Network Layer, Security Services at the Application Layer, Message Confidentiality, Data Integrity, Identification of the Participants, Biometric Identification, Authentication of the Participants, Access Control, Denial of Service, Nonrepudiation, Secure Management of Cryptographic Keys, Exchange of Secret Keys: Kerberos; Public Key Kerberos, Exchange of Public Keys, Certificate Management, Authentication, Security Cracks; Business-to-Business Commerce-Drivers for Business-to-Business Electronic Commerce, Four Stages of Systems

Overview of Business-to-Business Commerce

Short History of Business-to- Business Electronic Commerce, Examples of Business-to-Business Electronic Commerce, Evolution of Business-to-Business Electronic Commerce, Implementation of Business-to- Business Electronic Commerce, X12 and EDIFACT, EDI Messaging, Security of EDI, Integration of XML and Traditional EDI, New Architectures for Business-to-Business Electronic Commerce, Electronic Business

(Using) Extensible Markup Language, Web Services, Relation of EDI with Electronic Funds Transfer; Transport Layer Security and Secure Sockets Layer - Architecture of SSL/TLS, SSL/TLS Security Services, SSL/TLS Subprotocols, Performance of SSL/TLS, Implementation Pitfalls; Wireless Transport Layer Security - Architecture, From TLS to WTLS, Operational Constraints, WAP and TLS Extensions, WAP Browsers; The SET Protocol -SET Architecture, Security Services of SET, Certification, Purchasing Transaction, Optional Procedures, Efforts to Promote SETs, SET versus TLS/SSL; Payments with Magnetic Stripe Cards - Point-of-Sale Transactions, Communication Standards for Card Transactions, Security of Point-of-Sale Transactions, Internet Transactions, 3D Secure, Migration to EMV; Secure Payments with Integrated Circuit Cards - Description of Integrated Circuit Cards, Integration of Smart Cards with Computer Systems, Standards for Integrated Circuit Cards, Multi application Smart Cards, Security of Smart Cards, Payment Applications of Integrated Circuit Cards, EMV® Card, General Consideration on the Security of Smart Cards; Mobile Payments - Reference Model for Mobile Commerce, Secure Element in Mobile Phones; Barcodes, Bluetooth, Near-Field Communication, Text Messages, Bank- Centric Offers, Mobile Operator–Centric Offers, Third-Party Service Offers, Collaborative Offers, Payments from Mobile Terminals; Micropayments - Characteristics of Micropayment Systems, Standardization Efforts, Electronic Purses, Online Micropayments, Market Response to Micropayment Systems; Case Study of PayPal - Evolution of PayPal, Personal Accounts, Business Accounts; Digital Money -Privacy with Cash and Digital Money, DigiCash (eCash), Anonymity and Untraceability in DigiCash, Evaluation of DigiCash; Bitcoin and Cryptocurrencies - Bitcoin Protocol, Operation, Risk Evaluation;

Electronic Commerce in Society

Harmonization of Communication Interfaces, Governance of Electronic Money, Protection of Intellectual Property, Electronic Surveillance and Privacy, Content Filtering and Censorship, Taxation of Electronic Commerce, Trust Promotion, Archives Dematerialization

Text Books/Reference Books:

1.Mostafa Hashem Sherif, Protocols for Secure Electronic Commerce, Third Edition, CRCPress, Taylor and Francis group, 2016.

2.Ghosh, Anup K. (Ed.), E-Commerce Security and Privacy, Springer Publishing, 2001.

SECURE SOFTWARE ENGINEERING
Subject Code: CS60320
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

The course will cover a wide range of software security topics ranging from as security as a cross-cutting concern, methodological approaches to improving software security during different phases of software development lifecycle, integrating secure software development principles and patterns into software development processes, contemporary paradigm of secure continuous software engineering, DevSecOps. The course will be offered in a workshop style mode with small and large parts of software development projects being the major types of assessment tasks.

Course Outcomes:

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

CO1: Evaluate secure software engineering problems, including the specification, design, implementation, and testing of software systems

CO2: Elicit, analyze and specify security requirements through SRS

CO3: Design and Plan software solutions to security problems using various paradigms

CO4: Model the secure software systems using Unified Modeling Language Sec(UMLSec)

CO5: Develop and apply testing strategies for Secure software applications

CO6: Propose solutions for secure software engineering

Course Contents:

Software assurance and software security

Threats to software security, sources of software insecurity, benefits of detecting software security, managing secure software development, Defining properties of secure software, how to influence the security properties of software, how to assert and specify desired security properties,

Secure software Architecture and Design

Software security practices for architecture and design: Architectural risk analysis, software security knowledge for Architecture and Design: security principles, security guidelines, and attack patterns, secure design through threat modeling,

Writing secure software code

Secure coding techniques, Secure Programming: Data validation, Secure Programming: Using Cryptography Securely, Creating a Software Security Programs.

Secure Coding and Testing

Code analysis- source code review, coding practices, static analysis, software security testing, security testing consideration through SDLC

Text Books/Reference Books:

1.Julia H Allen, Sean J Barnum, Robert J Ellison, Gary McGraw, Nancy R Mead, SoftwareSecurity Engineering: A Guide for Project Managers, Addison Wesley, 2008.

2.Ross J Anderson, Security Engineering: A Guide to Building Dependable DistributedSystems, 2nd Edition, Wiley, 2008.

3.Howard, M. and LeBlanc, D., Writing Secure Code, 2nd Edition, Microsoft Press, 2003.

Software Requirement Engineering
Subject Code: CS60401
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To understand the requirements of an engineering process and apply it for elicitation, specification, modeling and analysis of software and system requirements.This course will involve building models of both software engineering processes and products, concerning both functional and non-functional goals, requirements, and specifications. It will provide students with the skills needed for software requirements engineering, as well as a foundation that can be used to systematically establish, define, and manage the requirements for large, complex, and changing software-intensive systems, from technical, organizational, and management perspectives.

Course Outcomes:

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

CO1: Utilize the knowledge of software requirement and management
CO2: Construct software requirement engineering and its application using various models
CO3: Describe how to calculate estimation of project
CO4: Analysis of different ways of quickly estimating an effort (Cost Estimation)
CO5: Describe the critical factors we must consider when estimating software projects
CO6: Evaluate the models for software requirement engineering

Course Contents:

Introduction to Software Requirements

Essential Software requirement, Object model, data flow model, Behavioral Modeling, State Diagram, System Diagram, Data Dictionary, Improving requirements processes. IEEE standards for Software requirement specification.

Requirements Analysis, Specification & Engineering Processes

Requirements Gathering and Analysis, SRS, Formal Specification, Axiomatic Specification, Algebraic Specification, Z- Specification, Process Models, Actors in requirements engineering processes, Process support, Process improvement.

Software Requirements Management

Requirements management Principles and practices, Requirements attributes, Change Management Process, Requirements Traceability Matrix, Links in requirements chain. Tools for Requirements Management and Estimation Requirements Management.

Software Requirements Modeling

Use Case Modeling, Analysis Models, , state transition diagram, class diagrams, Object analysis, Problem Frames. Software Estimation: Components of Software Estimations, Estimation methods, Problems associated with estimation, Key project factors that influence estimation.

View point-oriented Requirements Methods

Viewpoint-Oriented System Engineering, View point-oriented Requirements Definition, Viewpoints-oriented requirements validation, Classification of non-functional requirements, Deriving non-functional requirements, Requirements for critical systems, Requirements engineering for safety-related systems.

Text Books:

1.G. Kotonya and Ian Sommerville, Requirements Engineering: Processes and Techniques, John Wiley & Sons, 2002.

2.Rajesh Naik and Swapna Kishore, Software Requirements and Estimation, published by Tata Mc Graw Hill .

Reference Books:

1.Rajib Mall, Fundamentals of Software Engineering, PHI Third edition, 2011.

2.Klaus Pohl, Requirements Engineering: Fundamentals, Principles & Techniques, Springer International Edition, 2010.

3.Elizabeth Hull, Ken Jackson and Jeremy Dick, Requirements Engineering, Springer, 2011.

4.Ian Sommerville, Pete Sawyer., Requirements Engineering: A Good Practice Guide, Wiley India, Wiley Students Edition, Reprint, 2011.

SOFTWARE TESTING
Subject Code: CS60402
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

The course introduces the main principles underlying software testing: purpose of testing, model for testing , consequences of bugs, taxonomy of bugs, path testing, Test Case Design Strategies-Black-Box Approach, White–Box Approach, decision tables, path expressions, kv charts, state testing, Testability tips, On the completion of the units, students will understand the fundamentals of Software testing and be able to test the applications with the help of testing tools.

Course Outcomes:

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

CO1: Understand software testing as a fundamental component of software life cycle
CO2: Define the scope of Software Testing projects
CO3: Efficiently perform testing activities using modern software tools
CO4: Estimate cost of a testing project and manage budgets
CO5: Prepare test plans and schedules for a Testing project
CO6: Select test plan based on criticality of requirements

Course Contents:

Introduction to Software Testing

Software testing terminology and methodology, verification and validation, evolution of testing, software testing life cycle, V-model for software testing, testing and debugging, levels of testing, software defect management, flow graphs, code-based testing, logic based testing, configuration management, risk analysis, model based testing, statistical testing, formal testing.

