M. Tech. I SEMESTER COMPUTER SCIENCE & ENGINEERING: Scheme 2019 – 2021
Academic year: 2019-2020

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UE19CS501	Computer Systems for Programmers	4	0	0	0	4	CC
2.	UE19CS502	Advanced Data Structures	4	0	0	0	4	CC
3.	UE19CS503	Fundamentals of Scalable Computing	4	0	0	0	4	CC
4.	UE19CS504	Topics in Artificial Intelligence	4	0	0	0	4	CC
5.	UE19CS505	Cyber Security Essentials	4	0	0	0	4	CC
6.	UE19CS506	Special Topics - I (Select Topics in Data Science)	2	0	0	0	2	ST
Total			**22**	**0**	**0**	**0**	**22**	-

SPECIALIZATION For CORE SUBJECTS

Sl. No.	SPECIALIZATION	SUBJECT	SUBJECT CODE
1.	**Cloud Computing**	UE19CS503	Fundamentals of Scalable Computing
		UE19CS505	Cyber Security Essentials
2.	**Big Data and IoT**	UE19CS503	Fundamentals of Scalable Computing
		UE19CS505	Cyber Security Essentials
3.	**Artificial Intelligence**	UE19CS504	

			Topics in Artificial Intelligence
4.	**Cyber Security**	UE19CS505	Cyber Security Essentials

M. Tech. II SEMESTER COMPUTER SCIENCE & ENGINEERING: Scheme 2019 – 2021
Academic year: 2019 – 2020

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1.	UE19CS551	Topics in Advanced Algorithms	4	0	0	0	4	CC
2.	UE19CS552	Stochastic models and Machine Learning	4	0	0	0	4	CC
3.	UE19CS56*	Elective –I	3	2	0	0	4	EC
4.	UE19CS57*	Elective –II	3	2	0	0	4	EC
5.	UE19CS58*	Elective -III	3	2	0	0	4	EC
6.	UE19CS553	Special Topics - II (Research Methodology)	2	0	0	0	2	ST
Total			**19**	**6**	**0**	**0**	**22**	

	Elective – I							
1.	UE19CS561	Million Way Parallelism	3	2	0	0	4	EC
2.	UE19CS562	Speech and Natural Language Processing	3	2	0	0	4	EC
3.	UE19CS563	Bio Inspired Computing	3	2	0	0	4	EC
4.	UE19CS564	Cryptography	3	2	0	0	4	EC
5.	UE19CS565	Topics in Computer and Network Security	3	2	0	0	4	EC

	Elective – II							
1.	UE19CS571	Advanced Cloud Computing and Security	3	2	0	0	4	EC
2.	UE19CS572	Cloud Computing Fundamentals	3	2	0	0	4	EC
3.	UE19CS573	Advanced Big Data Analytics	3	2	0	0	4	EC
4.	UE19CS574	Foundations of IoT Streaming and Analysis	3	2	0	0	4	EC
5.	UE19CS575	Virtual Reality	3	2	0	0	4	EC
6.	UE19CS576	Reinforcement Learning	3	2	0	0	4	EC
7.	UE19CS577	Digital Video Perception and Algorithms	3	2	0	0	4	EC
8.	UE19CS578	Cyber Forensics	3	2	0	0	4	EC
9.	UE19CS579	Software Security	3	2	0	0	4	EC
	Elective – III							
1.	UE19CS581	Topics in Storage Area Networks	3	2	0	0	4	EC
2.	UE19CS582	Data Acquisition and Visualization	3	2	0	0	4	EC
3.	UE19CS583	Deep Learning Theory and Practices	3	2	0	0	4	EC
4.	UE19CS584	Soft computing	3	2	0	0	4	EC
5.	UE19CS585	Cyber Policies, Standards and Laws	3	2	0	0	4	EC
6.	UE19CS586	Research Credits	0	0	0	16	4	PW