Testing Techniques

Dynamic testing-white-box testing techniques, Static testing- Slice based testing, mutation testing, coverage analysis, defect seeding, Regression testing- Regression test process, test case selection, test case prioritization, code based and model based regression testing.

Testing Process

Test planning-Test policy, test strategy, quality plan and test plan, test estimation, test scenario, test scripts, test log document, generation of test data, test progress monitoring, Test metrics and test reports: Testing data, categories of product test metrics, resource consumed in testing, defect density, test reports, project test status reports, integration, system and acceptance test report, test process improvement, benchmarking.

Testing Strategies

Integration and System Testing-Top down and bottom up integration, bi-directional integration, system integration, scenario testing, defect bash, functional versus non-functional testing, design/architecture verification, deployment testing, scalability testing, reliability testing, stress testing.

Acceptance Testing

Acceptance testing criteria, alpha, beta and gamma testing , acceptance testing during each phase of SDLC, criticality of requirements, software acceptance plan, user's responsibility.

Text Books:

1.S. Desikan and G. Ramesh, "Software Testing: Principles and Practices", Pearson Education, Sixth Impression.

Reference Books:

1.M.G. Limaye, " Principles, Techniques and Tools", MGH, 6th Reprint 2012.

2.Naresh Chauhan,"Software Testing Principle and Practices", 2nd Impression, Oxford University Press, 2011.

3.Aditya P. Mathur, "Foundation of Software Testing", Pearson Education, 2007.

4.Sagar Naik, Piyu Tripathy, "Software Testing and Quality Assurance: Theory and Practice", Wiley, 2011.

SOFTWARE ENGINEERING PROCESS & QUALITY

Subject Code: **CS60404**
Credit: **3-0-0-3**
Prerequisite: **Nil**

Course Objectives:

This course will define and criticise the concepts of process and quality in the context of software development, evaluate development activities against an accepted, standardized life cycle model. It will recognise or define frameworks by which the delivery of quality can be made the focus of an organization or project. It determines the nature of compliance with, or location within, standards and models such as the CMMI.

Course Outcomes:

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

CO1: Use software engineering process management
CO2: Distinguish the various methods of project assessment
CO3: Inspect Software Quality Management
CO4: Explain Software development process
CO5: Evaluate Quality control practices
CO6: Make use of software quality and control practices

Course Contents:

Process Implementation and Change
Process infrastructure: software engineering process group, experience factory; Activities; Models for process implementation and change; Practical Consideration.

Process Definition
Perspective Models, The Waterfall Model, Incremental Process Model, Evolutionary Process Models, Specialized Process Models: Component-based development, Formal Methods Model, Aspect-Oriented Software Development; The Unified Processes, Timebox Model, Agile Process Models: Extreme Programming, Adaptive Software Development (ASD), Dynamic Software Development Methods (DSDM), Scrum, Crystals, Feature Driven Development (FDD), Agile Modeling (AM); Process Adoption; Automation.

Process Assessment
Process assessment models; Process assessment methods.

Product & Process Measurement
Software process measurement; Software product measurement: size measurement, structure measurement, Measurement Techniques: analytical techniques, Benchmark techniques.

Software Quality Fundamentals
Concepts of S/W Quality: quality views from different perspectives and stakeholders, core components of the quality of a product, quality gap, Total Quality Management, Six Sigma Quality, quality control, quality assurance and quality management. Value & cost of quality.

Quality models and characteristics
Software process quality, software product quality; Quality Improvement.

Software Quality Management Processes
Software quality assurance (SQA), SQA Activities, Software Reviews, Formal Technical Reviews, Formal Approaches to SQA, Statistical Software Quality Assurance: Six sigma for software engineering, The ISO 9000 Quality Standards,PSP, SPICE, The SQA Plan.

Software quality management techniques
Static techniques, people intensive techniques, analytic techniques, dynamic techniques; Software quality measurement.

Software Quality Control Practices
Software Verification & Validation (V&V): Definition of V&V: system V&V and software V&V, independent V&V; V&V Techniques: testing, demonstration, traceability, analysis, inspection, peer review, walkthrough, and Audit.

Text Books:

1.Roger S Pressman, Software Engineering-A Practitioner's Approach, TATA McGRAW-HILL, 6th Edition, 2010.

Reference Books:

1.M. Limaye, Software Quality Assurance, 1st Edition, Tata Mcgraw Hill Education Private Limited, 2011.

2.Authored by IEEE Computer Society, Guide to the Software Engineering Body of Knowledge, Software Engineering Body of Knowledge (SWEBOK), Edited by Alain Abran, James W. Moore, Pierre Bourque, Robert Dupuis, 2004.

SOFTWARE MAINTENANCE & CONFIGURATION MANAGEMENT
Subject Code: CS60406
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

At the core, software maintenance involves taking existing software artefacts, understanding them, and then modifying or extending the code and/or other work products associated with the software (such as requirements, design and test suites). Other aspects, such as migrating a system from one platform to another, reverse-engineering (i.e., extracting higher-level artefacts such as design from code), and inter-connecting existing systems for inter-operability, are also part of this field.

Course Outcomes:

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

CO1: Elaborate software maintenance and estimate probable maintenance cost of a software
CO2: Follow different features of maintenance process and understand system evolution dynamics
CO3: Perform effective re-engineering process and construct different suitable design patterns
CO4: Make use of Software Configuration Management process and identify different important configurable items
CO5: Apply configuration controls
CO6: Evaluate Software Configuration Status Accounting

Course Contents:

Software Maintenance

Maintenance context, Maintenance cost :Context: Nature of software maintenance, Software Maintenance Types, Characteristics of Maintainable Software, Lehman's laws. Maintenance cost: cost issues using COCOMO model, Maintainability Measurements and Maintenance Cost Factors.

Software maintenance process

Software maintenance process, System Evolution: Change requests management, Version and Release management issues, Version and Release management issues, Legacy Systems Structure and definitions, Legacy System Design, Legacy replacement strategies, Legacy System Assessment. Program Evolution Dynamics, Architectural Evolution (n-tire), Architectural Evolution (VMC, SC, Web services).

Software Re-engineering

Software Re-engineering, Design Patterns: Software Re-engineering: The re- engineering Process definition, Reverse Engineering Vs forward engineering, Re-engineering process

structure, Software Reusability Definition, Software Reuse and Maintainability Issues, Reusable Components, Design patterns and effects on software maintainability, A look at some design patterns under use, Open-source and maintainability issues, Frameworks and maintainability issues.

Software Configuration Management

SCM Process, Software Configuration Identification Management of the SCM Process: Organizational Context for SCM; Constraints and Guidance for the SCM Process; Planning for SCM: SCM organization and responsibilities, SCM resources and schedules, Tool selection and implementation, Vendor/Subcontractor Control, Interface control; SCM Plan; Surveillance of Software Configuration Management: SCM measures and measurement, In- process audits of SCM. Software Configuration Identification: Identifying Items to Be Controlled: Software configuration item, Software configuration item relationships, Software version, Baseline, Acquiring software configuration items; Software Library.

Software Configuration Control

Requesting, Evaluating, and Approving Software Changes: Software Configuration Control Board, Software change request process; Implementing Software Changes; Deviations and Waivers.
Software Configuration Status Accounting: Software Configuration Status Reporting.

Text Books

Grubb P., Takang A A., Software Maintenance- Concepts and Practice, 2nd Edition, World Scientific, 2007.

Gopalaswamy Ramesh, Ramesh Bhattiprolu, Software Maintenance, Tata Mcgraw Hill Education Private Limited, 2005, 1st edition.

Reference Books

Authored by IEEE Computer Society, Guide to the Software Engineering Body of Knowledge, Software Engineering Body of Knowledge (SWEBOK), Edited by Alain Abran, James W. Moore, Pierre Bourque, Robert Dupuis, 2004.

SommervilleIan,Software Engineering, Addison Wesley, 2008Babich, W. A., Software Configuration Management, Addision-Wisley, 2006.

Gunther, R.C., Management Technology for software product engineering, New York, John Wiley, 2005.

SOFTWARE RELIABILITY
Subject Code: CS60408
Credit: 3-0-0-3
Prerequisite: Nil

Course Objectives:

To introduce students to techniques and tools for improving the reliability of software systems. The course will provide an overview of the main types of software reliability techniques and discuss their respective strengths and weaknesses. The course will present in detail a selection of these techniques and associated tools, focusing on recent directions in both research and practice.

Course Outcomes:

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

CO1: Use scientific concepts of Software and Hardware Reliability
CO2: Apply Software Reliability Growth Models in Software Development
CO3: Emphasize the Application of Software Reliability Models
CO4: Conceive the concept of software reliability
CO5: Make use of the Reliability Estimation Methods
CO6: Evaluate Reliability Growth Models and Tools

Course Contents:

Introduction

Defining Software Reliability, Software Reliability Attributes and Specification, Concept of Defects, Faults, Failures, Defect Rate and Reliability, Defect Prevention, Reduction, and Containment, Overview of Different Types of Software Review, Introduction to Measurement and Inspection Process, Documents and Metrics.

Software Reliability Metrics

Collection of fault and failure data, Measurement of internal and external product attributes, Customer Problems Metric, Customer Satisfaction Metrics, In-Process Quality Metrics: Defect Arrival Pattern, Phase-Based Defect Removal Pattern, Defect Removal Effectiveness, Metrics for Software Maintenance, Software Reliability indicators, Software Reliability Metrics, Static Code Metrics, Dynamic Metrics.