ELECTIVES TO BE OPTED FOR SPECIALIZATION				
Sl. No.	**SPECIALIZATION**	**ELECTIVE – I**	**ELECTIVE – II**	**ELECTIVE – III**
5.	**Cloud**	Million Way Parallelism	Advanced Cloud Computing and	Topics in Storage Area

	Computing		Security	Networks
			Cloud Computing Fundamentals	Research Credits
6.	**Big Data and IoT**	Million Way Parallelism	Advanced Big Data Analytics	Data Acquisition and Visualization
			Foundations of IoT Streaming and Analysis	Research Credits
7.	**Artificial Intelligence**	Speech and Natural Language Processing	Virtual Reality and its Applications	Deep Learning Theory and Practices
				Soft Computing
		Bio Inspired Computing	Reinforcement Learning	Research Credits
			Digital Video Perception and Algorithms	
8.	**Cyber Security**	Cryptography	Cyber Forensics	Cyber Policies, Standards and Laws
		Topics in Computer and Network Security	Software Security	Research Credits

Special Topics

Sl. No.	Course Code	Course Title	Hours / week				Credits	Course Type
			L	T	P	S		
1	UE19CS506	Select Topics in Data Science	2	0	0	0	2	ST
2	UE19CS553A	Research Methodology and IPR	2	0	0	0	2	ST
3	UE19CS553B	Chaos and Applications.	2	0	0	0	2	ST
4	UE19CS602A	Industrial Safety.	2	0	0	0	2	ST
5	UE19CS602B	Stochastic Models in Machine Learning.	2	0	0	0	2	ST
6	UE19CS652A	Cost Management of	2	0	0	0	2	ST

		Engineering Projects.						
7	UE19CS652B	Intellectual Property Management.	2	0	0	0	2	ST
8	UE19CS652C	Quantum Machine Learning.	2	0	0	0	2	ST

UE19CS501

COMPUTER SYSTEMS FOR PROGRAMMERS (4-0-0-0-4)

Course Objectives:

This course is an in-depth analysis of the the hardware-interface/mapping of a program in modern processor architectures. This course provides an end-to- end picture in sufficient advanced detail of software and hardware components of contemporary computing systems and their efficent utilisation for optimum performance.

Course outcomes:

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

- Trace the execution of a program with respect to modern processor architecture fundamentals, Caching and Virtual Memory implementations
- Utilize modern Processor architectures with complete understanding of contemporary programming language features
- Design and implement Instruction Set Simulators for novel processor architectures
- Write and debug complex programs.

Course Content:

1. **Introduction to computer systems: C**ompilation system, Processor functioning, Caches, Storage devices, Networks, information storage, Processes, Threads and Concurrency, Parallelism , Number representations. Machine level representation of programs.

2. **Processor architecture:** Instruction set architecture logic design, Clocking, Pipelining, Data hazards, Exception handling, Simulators.

3. **Memory Hierarchy:** storage technologies, locality of reference, cache memories. Impact of caches on program performance.

4. **Linking: C**ompiler drivers, Static linking, Object files formats, relocatable object files, Symbol tables, Symbol resolution, Relocation, Dynamic linking, Shared libraries, Loading executable object files, Position independent code.

5. **Virtual Memory:** Page tables, Locality, Address translation, memory mapping, Dynamic memory allocation, Garbage collection, Common memory related bugs.

Prerequisite Courses: None

Reference Books:

1. “Computer Systems: A Programmer’s Perspective”, Randal Bryant and David O’ Halloran, Prentice Hall, 2nd Edition, 2011.
2. Computer Architecture: A Quantitative Approach”, Hennessey and Patterson, MK publishers, 5th Edition,2011.

UE19CS502

ADVANCED DATA STRUCTURES (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Appreciate the impact of Data Structures on Algorithms, Program Design and Program Performance.
- Understand and apply Amortized Analysis on Data Structures, including Binary search trees, Mergeable Heaps and Dynamic Tables.
- Analyze the applications of static and dynamic Search Trees and Heaps.
- Understand advanced ADTs with Interface and Implementation separation
- Understand State Space search and Spatial Data Structures with R-Trees .