Software Reliability Assessment Models

Basics of Reliability Theory, Software Reliability Problem, Modeling Process, Software Reliability Models, Parametric Reliability Growth Models, The Rayleigh Model, Exponential Distribution and Software Reliability Growth Models, Software Quality Assessment Models: Hierarchical Model of Software Quality Assessment.

Software Reliability Allocation Models

Software Reliability Allocation Models, Criteria for Model Evaluation, Optimal ReliabilityAllocation, Quality Planning and Control, Quality Improvement Process, Evolution of Software Quality Assurance (SQA), Major SQA Activities, Major SQA Issues, Zero Defect Software.

Reliable Software Design

Basic design principle of reliable software, requirements, objectives, and specifications, system architecture, program structure design, design practices, module design and coding, programming style.

Software Reliability Techniques
Reliability Techniques: Trending Reliability Techniques, Predicting Reliability Techniques, Error Seeding, Failure Rate, Curve Fitting, Operational Profile, Reliability Growth Models and Tools: Study of tools like CASRE, SARA, SMERFS.

Text Books:

1.John D. Musa, Software Reliability Engineering: More Reliable Software Faster and Cheaper, Tata Mcgraw Hill Education Private Limited, 2nd Edition, 2005.

Reference Books:

1.Hoang Pham, “Software Reliability”, Springer, 2000.

2.Min Xie, “Software reliability modeling”, World Scientific, 1991.

3.M.L Shooman, “Software Engineering: Design, Reliability and Management”, Mcgraw Hill, 1983.

4.Fenton, and Pfleeger, “Software Metrics: A Rigorous and Practical Approach”, International Thomson Computer Press, 2nd Revised Edition, 1998.

CLOUD COMPUTING PRINCIPLES
Subject Code: CS62101
Credit: 3-0-2-4
Prerequisite: Nil

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 Outcomes:

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

CO1:Able to provide an in-depth and comprehensive knowledge of the Cloud Computing fundamental issues, technologies, applications and implementations
CO2: Able to expose the students to the frontier areas of Cloud Computing
CO3: Able to motivate students to do programming and experiment with the various cloud computing environments
CO4: Able to analyze various Security issues in Cloud Computing
CO5: Able to realize about various Cloud Standards
CO6: Able to perform Cloud Programming under different Software Environments

Course Contents:

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

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

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

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.

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.

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.

DEEP LEARNING AND ITS APPLICATIONS
Subject Code: CS62102
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

Modern deep learning has had tremendous success in applying complex neural networks to problems from a wide range of disciplines. This course gives and understanding of the theoretical basis underlying neural networks and deep learning. Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.

Course Outcomes:

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

CO1: Develop an idea on various types of learning for addressing machine learning issues and challenges
CO2: List different deep learning models and real world application of deep learning.
CO3: Analyze various pretrained models and test on case studies of CNN in varied sectors
CO4: Discuss on sequence modeling approach for time series analysis
CO5: Explore the essentials of Deep Learning and Deep Network architectures
CO6: Train Deep Neural Networks for solving real world problems that require artificial intelligence based solutions

Course Contents:

Introduction

Learning – Various types Learning – Machine Learning: issues and challenges – CPU vs GPU – massive parallelism – Introduction to Deep Learning – Deep Learning Models: CNN – RNN – AE – GAN – real world applications of Deep Learning – Packages used for Deep Learning.

Deep Learning

Introduction – shallow neural networks – Deep neural networks – Architecture Design – Convolutional Neural Networks – Introduction – Convolution (1D and 2D)

– Pooling – Training of network – Hyper parameter tuning – pre-trained models: AlexNet – GoogleNet – Resnet – VGG-16 – VGG-19 – ImageNet – Case study of CNN (Healthcare – Agriculture – Stock Market – Weather Forecasting.

Sequence Modeling

Recurrent Neural Network (RNN) Model – Types of RNNs – Vanishing Gradients with RNN – Gated Recurrent Unit – Long Short Term Memory (LSTM) – Deep Recurrent Neural Networks – RNN for Time Series – Transformer Network Models - Case Studies on Recent Real World Problems.

Autoencoders And Generative Adversarial Networks

Autoencoders –Architecture of Autoencoders – Types of Autoencoders – Applications of Autoencoders – Generative Models – Generative Adversarial Networks – Applications – Autoencoders vs Generative Adversarial Networks – Use Cases.

Deep Reinforcement Learning

Foundations of Reinforcement Learning – Value-based models – Policy-based models – Multi-Agent Reinforcement Learning – Deep Q-Learning – SARSA Learning – Real World Applications.

Reference Books:

1.Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press 2016.

2.Andrew Glassner, Deep Learning from basics to practice. Volume 1 & 2, Kindle Edition,2018.

3.François Chollet, Deep Learning with Python, Manning Publications, 2018.

IMAGE PROCESSING
Subject Code: CS62103
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

To introduce the concepts of image processing and basic analytical methods to be used in image processing. To familiarize students with image enhancement and restoration techniques, To explain different image compression techniques. To introduce segmentation and morphological processing techniques

Course Outcomes:

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

CO1: To apply the theory and algorithms of image processing
CO2: To understand the image restoration techniques
CO3: To learn and apply different image compression techniques
CO4: To learn the image segmentation methods
CO5: To develop applications using different image processing techniques
CO6: To discuss the applications of motion in segmentation

Course Contents:

Introduction

Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization, Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian, Hotelling Transform, Fourier Transforms and properties, Convolution, Correlation, 2-D sampling, Discrete Cosine Transform, Frequency domain filtering

Image Enhancement & Restoration

Basic Intensity transformation functions, Histogram processing, smoothing and sharpening filters in spatial and frequency domain , Periodic noise, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections

Image Compression

Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, blocking artifacts, DCT, Run length coding, FAX compression, Symbol-based coding, Bit-plane encoding, Bit-allocation, Zonal Coding, Threshold Coding, JPEG, Lossless predictive coding, Lossy predictive coding, Motion Compensation.

Morphological Image Processing

Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Reconstruction by dilation and erosion.

Image Segmentation

Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation.

Text Books:

1.Digital Image Processing, by Rafael C. Gonzalez, Richard E. Woods, 3rd edition, 2007, Pearson.

2.Digital Image Processing using MATLAB, by Ralph C. Gonzalez, Richard E. Woods, Steven L. Eddins, 2nd edition, 2014, McGraw Hill.

Reference Books:

1.Fundamentals of Digital Image Processing, by Anl K. Jain, PHI.

2.Fundamentals of Digital Image Processing, by Annadurai, 2016, Pearson.

PRINCIPLES OF MACHINE LEARNING & DEEP LEARNING
Subject Code: CS62104
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

To understand the basic building blocks and general principles that allow one to design machine learningalgorithms
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 Outcomes:

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

CO1: Able to realize the basic building blocks and general principles that allow one to design machine learning algorithms
CO2: Able to apply specific, widely used machine learning algorithms
CO3: Able to analyze deep neural network architecture
CO4: Able to apply representation and transfer of knowledge using deep learning
CO5: Able to design deep learning tools and framework for solving real-life problems
CO6: Able to apply different advanced deep learning tools

Course Contents:

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.

Decision Tree

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.

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.

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.

Deep Learning

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).

Text Books:

1.Ethem Alpaydin, Introduction to Machine Learning, PHI, 2005.

2.Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, The MIT Press, 2016.

INTERNET OF THINGS
Subject Code: **CS62105**
Credit: **3-0-2-4**
Prerequisite: **Nil**

Course Objectives:

This course will describe the market around the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of distributed systems needed to support them. Divided into four modules, we will learn by doing. We will start with simple examples and integrate the techniques we learn into a class project in which we design and build an actual IoT system. The client will run in an emulated ARM environment, communicating using common IoT protocols with a cloud enabled backend system. Students will be explored to the interconnection and integration of the physical world and the cyber space. They are also able to design & develop IOT Devices.

Course Outcomes:

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

CO1: Choose the real-time system models and its components
CO2: Model the application of various strategies to handle the functioning of various real-time features such as resources, tasks etc
CO3: Inspect the implementation aspects of real time systems
CO4: List the real-time communications and real-time database
CO5: Discuss the applications of commercial real-time operating systems
CO6: Elaborate the implementation aspects of the basic operating system

Course Contents:

Introduction

Definition, Applications and Types of Real Time Systems, Typical Case Studies of Real Time Systems, Time Constraints.

A Reference Model for Real Time Systems

Processors and Resources, Periodic Task Model, Precedence and Data Dependency, Temporal, Foundational and Resource Parameters, Scheduling Hierarchy.

Real Time Scheduling

Different Approaches-Clock Driven, Priority Driven, Scheduling of Periodic and Sporadic Jobs in Priority- Driven Systems.

Resource Management Resources and Resource Access Control, Critical Section, Priority-Ceiling Protocols, concurrent Access to Data Objects.

Implementation Aspects

Timing Services and Scheduling Mechanisms, Other Basic Operating System Functions, Processor Reserves and Resource Kernel, Open System Architecture, Capabilities of Commercial Real Time Operating Systems, Predictability of General Purpose Operating Systems. Case Studies: Vx – Works, and RT Linux.

Text Books:

1. Jane W.S. Liu, Real Time Systems, Pearson Education, 2001.

Reference Books:

1.C.M. Krishna and Kang G. Shin, Real Time Systems, Mc-Graw Hill Companies Inc., 1997.

2.Raymond J.A. Buhr, Donald L. Bailey, An Introduction to Real Time Systems, Prentice Hall International, 1999.

3. Rajib Mall, Real Time Systems: Theory and Practice, Pearson.

STATISTICAL NATURAL LANGUAGE PROCESSING

Subject Code: **CS62106**
Credit: **3-0-2-4**
Prerequisite: **Nil**

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

Course Outcomes:

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

CO1: Identify the need for morphological processing and their representation
CO2: Analyze the various techniques used for speech synthesis and recognition
CO3: To assess the syntax analysis and parsing that is essential for natural language processing
CO4: Explain the various representations of semantics and discourse
CO5: Estimate Computational Semantics -Word Senses -Relations Between Senses
CO6: Discuss the applications of natural language processing

Course Contents:

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

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

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

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

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

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.

REAL TIME SYSTEMS
Subject Code: CS62107
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

To introduce students to the fundamental problems, concepts, and approaches in the design and analysis of real-time systems. To study issues related to the design and analysis of systems with real-time constraints. The problem of ensuring such constraints is ultimately a scheduling problem, so much attention is devoted to such problems.Describe real-time systems and how real-time resource management algorithms and mechanisms (e.g., scheduling, synchronization) enable satisfaction of application timing constraints.

Course Outcomes:

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

CO1: Able to analyze the real-time system models and its components
CO2: Able to apply various strategies to handle the functioning of various real-time features such as resources, tasks etc
CO3: Able to choose about the implementation aspects of real time systems
CO4: Able to survey real-time communications and real-time database
CO5: Able to know about the applications of commercial real-time operating systems
CO6: Able to apply different realtime task scheduling algorithms

Course Contents:

Introduction

Definition, Applications and Types of Real Time Systems, Typical Case Studies of Real Time Systems, Time Constraints.

A Reference Model for Real Time Systems

Processors and Resources, Periodic Task Model, Precedence and Data Dependency, Temporal, Foundational and Resource Parameters, Scheduling Hierarchy.

Real Time Scheduling

Different Approaches-Clock Driven, Priority Driven, Scheduling of Periodic and Sporadic Jobs in Priority- Driven Systems.

Resource Management

Resources and Resource Access Control, Critical Section, Priority-Ceiling Protocols, concurrent Access to Data Objects.

Implementation Aspects

Timing Services and Scheduling Mechanisms, Other Basic Operating System Functions, Processor Reserves and Resource Kernel, Open System Architecture, Capabilities of Commercial Real Time Operating Systems, Predictability of General Purpose Operating Systems. Case Studies: Vx – Works, and RT Linux.

Text Books:

2. Jane W.S. Liu, Real Time Systems, Pearson Education, 2001.

Reference Books:

1. C.M. Krishna and Kang G. Shin, Real Time Systems, Mc-Graw Hill Companies Inc., 1997.

2. Raymond J.A. Buhr, Donald L. Bailey, An Introduction to Real Time Systems, Prentice Hall International, 1999.

3. Rajib Mall, Real Time Systems: Theory and Practice, Pearson.

WEB TECHNOLOGIES & SERVICES

Subject Code: **CS62108**
Credit: **3-0-2-4**
Prerequisite: **Nil**

Course Objectives:

To comprehend the basics of the internet and web terminologies. To introduce scripting language concepts for developing client-side applications. To practice server-side programming features – PHP, JSP. To know the usefulness of web services.On completion of this course, a student will be familiar with client server architecture and able to develop a web application using java technologies. Students will gain the skills and project-based experience needed for entry into web application and development careers.

Course Outcomes:

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

CO1: Implement, compile, test and run Java programs, comprising more than one class, to address a particular software problem
CO2: Demonstrate the ability to employ various types of selection statements and iteration statements in a Java program
CO3: Leverage the object-oriented features of Java language using abstract class and interface
CO4: Handle errors in the program using exception handling techniques of Java
CO5: Design applets with event handling facility
CO6: Analyze different web services developed using Java

Course Contents:

Introduction to Java

Java and Java Runtime Environment(JRE), Java characteristics, Object oriented Programming, Data types, Operators, Expressions, control statements, Selection statements, Iteration statements.

Classes, Inheritance

Classes in java, Declaring a class, Creating instances of class, Constructors, Argument Passing, use of static keyword, Innner class, Method overloading, Inheritance, use of super keyword, Method overriding, Abstract class, Dynamic method dispatch, use of final keyword, Interface, Package: Package, Acesss control mechanism, Interface and it's use.

Exception Handling

Java Exception Handling Mechanism, try, catch, throw, throws and finally, Exception types, Built in Exceptions: checked and unchecked exceptions, User defined Exceptions. String Handling: String and String Buffer, Constructors, String operations : character extractions, String comparisons, searching strings, modifying a string. To String() and valueOf() methods, String Buffer operations.

Applet

Applet class, Applet architecture, Applet Skeleton, Life cycle methods, Using the status window,HTML Applet tag, Passing parameters to an applet, getCodebase() and getDocumentbase() methods. Event Handling and AWT: Delegation Event Model, Event classes, Sources of Events, Event Listener interfaces, Event handling using adapter class, Inner and anonymous class, AWT classes: Label,Button,TextField etc.

Web Services

Introduction to Web Services, its architecture & benefits, SOAP, WSDL, Restful Web Services, Comparison between web services etc.

Text Books:

1. Java Programming – for Core and Advanced Learners by Sagayaraj, Denis, Karthik, University Press publication, 2018 .

Reference Books:

1. Java-The Complete Reference, Herbert Schildt, 9th Edition, McGraw Hill Education 2014.

2. Java – One Step Ahead, B. L. Juneja & Seth , Oxford Publisher.

3. Java Web Services, D.A. Chappell & T. Jewell, O'Reilly, SPD.

WIRELESS SENSOR NETWORKS

Subject Code: **CS62109**

Credit: **3-0-2-4**

Prerequisite: **Nil**

Course Objectives:

This course covers the challenges and the latest research results related to the design and management of wireless sensor networks (WSNs). WSNs have recently gained tremendous popularity due to the wide range of applications they can be used for such as disaster management, military, building and road monitoring, health care, etc. WSNs are infrastructure wireless networks that are significantly constrained in the amount of available resources such as energy, storage and computation. Such constraints make the design and operation of sensor networks considerably different from contemporary wireless networks, and necessitate the development of resource conscious protocols and management techniques.

Course Outcomes:

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

CO1: Get an overview about sensor networks and emerging technologies
CO2: Summerize about the node and network architecture of sensor nodes and its execution environment
CO3: Analyze various concepts of communication, MAC, routing protocols and also study about the naming and addressing in WSN
CO4: Able to apply different topology control and clustering in networks with timing synchronization for localization services with sensor tasking and control
CO5: Experiment about sensor node hardware and software platforms and understand the simulation and programming techniques
CO6: Able to design different sensor networks for different practical implementations

Course Contents:

Overview of Wireless Sensor Networks

Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks.

Architectures

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

Networking Sensors

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

Infrastructure Establishment

Topology Control , Clustering, Time Synchronization, Localization and Positioning,

Sensor Tasking and Control.

Sensor Network Platforms and Tools

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

Text Books:

1.Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005.

2.Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

Reference Books:

1.Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

2.Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007.

DATA WAREHOUSING AND DATA MINING
Subject Code: CS62201
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

This course builds on the introductory module in data warehouse and data mining. It intends to introduce more advanced topics in databases such as data mining and data warehousing.It will helps to extract knowledge from data repository for data analysis, frequent pattern, classification and prediction.

Course Outcomes:

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

CO1: Understand the principles of Data warehousing and Data Mining
CO2: Analyze the Data warehouse architecture and its Implementation
CO3: Discover the Architecture of a Data Mining system
CO4: Compare the various Data preprocessing Methods
CO5: Utilize the Data Mining principles and techniques useful for real time applications
CO6: Implement different methods of clustering and data mining

Course Contents:-

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.

Data Mining

Introduction – Data – Types of Data – Data Mining Functionalities – Interestingness of Patterns – Classification of Data Mining Systems – Data Mining Task Primitives –

Integration of a Data Mining System with a Data Warehouse – Issues – Data Preprocessing.

Association Rule Mining

Mining Frequent Patterns, Associations and Correlations – Mining Methods – Mining Various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining.

Classification and Prediction

Basic Concepts - Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction.

Clustering and Applications in Data Mining

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

Text Books:

1.Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2011.

Reference Books:

1.Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.

2.K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.

3.G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.

4.Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.

DATA VISUALIZATION

Subject Code: **CS62202**
Credit: **3-0-2-4**
Prerequisite: **Nil**

Course Objectives:

This course introduces data literacy required as a key twenty-first century skill. You will learn the nature of data across different domains and the concepts and skills of data visualization by understanding, questioning, and problematizing how data are generated, analyzed, and used. You will be able to apply its concepts and skills to visualize your own data, interpret the findings, and examine the impacts of data-driven decisions.