Course Outcomes:

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

- Demonstrate the notion of Abstract Data Types (ADT) & Recursive accesses on them.
- Illustrate the relation between Data Structure operations and Amortized Complexity analysis.
- How to Analyze Iterated Lists and variations thereof.
- Demonstrate tree data structures and how to balance them, for specific access needs.
- Implement different Heaps and B-Tree variations
- Analyze and implement Spatial data implementations and their search

Course Content:

1. Complexity, Amortized Analysis, Abstract Data Types(ADT): Asymptotic Complexity Notations, Amortized Complexity analysis of Stacks/Binary Counters, and Dynamic Tables.
Concept of interface and implementation, Array as an ADT: Different types of Array Implementations. List Interface& List implementations, Concept of Iterator: Operations on Lists and Arrays – traverse, search, replace, reverse, copy.

2. Queues, List variations and Binary Search Trees: Stack, Queue, Doubly Ended Queue, Doubly Linked List, Skip list, interface and implementation, Multilist: sparse matrices, General purpose tree, binary tree, Binary search trees, AVL trees.

3. Search Tree Variations: Red-Black trees, Splay trees, B trees, B+ trees, B* trees, 2-3 trees, Prefix and Suffix trees.

4. Heaps & Graphs: Priority Queue, Binomial Heaps, Leftist Heaps, Skewed Heaps, Fibonacci Heaps, Graphs-Interface and Implementation, Adjacency matrix, Adjacency list, Incidence matrix , Spanning tree , Isomorphism.

5. Combination of Data Structures: State space search techniques, Greedy method, Branch and Bound techniques, Introduction to Spatio, Temporal Data structures and R-Trees.

Pre-requisite Courses: None

Reference Books:

- "Abstract Data Types: Specifications, Implementations, and Applications", Nell Dale, Henry M. Walker, Jones & Bartlett Learning, 1996.
- "Introduction to Algorithms", T. H Cormen, C E Leiserson, R L Rivest and C Stein, Prentice-Hall of India, 3rd Edition, 2010.
- "Data Structures and Algorithm Analysis in C++", Mark Allen Weiss, Pearson, 4th Edition, 2014.
- "Data Structures and Algorithms", Alfred V. Aho, Jeffrey D. Ullman, Pearson, 1983.
- "Spatial Statistics and Spatio-Temporal Data: Covariance Functions and Directional Properties", Michael Sherman, Wiley, 2010.

UE19CS503

FUNDAMENTALS OF SCALABLE COMPUTING (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce the basic principles of computing at scale and differentiate between scale up and scale out
- Introduce the business need and applications for scaling computing
- Introduce case studies of scalability from Cloud computing and Big Data and how the two relate to each other.
- Understand the theoretical considerations that impact the design of scalable systems.
- Introduce different programming models for computing at scale.

Course Outcomes:

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

- Motivate and explain trade-offs in computing at scale
- Demonstrate development of Cloud/Hadoop applications.
- Evaluate Service-oriented technologies and their potential for business transformation.
- Analyze various cloud programming models and choose the appropriate model for application development
- Demonstrate use of tools for developing applications at scale

Course Content:

1. **Systems Modeling, Clustering and SOA** – Operating systems concepts review, Scalable computing over the internet, Technologies for network based systems, system models for distributed and cloud computing, Software environments for distributed systems, performance metrics, Services and SOA, REST, RPC

2. **Cloud Platform Architectures -** Cloud computing and service models – IaaS, PaaS, SaaS, Architectural design, Programming models - IaaS - Case study: AWS

3. **Programming Models -** PaaS Models Case study: Azure. Messaging Oriented Middleware, Microservices model,