Course Outcomes:

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

CO1: Apply the fundamental design principles of data visualization
CO2: Present data by applying different data visualization techniques for better communication
CO3: Analyse data and communicate information through visual representation
CO4: Make use of connections and correlations for different network and graphs
CO5: Develop different visualization maps
CO6: Make use of visual analytics process for visualization

Course Contents:

Data – Perception and Data Visualization – Graphical Excellence – Data Maps – Time-Series – Graphics of Space and Time – Graphical Integrity – Distortion in a Data Graphic – Design and Data Variation – Visual Area and Numerical Measure

Data-Ink and Graphical Redesign – Data-Ink – Maximizing the Share of Data-Ink – Two Erasing Principles – Application of the Principles in Editing and Redesign - Data-Ink Maximization and Graphical Design – Redesign of Box Plot – Histograms and Scatterplot – Data Density

Visualizing Amounts – Bar Plots – Grouped and Stacked Bars – Dot Plots and Heatmaps - Visualizing Distributions – Histograms and Density Plots – Q-Q Plots – Skewed Distributions - Visualizing Proportions – Pie Charts - Visualizing Time Series – Individual Time Series – Multiple Time Series – Time Series with Multiple Response Variables

Mapping – Connections and correlations – Multivariate Analysis – Scatterplot Maps – Trees –

Hierarchies and Recursion – Networks and Graphs

Visual Analytics – Visual Analytics vs Data Visualization – Visual Analytics Process – Visual Analytics Applications – Case Studies - Python Data Visualization Libraries – Tableau

Reference Books:

1.Edward R. Tufte, The Visual Display of Quantitative Information, 2nd edition, GraphicsPress, 2007.

2.Claus O. Wilke, Fundamentals of Data Visualization, O'Reilly, 2019.

3.Ben Fry, Visualizing Data: Exploring and Explaining Data with the Processing Environment, O'reilly, 1st edition, 2008.

4.A. Kerren, J. T. Stasko, J. Fekete, C. North, Information Visualization, Springer, 2008.

5.Alex Campbell, Data Visualization: Ultimate Guide to Data Mining and Visualization,2020.

6.A. Loth, Visual Analytics with Tableau, Willey, 2019.

7.Kieran Healy, Data Visualization: A Practical Introduction, Princeton University Press,2018.

8.Alexandru C. Telea, Data Visualization: Principles and Practice, Second Edition, CRCPress, 2015.

EXPLORATORY AND INTERACTIVE DATA ANALYSIS

Subject Code: **CS62204**
Credit: **3-0-2-4**
Prerequisite: **Nil**

Course

Objectives:

To learn the essential exploratory techniques for analyzing and visualizing data, and to gain hands-on experience of using software tools for data analytics. Learn to use modern data exploration tools with real data to uncover interesting things.

Course

Outcomes:

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

CO1: Manage, Explore, Analyse and synthesize the results of specific data processing methods
CO2: Apply the knowledge of data analysis in the fields such as diagnosis; forecasting; planning; decision making
CO3: Highlight the statistical features of observed datasets
CO4: Apply Data Analysis to various sizes and complexity of the data sets
CO5: Select Proximities Data Sets
CO6: Analyze exploratory data analysis

Course Contents:

Introduction

Data conception, Statistical Data Elaboration, 1-D statistical analysis. 2-D statistical analysis, N-D Statistical analysis,

Factor analysis

Factor analysis, Principal Component Analysis, 2-D Correspondence Analysis, N- D Correspondence Analysis,

Classification of Individuals

Variables and Data Sets, Classification and Analysis of Proximities Data Sets, Singular Value Decomposition,

Advanced exploratory data analysis

Data classification or clustering, Data input.

Text Books/Reference Books:

1.Michel Jambu, Exploratory and Multivariate Data Analysis, Academic Press,1991.

2.Francois Husson, Sebastien Le, Jérôme Pagès, Exploratory Multivariate Analysis by ExampleUsing R, CRC Press,2010.

SOCIAL NETWORK ANALYSIS

Subject Code: **CS62206**
Credit: **3-0-2-4**

Prerequisite: **Nil**

Course Objectives:

This course helps to collect social network data in online and offline contexts, selecting the right data collection tools and assessing the validity and reliability of the data collection. Apply a wide range of analytical techniques to social network data. Statistically model the mechanisms for social network formation and evolution.The use of social network analysis to understand the growing connectivity and complexity of the world around us on different scales, ranging from small groups to the World 'Wide Web.

Course Outcomes:

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

CO1: Interpret the social network structure
CO2: Model and visualize the social network
CO3: Mine the user relations in the social network
CO4: Analyse social network content
CO5: Discover mining communities
CO6: Evaluate social media content

Course Contents:

Introduction

Properties of Social Networks – Network Analysis – Network Measures – Discussion Networks – Blogs and Online Communities – Semantic Web

Modeling and Visualization

Visualizing Social Networks – Graph Representation – Node-Edge Diagrams – Modelling and Aggregating Social Network Data – Random Walks – Tools: NetworkX – SocioViz – NetworkKit – Infinite Graph

Mining Communities

Aggregating and Reasoning with Social Network Data – Detecting Communities in Social Networks – Evaluating Communities – Community Welfare – Collaboration networks – Co-Citation Networks - Link Prediction – Rank Aggregation and Voting Theory – Tools: Ghephi – Neo4J – Mathematica

Semantic Web

Resource Description Framework – Linked Open Data – Ontological Representation of Social Individuals and Relations – Entity Linking – Entity Resolution – Graph based Event Detection

Social Media Content Analytics

Text Mining in Social Networks – Opinion Extraction – Sentiment Classification and Clustering – Irony Detection – Review Classification – Recommendation Systems – Hashtags – Information Diffusion

Reference Books:

1.Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn,Google+, GitHub, and More, 3nd Edition, O'Reilly Media, 2019.

2.Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013.

3.GuandongXu, Yanchun Zhang and Lin Li, Web Mining and Social Networking – Techniques and applications, 1st edition, Springer, 2011.

4.BorkoFurht, Handbook of Social Network Technologies and Applications, 1st edition,Springer, 2010.

5.John G. Breslin, Alexander Passant and Stefan Decker, The Social Semantic Web, Springer, 2009.

TEXT MINING
Subject Code: CS62208
Credit: 3-0-2-4
Prerequisite: Nil

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 Outcomes:

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

CO1: Design text extraction techniques
CO2: Design clustering techniques for text
CO3: Design classification techniques for text
CO4: Practice visualization methodologies using tools
CO5: Practice feature extraction using tools
CO6: Inspect feature extraction using tools

Course Contents:

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.

Clustering

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

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.

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.

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.

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.

DATA PRIVACY
Subject Code: CS62301
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

The successful student will have an advanced understanding of the theoretical underpinnings of data privacy. Able to relate this understanding to areas ranging from the philosophical, through the political and organizational, to the technical. In particular, student will know privacy as a process of adapting to a changing circumstance and understand the significance of randomness in protecting privacy and quantifying risk, and be able to operationalize this understanding.

Course Outcomes:

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

CO1: Define differential privacy

CO2: Design techniques to achieve differential privacy for linear queries

CO3: Design mechanisms for query release problem using online learning algorithms

CO4: Analyze computational complexity of differentially private mechanisms

CO5: Inspect Polynomial time curators and hard to synthesize distributions

CO6: Design mechanisms for privacy aware agents and empirical risk minimization

Course Contents:

The Promise of Differential Privacy:

Privacy-preserving data analysis; Basic Terms: The model of computation, Towards defining private data analysis, Formalizing differential privacy; Basic Techniques and Composition Theorems: Useful probabilistic tools, Randomized response, The laplace mechanism, The exponential mechanism, Composition theorems, The sparse vector technique;

Releasing Linear Queries with Correlated Error:

An offline algorithm: SmallDB, An online mechanism: private multiplicative weights; Generalizations: Mechanisms via α-nets, The iterative construction mechanism, Connections;

Boosting for Queries:

The boosting for queries algorithm, Base synopsis generators; When Worst-Case Sensitivity is Atypical: Subsample and aggregate, Propose- test-Release, Stability and privacy;

Lower Bounds and Separation Results:

Reconstruction attacks, Lower bounds for differential privacy; Differential Privacy and Computational Complexity: Polynomial time curators, Some hard-to-Syntheticize distributions, Polynomial time adversaries; Differential Privacy and Mechanism Design: Differential privacy as a solution concept, Differential privacy as a tool in mechanism design, Mechanism design for privacy aware agents;

Differential Privacy and Machine Learning:

The sample complexity of differentially private machine learning, Differentially private online learning, Empirical risk minimization; Additional Models: The local model, Pan-private streaming model, Continual observation, Average case error for query release.

Text Books/Reference Books:

1.C. Dwork and A. Roth, The Algorithmic Foundations of Differential Privacy, now Publishers, 2014.

2.Charu C. Aggarwal, Privacy-Preserving Data Mining: Models and Algorithms, 1st Edition, Springer, 2008.

3.Relevant Research Papers

BIOMETRIC SECURITY
Subject Code: CS62302
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

To understand the concept of biometry and its role in identification and various kinds of biometrics.Biometrics has emerged as a specialized field in criminal forensics, public safety surveillance, user authentication and identification. Expansion of biometric modalities are ranged from fingerprint, face and other traits to multimodal biometric

traits. Objectives of this course include scientific foundations needed for the design, implementation, and evaluation of large scale biometric identification systems.

Course Outcomes:

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

CO1: Understand the overview of Biometrics - definition, modalities, application and security
CO2: Evaluate different biometrics parameters and design secure system architecture
CO2: Perform R&D on biometrics methods and systems
CO3: Analyze the privacy challenges of Biometrics
CO4: Judge the errors generated in biometric measurements
CO5: Examine Multimodal biometric systems
CO6: Apply the technology of biometrics for public policy matters involving security and privacy

Course Contents:

Overview of Biometric

Definitions, biometric modalities, basic applications, access control, security

Biometric System Architecture

Scanning/digitizing, enhancement, feature extraction, classification, matching, searching and verification.

Probability, statistics and estimation Random variables, discrete and continuous distribution - pattern classification and recognition - Signals in time and frequency domain – multivariate statistical analysis, Algorithms Face recognition Voice Recognition Fingerprint Recognition Iris Recognition

Other Biometric Modalities

Retina, signature, hand geometry, gait, keystroke, Quantitative analysis on the biometrics, Performance evaluation in Biometrics – false acceptance rate; false rejection rate.

Multimodal Biometric systems

Biometric system integration, multimodal biometric systems: theory and applications, performance evaluation of multimodal biometric systems.

Biometric System Security

Biometric attacks/tampering; solutions; biometric encryption

Text Books:

1.Security, Risk and The Biometric State: Governing Borders and Bodies, by Benjamin Muller, 1st Edition, 2011, Routledge.

2.Handbook of Biometrics, by Anil K. Jain, Patrick Flynn, Arun A. Ross, 1st Edition, 2008, Springer.

Reference Books:

1.Biometric: Advanced Identity Verification: The Complete Guide, by Julian Ashbourn, 1st edition, 2000, Springer.

2.Biometric Systems: Technology, Design and Performance Evaluation, by James L. Wayman, Anil Jain, Davide Maltoni, Dario Maio, 1st edition, 2005, Springer.

3.Implementing Biometric Security, by John Chirillo, Scott Blaul, 1st edition, 2003, Wiley.

INFORMATION THEORY & CODING
Subject Code: CS62303
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

Formulate the fundamenal concepts of information theory such as entropy, mutual information, channel capacity. Elaborate the principles of source coding and data transmission. Analyze source codes and channel codes. Apply information theoretic methods to novel settings.

Course Outcomes:

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

CO1: Understand the basics of Information theory and source coding
CO2: Design the channel capacity and coding using information theory
CO3: Analyze various error control codes and their properties
CO4: Apply linear block codes for error detection and correction
CO5: Design BCH and RS codes for channel performance improvement against burst errors
CO6: Apply convolution codes for performance analysis and cyclic codes for error detection and correction

Course Contents:

Information Theory

Entropy, Information, Mutual information. Source Coding: Source coding theorem, Shannon-Fano coding, Huffman coding, Arithmetic coding, Lempel-Ziv algorithm, Run length coding.

Channel Capacity and Coding

Channel capacity, Channel coding, Information capacity theorem. Error Control Codes: Product codes, single parity check codes, Hamming codes, Performance of Error Control Codes.

Linear Block Codes

Generator matrices, Parity check matrices, linear block codes and properties, Error detection and correction properties, modified linear block codes.

BCH and RS codes

Algebraic description, decoding algorithms for BCH and RS codes. Convolution Codes: Convolution encoders, Trellis diagram, Viterbi algorithm.

Cyclic Codes

Shift register implementation, CRCs for error detection

Text Books:

1. Information Theory, Coding and Cryptography by Ranjan Bose, TMH Publication, 2017.

Reference Books:

1.Introduction to Cryptography with Coding Theory by Trape and Washington, Pearson Publication, 2001.

2.Digital Communications by Proakis, TMH Publication, 2000.

3.Error Control Codes by Salvatore and Gravano, Oxford Publication, 2017.

Cyber Security
Subject Code: CS62304
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:
To prepare students with the technical knowledge and skills needed to protect and defend computer systems and networks.
To develop graduates that can plan, implement, and monitor cyber security mechanisms to help ensure the protection of information technology assets.
To develop graduates that can identify, analyze, and remediate computer security breaches.

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

CO1: Understand cyber security fundamentals along with concepts of cryptography
CO2: Analyze the different types of threats and vulnerabilities
CO3: Compare several defense and mitigation measures
CO4: Analyze several possible run-time attacks
CO5: Evaluate cyber forensic mechanisms along with different data acquisition and extraction techniques
CO6: Evaluate the cyber warfare deception and legal framework of cyber security

Course Contents:

Cyber Security Fundamentals

Network and Security Concepts-Information Assurance Fundamentals, Basic Cryptography, Symmetric and Asymmetric Encryption, Public Key Encryption, The Domain Name System (DNS), Firewalls, Virtualization, Radio-Frequency Identification.

Threats and Vulnerabilities

Types of Threats- Malware, Phishing, Ransomware, Adware and Spyware, Trojan, Virus, Worms, Man-in-the-middle-attack, Scareware, Distributed Denial-Of- Service Attack, Rootkits, click-fraud. Vulnerability-Shellcode, Integer Overflow Vulnerabilities, Buffer Overflows, SQL Injection.

Defense and Mitigation Measures

Anti-virus scanners, static and dynamic methods, anti-analysis, eavading obfuscations and run-time attacks.

Cyber Forensics

Memory and network Forensics for Winodws and Linux internals, Forensic tools, OS hardening and RAM dump analysis, data acquisition, data extraction, volatility analyses for OS artifacts and other information. Automated malicous code analysis.

Cybersecurity Law and Regulations

Introduction, Cyber Warfare, Deception in the Cyber-World, Legal Framework of Cyber Security.

Text Books/Reference Books:

1.James Graham, Richard Howard, Ryan Olson, CYBER SECURITY ESSENTIALS, Taylor and Francis Group, 2011.

2.MarttiLehto, PekkaNeittaanmäki, Cyber Security: Analytics, Technology and Automation,Springer, 2015.
3.David Salomon, Foundations of Computer Security, Springer, 2006.

INTRUSION DETECTION SYSTEM
Subject Code: CS62305
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:
To evaluate the security of an organization and appropriately apply Intrusion Detection tools and techniques in order to improve their security posture.
To identify and describe appropriate situations and scenarios where intrusion detection may be applied to achieve an increased level of situational awareness and information assurance.
Apply the knowledge to the architecture, configuration, and analysis of specific intrusion detection systems

Course Outcomes:

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

CO1: Apply the knowledge of fundamentals of Intrusion Detection in the creation and evaluation of new Intrusion Detection Systems
CO2: Identify common threats faced today and the necessity of intrusion detection systems for securing the systems
CO3: Analyse several methodologies of intrusion detection
CO4: Evaluate ethics and legalities of probable intrusion mechanisms
CO5: Identify the essential components of an IDS - architecture, scope, goal and type
CO6: Examine several intrusion detection tools and techniques in terms of their use and deployment

Course Contents:

Introduction to Data and methodologies of computer intrusion detection, Statistical & machine approaches to detection of attacks on computer, Techniques for estimating the number & severity of attacks, Network based attacks such as probes & denial of service attacks, Host based attacks such as buffer overflows and race conditions, Malicious codes such as virus and worms, Statistical pattern recognition for detection & classification of attacks, Techniques for visualizing networked data etc.

Ethics and legality - Footprinting - Scanning - Enumeration - System Hacking - Trojans and Back doors - Sniffers - Social Engineering - Session hijacking - Hacking Web Servers - Web based Password cracking techniques - Wireless Hacking - SQL Injection - Linux Hacking - Buffer overflows - Evading IDS, Honeypots and Firewalls.

Components of an IDS , Characterstics of an IDS, Detection Model, Scope & Operation of IDS, Goals of an IDS, Types of IDS,Architecture of IDS, Centralized IDS Architecture, Distributed IDS Architecture, Hierarichal IDS Architecture.

Introduction to intrusion detection tools and techniques, Stream Reassembly, Traffic Normalization, Feature equality heuristics, genetic programming and other researched IDS techniques, Technical issues, Legal issues related to testing, use and deployment of an IDS, Organizational and management issues

IDS Today and Tomorrow, Reality with no IDS, Review of Current research related to IDS

Text Books:

1.Web Hacking, S. McClure, S.Shah, Shreeraj Shah, 1st Edn, Pearson Press, 2002.

2.The Database Hacker's Handbook, D. Litchfield, C. Anley J. Heasman, B. Grindlay, 1st Edn Wiley Publishers, 2005.

Reference Books:

1.Gray Hat Hacking: The Ethical Hacker's Handbook, Shon Harris, Allen Harper, Chris Eagle, Jonathan Ness, 3rd Edn, McGraw Hill-Osborne Media, 2011.

2.CEH: Official Certified Ethical Hacker Review Guide, Kimberly Graves, Pap/ Cdr Re, Wiley Publishing Inc., 2007.

3.Hands-on Ethical Hacking and Network Defense, Michael T. Simpson, Kent Backman, James Corley, 2nd Edn, Course Techn, 2010.

DIGITAL FORENSICS

Subject Code: **CS62306**
Credit: **3-0-2-4**
Prerequisite: **Nil**

Course Objectives:

Students will learn the fundamental principles of forensic science. This hands-on course covers the technical aspects of digital forensics including general forensic procedures, imaging, hashing, file recovery, file system basics, identifying mismatched file types, reporting, and laws regarding computer evidence. Students will also use open-source digital forensic software tools to conduct forensic examinations.