4. **Big Data Programming models -** Introduction, HDFS/GFS, MapReduce Programming Model, Hbase/BigTable, Matrix operations

5. **Distributed systems and Trends:** Master slave, p2p and overlay networks, Orchestration, Continuous integration, DevOps, Case Study: Kubernetes

Reference:

1. "Moving to the Cloud", Dinkar Sitaram, Geetha Manjunath, Elsevier Publications, 2011.
2. "Distributed and Cloud Computing: From Parallel Processing to Internet of Things", Kai Hwang, Jack Dongarra and Geoffrey Fox, 1st Edition, 2013, Morgan Kaufmann
3. "Hadoop: The Definitive Guide, Tom White", 4th Edition, O'Reilly, 2015
4. Mining of Massive Datasets, Anand Rajaraman, Jure Leskovec, Jerey D. Ullman, 2nd Edition, Cambridge University Press, 2014
5. Cloud Native DevOps with Kubernetes, Justin Domingus and John Arundel, O'Reilly, 2019

UE19CS504

Topics in Artificial Intelligence (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Provide an introduction to Machine Intelligence, Problem Solving, Heuristic Search.
- Provide an introduction to Game Playing.
- Provide an introduction to various knowledge representation techniques, reasoning, and expert systems.
- Provide an introduction to planning and learning in AI.
- Introduce Understanding, Natural Language Processing, and Robotics - Perception and Action.

Course Outcomes:

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

- Apply various search techniques for solving problems in AI.
- Write programs to play games.
- Apply knowledge representation techniques and build algorithms for reasoning with knowledge.
- Apply planning and learning algorithms to enhance AI problem solving.

- Identify the AI research and problem areas and choose appropriate problem solving methods.

Course Content:

1. Introduction
What Is AI? ,The Foundations of Artificial Intelligence ,The History of Artificial Intelligence , The State of the Art. **Intelligent Agents:** Agents and Environments, Good Behavior: The Concept of Rationality , The Nature of Environment, The Structure of Agents.

2. Solving Problems by Searching
Problem-Solving Agents , Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies , Heuristic Functions, **Beyond Classical Search:** Local Search Algorithms and Optimization Problems, Local Search in Continuous Spaces Searching with Nondeterministic Actions, Searching with Partial Observations, Online Search Agents and Unknown Environments.

3. Adversarial Search
Games ,Optimal Decisions in Games ,Alpha–Beta Pruning, Imperfect Real-Time Decisions, Stochastic Games .Partially Observable Games, State-of-the-Art Game Programs, Alternative Approaches .**Constraint Satisfaction Problems:** Defining Constraint Satisfaction Problems, Constraint Propagation: Inference in CSPs, Backtracking Search for CSPs, Local Search for CSPs , The Structure of Problems.

4. Knowledge, reasoning, and planning
Logical Agents: Knowledge-Based Agents , The Wumpus World, Logic , Propositional Logic: A Very Simple Logic , Propositional Theorem Proving , Effective Propositional Model Checking, Agents Based on Propositional Logic **First-Order Logic:** Representation Revisited, Syntax and Semantics of First-Order Logic , Using First-Order Logic ,Knowledge Engineering in First-Order Logic. **Inference in First-Order Logic:** Propositional vs. First-Order Inference, Unification and Lifting , Forward Chaining Backward Chaining , Resolution , Classical Planning, Definition of Classical Planning Algorithms for Planning as State-Space Search, Planning Graphs , Other Classical Planning Approaches , Analysis of Planning Approaches.

5. Planning and Acting in the Real World
Time, Schedules, and Resources, Hierarchical Planning ,Planning and Acting in Nondeterministic Domains , Multiagent Planning **Knowledge Representation:** Ontological Engineering, Categories and Objects, Events , Mental Events and Mental Objects ., Reasoning Systems for Categories, Reasoning with Default Information, The Internet Shopping World , **Learning:** Introduction, Robot Hardware, Robotic Perception, Planning to Move, Planning Uncertain Movements, Moving, Robotic Software Architectures, Application Domains.

Reference Book(s):

1. “A First Course in Artificial Intelligence”, Deepak Khemani, McGraw Hill, 1st Edition, 2013.
2. “Artificial Intelligence – A Modern Approach”, Stuart Russell and Peter Norvig, Pearson, 3rd Edition (Paperback), 2016.
3. “Artificial Intelligence”, E Rich and K Knight and Shivashankar Nair, Tata McGraw Hill, 3rd Edition, 2009.

UE19CS505

Cyber Security Essentials (4-0-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Understand various cyber security issues with respect to operating system, wired and wireless networks
- Analyse the risks and incidents' response
- Learn the art of encryption and decryption
- Understand the violations in cyber world

Course Outcomes:

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

- Design a Threat model
- Perform various attacks and their mitigation strategies
- Perform cryptanalysis
- Analyse the security issues and risks
- Aware of the policies and law in cyber security

Course Content:

1. Introduction: Introduction to Information Security, What is cyber security? Need for cyber security, Privacy of data, Risk Management, Digital Forensics- Incident response, Security operations

2. Network Security: Wired Security Issues: Firewalls, Intrusion Detection, Intrusion Prevention Systems, Honeypots**,** DoS and DDOS attack**,** Wireless Security issues-Android and iOS Security, App Security, Secure Boot, Data Exfiltration, Wireless Protected Access (WPA), IEEE 802.1x, 802.11i/ WPA2, Wireless Network Threats**,** Cloud and IoT Application Security

3. Software and Web Security: Operating system security: Attack Surfaces of Set-UID Programs, Principle of Least Privilege; Environment variables attack surface, Control Hijacking– Buffer overflow and Countermeasures, Web security: Cross-Site Request Forgery, Cross-Site Scripting, SQL Injection, Threat Modelling- design, Types of Security testing : Fuzz testing, Vulnerability scanning, Penetration Testing; Static and Dynamic analysis

4**. Cryptography**: What is cryptography? Classical encryption techniques : Substitution and transposition techniques, Steganography, Modern cryptography: Perfectly-secret encryption, Symmetric Key Ciphers : AES, Asymmetric Key ciphers-Key distribution and Key Management, Diffie Hellman Protocol, RSA Encryption, Digital Signature, Cryptanalysis

5. **Cyber security**: The legal perspectives: Cyber crime and legal landscape around the world, Why do we need cyber laws: The Indian context, Indian IT Act, Challenges to Indian Law, Weakness in IT Act, Digital Signatures and Indian IT Act, Amendments to Indian IT Act, Cyber crime and punishment, Policy approaches

Reference Book(s):

1. William Stallings, Lawrie Brown, "Computer Security: Principles and Practice", Indian Edition,Pearson, 2010.
2. Jonathan Katz, Yehuda Lindell, Introduction to Modern Cryptography, CRC Press, 2018
3. Behrouz A.Foruzan, Cryptography and Network Security, Tata McGraw Hill 2007.
4. Wenliang Du,Computer Security A Hands-on Approach,2017
5. Jonathan Rosenoer,"Cyber Law: The law of the Internet", Springer-Verlag, 1997.
6. Mark F Grady, Fransesco Parisi, "The Law and Economics of Cyber Security", Cambridge University Press, 2006.

UE19CS551

TOPICS IN ADVANCED ALGORITHMS (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Understand in depth, Complexity notions and Computability of functions.
- Understand a few string matching/prediction algorithms and their applications.
- Understand Graph Centric, Max-Flow and Shortest Path algorithms.
- Understand eficient Polynomial Multiplication and hence DFT/FFT algorithm.
- Understand Number Theoretic algorithms and hence RSA cryptography.