Course Outcomes:

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

CO1: Understand the need for digital forensics
CO2: Identify and compare different information formats
CO3: Identify different technologies for digital forensics
CO4: Evaluate different investigation methodologies
CO5: Analyze the several forensic tools
CO6: Apply possible facets of digital forensics in the appropriate fields - UNIX, Embedded Systems and Finance

Course Contents:

Information formats, PC hardware, Disc geometry, File system, Electronic organizers.

Forensic analysis – Investigative Methodology: Forensic Analysis, Electronic Discovery, Intrusion Investigation.

Technology: Windows Forensic Analysis, UNIX Forensic Analysis, Embedded Systems Analysis, Mobile Network Investigations.

Intrusion Investigation, Analysis tools, Financial forensics.

Text Books/Reference Books:

1.Sammes T, B. Jenkinson, Forensic Computing, Springer, 2007.

2.Eoghan Casey. Ed., Handbook of Digital Forensics and Investigation, Academic Press,2010.

SECURE CLOUD COMPUTING
Subject Code: CS62307
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

Describe cloud security architectures from the perspectives of: providers, brokers, carriers, and auditors. Describe a methodology for orchestrating a cloud ecosystem. Understand how cloud computing changes the traditional enterprise security considerations compared to on-premise. The course delves deep into the secure cloud architectural aspects with regards to identifying and mitigating risks, protection and isolation of physical & logical infrastructures including compute, network and storage, comprehensive data protection at all OSI layers, end-to-end identity management & access control, monitoring and auditing processes and meeting compliance with industry and regulatory mandates.

Course Outcomes:

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

CO1: Analyze the security and privacy issues in the cloud computing
CO2: Use the auditing and compliance process
CO3: Build security as a cloud service for secure cloud computing
CO4: Implement various case studies considering the security and privacy issues
CO5: Analyze the Impact of Cloud Computing on the Role of Corporate IT
CO6: Evaluate the Managementon the Cloud, Privacy, Audit and Compliance

Course Contents:

Cloud Computing Defined, SPI Framework, Traditional Software Model, Cloud Services Delivery Model, Cloud Deployment Models,

Key Drives to Adopting the Cloud, Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoptionin the Enterprise,

Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Identity and Access Management, Security Management on the Cloud, Privacy, Audit and Compliance,

Cloud Service Providers, Security as a Cloud Service, Impact of Cloud Computing on the Role of Corporate IT, The Future of the Cloud, Case Studies.

Text Books/Reference Books:

1.Tim Mather, Subra Kumaraswamy and Shahed Latif, Cloud Security and Privacy, First Edition, O'Reilly, 2009.

2.Simon Gallagher and Aidan Dalgleish, VMware Private Cloud Computing with vCloud Director, SYBEX, A Wiley Brand, 2013.

STEGANOGRAPHY AND DIGITAL WATER MARKING
Subject Code: CS62308
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

To develop an understanding of digital watermarking and steganography basics, various approaches, characteristics and application domains.
To apply digital watermarking as an authentication tool for distribution of content over the Internet and steganography techniques for covert communication.
To understand the basics of the counter measures like steganalysis for assessing the data hiding methods.
To enable to evaluate and choose appropriate data hiding technique based on a multitude of security factors

Course Outcomes:

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

CO1: Formulate machine learning problems corresponding to different applications: data, model selection, model complexity
CO2: Demonstrate the implementation of a range of machine learning algorithms along with their strengths and weaknesses
CO3: Implement machine learning solutions to classification, regression, and clustering problems
CO4:Design and implement various machine learning algorithms in a range of real-world applications
CO5: Evaluate and analyse the performance of a machine-learning algorithm or a system based on machine learning algorithm
CO6: Implement different clustering techniques to solve real world problems

Course Contents:

Introduction, Linear Classification, perceptron Update rule, Perceptron convergence, generalization, Maximum Margin classification, Classification errors, regularization, Logistic regression, linear regression,

Estimator bias and variance , active learning, Non-linear prediction, kernals, kernal regression, Support vector machine (SVM) and kernels, kernel optimization, model selection, Model selection criteria.

Description length, Feature Selection, Combining Classifiers, boosting, margin, and complexity, margin and generalization, mixture models, Mixture and expectation maximization (EM) algorithm, Regularization.

Clustering, Spectral Clustering, Markov Models, Hidden Markov Models(HMM), Bayesian Networks, Learning Bayesian Networks, Probabilistic inference, Collaborative filtering.

Text Books:

1.Machine Learning., Mitchell, Tom, McGraw-Hill, ISBN: 97800704280, 3rd Edition.

Reference Books:

1.Neural Networks for Pattern Recognition., Christopher, Bishop, Oxford University Press,1995,ISBN: 9780198538646.

2.Pattern Classification., Richard, Duda, Peter Hart and David Stork, Wiley Interscience, 2000,ISBN: 9780471056690.

3.The Elements of Statistical Learning: Data Mining, Inference and prediction., Hastie, T., R. Tibshirani and J.H Friedman . , NY. Springer, ISBN: 9780387952840, 2005.

4.Information Theory, Interference and learning algorithms., MacKay, David, Cambridge ,UK, Cambridge University Press,. ISBN: 9780521642989, 2003.

WEB AND DATABASE SECURITY
Subject Code: CS62310
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

Web application security (also known as Web AppSec) is the idea of building websites to function as expected, even when they are under attack. The concept involves a collection of security controls engineered into a Web application to protect its assets from potentially malicious agents. Establishing guidelines for appropriate authorization and prevention of unauthorized access is a key confidentiality component. Integrity is aimed at protecting data from modification by unauthorized users and improper modification by authorized users.

Course Outcomes:

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

CO1: Design of access control methods for secure web & database application development
CO2: Implement database security policies using DAC
CO3: Implement MAC to ensure confidentiality and control information flow
CO4: Simulate the HTML injections and cross-site scripting (XSS) to exploit the attackers
CO5: Implement Secure coding and design methods to break authentication schemes
CO6: Implementation of methods for abusing Design Deficiencies against web sites

Course Contents:

Creation and manipulation of database using SQL scripts and graphical interfaces.

Implementing DAC: Implementation of database security policies using DAC in oracle 10g/SQL server, Implementing of MAC to ensure confidentiality and control information flow using either Oracle 10g or SQL server. This provides exposure to understand the concepts of MAC and Trojan hose

Implementation of Virtual Private Database using View using Oracle 10g or SQL server

Design a method to simulate the HTML injections and cross-site scripting (XSS) to exploit the attackers. Determine HTML injection bugs and possible measures to prevent HTML injectionexploits.

Implement Secure coding for buffer flow heap attacks. Implementation of Design methods to break authentication schemes. Implementation of methods for abusing Design Deficiencies against web sites

Text Books/Reference Books:

1.Mike Shema, Hacking Web Apps Detecting and Preventing Web Application SecurityProblems, Syngress publications- Elsevier, 2012.

2.M. Gertz, S. Jajodia, Handbook of Database Security, Springer, 2008.

3.Ben-Natan, R. B, Implementing Database Security and Auditing: Includes Examples forOracle, SQL Server,Db2Udb, Sybase, Digital Press, 2005.

COMPONENT BASED SOFTWARE ENGINEERING

Subject Code: **CS62401**
Credit: **3-0-2-4**
Prerequisite: **Nil**

Course Objectives:

Component-based software engineering is a paradigm that aims at minimizing the complexity of developing and managing modern software through the use of reusable pieces of software called “software components”. The objective of the course is to give the students the fundamental knowledge of developing component-based software systems based of the latest research trends in the domain. Further, the course gives a deeper understanding in a sub-topic that is selected by the students. Students will be trained in identifying relevant information, summarizing, reporting and presenting the information, and also in using critical thinking to support their argumentation.

Course Outcomes:

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

CO1: Make use of the concepts used in component-based development and analyze its benefits over traditional software development and applying it for a case study

CO2: Evaluation of component-based design for different domain software
CO3: Design components using UML and other design techniques for construction of a basic software architecture
CO4: Comparison of existing component based software design techniques and their applications
CO5: Produce the real-world software from previous available components and also developing new components and making interaction between them
CO6: Evaluate the next generation software components

Course Contents:

Introduction to Component Based Development

Definition of Software Component and its Elements, The Component Industry Metaphor, Component Models and Component Services: Concepts and Principles, An Example Specification for Implementing a Temperature Regulator Software Component.

Case for Components

The Business Case for Software Components, COTS Myths and Other Lessons Learned in Component-Based Software Development, Roles for Component-Based Development, Common High Risk Mistakes in Component-Based Software Engineering, CBSE Success Factors: Integrating Architecture, Process, and Organization.

Software Component Infrastructure

Software Components and the UML, Component Infrastructures: Placing Software Components in Context, Business Components, Components and Connectors: Catalysis Techniques for Defining Component Infrastructures, an Open Process for Component-Based Development, Designing Models of Modularity and Integration.

Management of CBD

Measurement and Metrics for Software Components, Component Technologies: Overview of the CORBA Component Model, Transactional COM+ Designing Scalable Application.

The Enterprise JavaBeans Component Model, Choosing Between COM+, EJB, and CCM, Software Agents as Next Generation Software Components.

Text Books:

1. Clemens Szyperski, "Component Software" , Addison-Wesley Professional, 2nd Edition , 2002.

Reference Books:

1.G. Sudha Sadasioam, "Computer-based Technology", Wiley India, 1st Edition 2008.

2.George T. Heineman, William T.Councill, "Component-Based Software Engineering: Putting the Pieces Together George", Addison-Wesley Professional.

SOFTWARE DESIGN ARCHITECTURE
Subject Code: CS62402
Credit: 3-0-2-4

Prerequisite: **Nil**

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 Outcomes:

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

CO1: Use the abstraction of various architectural styles of a software
CO2: Analyze the software architectural design models to make design decisions
CO3: Propose the design, validate and document the software architecture
CO4: Design an algorithm for case studies
CO5: Enforce tools to implement algorithm for case studies
CO6: Evaluate the quality attribute of software architecture

Course Contents:

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?

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)

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

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)

Modeling Tools and Case studies

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

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.

SERVICE ORIENTED ARCHITECTURE
Subject Code: CS62403
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

The course aims to give the student an understanding of the strengths and weaknesses of a service-based architecture, informed by an ability to implement and deploy simple web services using a suitable development platform.To gain understanding of the basic principles of service orientation. To learn service oriented analysis techniques.

Course Outcomes:

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

CO1: To make use of service oriented analysis techniques
CO2: To use technology underlying the service design
CO3: To evaluate advanced concepts such as service composition, orchestration and Choreography
CO4: To implement various Web Service specification standards
CO5: To propose solutions using principles of service oriented architecture
CO6: To discuss service oriented architecture governances and its challenges

Course Contents:

Introduction to SOA

Service Oriented Analogy, Service Encapsulating Logic, Relationship and Communication in Services, Design and Building of Services, Primitive SOA.

Common Characteristics of SOA

Misperceptions of SOA, Benefits of SOA, Evolution of SOA, Overview & basic Components of SOA.

Principles of Service Orientation

Service Orientation and Enterprise, Anatomy of Service Oriented Architecture, Common Principles of Service Orientation and their Interrelation
Analysis &Designing of SOA, SOA framework, Service-Oriented Analysis, Enterprise oriented SOA, Business service modeling, Service-Oriented Design using UML & OSLO

SOA & Web Services

Web Service Framework, Roles and Models of Services, Web Services at different network layers HTTP, XML, SOAP, WSDL and SAML Standards, Use of XML in SOA, Service Descriptions with WSDL, Messaging with SOAP, Message Exchange Patterns, Service Activity, Coordination, Atomic Transaction, Business Activities, Orchestration and Choreography Addressing, Reliable Messaging Correlation, Policies, Metadata Exchange, Security.

Service Layers

Service Layer Abstraction, Different Service Layers (Application, Business, Orchestration.
Development of a SOA Application: SOA Life Cycle, SOA Governance and its Challenges Current trends in SOA

Text Book:

1.Thomas Erl, Service Oriented Architecture: Concepts Technology and Design, Pearson, 2011.

Reference Books:

1.Thomas Erl, SOA Principles of Service Design, Prentice Hall, 1st Edition, 2008.

2.Eric A. Marks, Michael Bell, Service Oriented Architecture (SOA): A Planning and Implementation Guide for Business and Technology, John Wiley & Sons, 2006.

3.Dirk Krafzig, Karl Banke, Dirk Slama, Enterprise SOA: Service-Oriented Architecture Best Practices, Prentice Hall PTR, 1st edition, 2004.

4.Sandeep Chatterjee, James Webber, David Bunnell, "Developing Enterprise Web Services, An Architect's Guide", Pearson Education, 2003.

5.Greg Lomow, Eric Newcomer, Understanding SOA with Web Services, Pearson, 1st Edition, 2005.

SOFTWARE DEVELOPMENT METHODOLOGIES
Subject Code: **CS62404**
Credit: **3-0-2-4**
Prerequisite: **Nil**

Course Objectives:

Students will learn how the security aspects of software development are embedded into the system to be developed. It includes secure architecture design, secure coding, secure deployment and secure software development methodologies.

Course Outcomes:

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

CO1: Review the basics of software engineering, processes, models and practices
CO2: Assess software requirement engineering and its application using various models
CO3: Use design thinking at varied levels i.e architectural and component level and to also user interface
CO4: Use testing and its theoretical background along with metrics to test source code, applications and maintenance of application
CO5: Identify risks, risk identification, risk projection, Risk refinement, risk management and dealing with change management, survey
CO6: Evaluate tools for configuration management

Course Contents:

Introduction to Software Engineering

The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering - A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Incremental process models, Evolutionary process models, specialized process models, The Unified process.

Software Requirements

Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management .System models: Context Models, Behavioral models, Data models, Object models, structured methods.

Design Engineering

Design process and Design quality, Design concepts, the design model, pattern based software design. Creating an architectural design: software architecture, Data design, Architectural styles and patterns, Architectural Design, assessing alternative architectural designs, mapping data flow into a software architecture. Modeling component-level design: Designing class based components, conducting component-level design, object constraint language, designing conventional components. Performing User interface design: Golden rules, User interface analysis and design, interface analysis, interface design steps, Design evaluation.

Testing Strategies

A strategic approach to software testing, test strategies for conventional software, Black-Box and White-Box testing, Validation testing, System testing, the art of Debugging. Product metrics: Software Quality, Frame work for Product metrics, Metrics for Analysis Model, Metrics for Design Model, Metrics for source code, Metrics for testing, Metrics for maintenance. Metrics for Process and Products: Software Measurement, Metrics for software quality.

Risk management

Reactive vs Proactive Risk strategies, software risks, Risk identification, Risk projection, Risk refinement, RMMM, RMMM Plan.Quality Management: Quality concepts, Software quality assurance, Software Reviews, Formal technical reviews, Statistical Software quality Assurance, Software reliability, The ISO 9000 quality standards.Configuration Management: Configuration Management planning, Change management, Version and release management, System building, CASE tools for configuration management.

Text Books:

1.Software Engineering: A practitioner's Approach, Roger S Pressman, sixth edition. McGraw Hill International Edition, 2005 .

2.Software Engineering, Ian Sommerville, seventh edition, Pearson education, 2004.

Reference Books:

1.Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India, 2010.

2.Software Engineering : A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008.

3.Fundamentals of Software Engineering, Rajib Mall,PHI, 2005.

4.Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

Software Project Management
Subject Code: CS62406
Credit: 3-0-2-4
Prerequisite: Nil

Course Objectives:

This course is aimed at introducing the primary important concepts of project management related to managing software development projects. They will also get familiar with the different activities involved in Software Project Management. Further, they will also come to know how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget.

Course Outcomes:

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

CO1: Describe and determine the purpose and importance of project management from the perspectives of planning, tracking and completion of project
CO2: Compare and differentiate organization structures and project structures.
CO3: Discuss the various aspects of project management
CO4: Implement the tasks in software project management
CO5: Describe the requirements of a project plan
CO6: Evaluate the project management software quality control

Course Contents:

Introduction to Software Project Management
Overview of project, project management, Project management process, Activities of project management, setting objectives, plans, methods and methodologies, setting objectives, project success and failures.

SW Project life cycles
Concept, analysis, planning, execution and closing stage, The ISO 12207 Software development life cycle, Project selection methodologies and technologies, process models, selection of appropriate process model.

SW Project evaluation & Planning
Tools and techniques, funds flow analysis, cost-benefit analysis, risk evaluation, project portfolio management, benefit management, Gathering requirements, Identification of

project scope, step wise project planning, case study. Software project estimation: Software effort estimation techniques, cost estimation, effect of schedule compression, Capers Jone's estimation.

Design of software project management system
Activity planning, Work breakdown structures, product breakdown structure, resource break-down structure, project scheduling, activity on arrow, activity on node, dummy activities, Use of Gantt chart, formulating a network (CPM), activity float, and critical activity.
Risk management: Risk identification, assessment, planning, and management, evaluating risks to schedule, application of PERT.

Project Cost Analysis
Resource Allocation, schedule resources, crashing and resource sharing, network scheduling with Limited Resources, capacity planning and capacity expansion decision

Software project monitoring and control
Design of monitoring system, prioritizing monitoring, Progress control, performance control, schedule control, cost control tools used in controlling project, earned value analysis, change control, status review meeting, project audit and reviews Managing contracts. Types of contracts, contract placements, contract management.

Software Project organizations & Managing people in software environment:
Functional, matrix and projectized organization, various team structures, Organization behavior, coordination and procedures, project management and procedure, working in teams, skills and competency of the manager

Scope and software quality control:
Importance of software quality, SQC, SQA, product process and quality, cost of quality, ISO 9126, Process capability models, quality management system, software testing and reliability.

Text Books:

1.Bob Hughes, Mike Cotterell, Rajib Mall, Software Project Management, McGraw-HILL, 2011, 5th Edition.

Reference Books:

1.R. Walker, Software Project Management, Pearson, 2003.

2.Jerome D. Wiest, Ferdinand K. Levy, A Management Guide to PERT/CPM, PHI, 2nd Edition, 2008.

3.Robert K. Wysocki, Effective Software Project Management, Wiley India, Edition, 2008.