Course Outcomes:

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

- Perform Complexity analysis of algorithms.
- Design and implement advanced string matching algorithms.
- Design Maxflow and other advanced Graph Centric algorithms.
- Design and implement FFT algorithm.
- Design and implement Number Theoretic algorithms and RSA encryption
- Design Randomized and Approximate algorithms and estimate complexity

Course Content:

1. Review of Analysis Techniques: Growth of Functions, Asymptotic notations, Standard notations and common functions, Recurrences and Solution of Recurrence equations- The Substitution method, the Recurrence tree method, the Master method, Amortized Analysis:, Aggregate, Accounting and Potential Methods.
NP-Completeness.

2. Shortest Path algorithms, Polynomials and FFT: Single source shortest paths in a DAG, Bellman - Ford Algorithm, Johnson's Algorithm for sparse graphs, Flow networks and Ford-Fulkerson method, Maximum Bi-partite matching.
Polynomials and FFT: Representation of polynomials, Efficient Polynomial Multiplication, The DFT and FFT, Efficient implementation of FFT.

3. Number-Theoretic Algorithms: Elementary notions; GCD, Modular Arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element; RSA cryptosystem; Primality testing; Integer factorization.

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4. String-Matching Algorithms: Naïve string Matching, Rabin - Karp algorithm, String matching with Finite State Automata, Knuth-Morris-Pratt algorithm, Boyer–Moore algorithm.

5. Probabilistic, Randomized and Approximation Algorithms: Probabilistic analysis, Indicator Random variables, uses of indicator random variables, the Hiring problem, Classes of Randomized algorithms.
Approximation Algorithms, Vertex Cover Problem, Travelling Sales man Problem, Randomisation and Linear Programming

Pre-requisite Courses: None

Reference Books:

- "Introduction to Algorithms", T. H Cormen, C E Leiserson, R L Rivest and C Stein, Prentice-Hall of India, 3rd Edition, 2010.

UE19CS552

STOCHASTIC MODELS AND MACHINE LEARNING (4-0-0-0-4)

Course Objectives:

The objective(s) of the course is to:

- Understand the basic concepts of learning and decision trees.
- Understand various techniques such neural networks and genetic algorithms.
- Understand Stochastic Learning and in Decision Trees, Bayesian Models, and Hidden Markov Models
- Understand Unsupervised Learning models like Clustering .
- Understand Computational learning complexity and Dimensionality reduction methods.

Course Outcomes:

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

- Display thorough knowledge about the key algorithms and theory that form the foundation of machine learning and computational intelligence.
- Identify and apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems.
- Compare and contrast different machine learning algorithms.
- Design and implement classifiers for several domains .

Course Content:

1. Concept Learning and Decision Trees:
Defining a Machine Learning problem, Version Spaces and Candidate Elimination Algorithm and it's Inductive Bias,
Decision Tree learning: Representation, Algorithm, Hypothesis Space Search, Inductive Bias and Issues.

2. Neural Nets and SVM:
Perceptrons, Gradient Descent, Back propagation, Neural Nets, Support Vector Machines(SVM).

3. Stochastic Models for Learning:
Bayesian Learning, Bayes Classifiers, Belief Networks, Bayesian Estimation, Expectation Maximisation(EM), Hidden Markov Models, Genetic Algorithms.

4. UnSupervised Learning :
Clustering, Instance based Learning, Frequent Item Set Analysis, FP-Growth Algorithm.

5. Learning Complexity and Dimensionality Reduction :
PAC models, Sample Complexity, Principal Component Analysis and Singular Value Decomposition.

Pre-requisite Courses: None

Reference Books:

- "Machine Learning", Tom Mitchell, McGraw Hill Education (India), 2013.
- "Pattern Recognition and Machine Learning", Christopher Bishop, Springer 2nd Printing, 2011.
- "Introduction to Machine Learning", Ethem Alpaydin, Prentice Hall(India), 3rd Edition, 2017
- "Machine Learning in Action", Peter Harrington, Dream Tech Press (India), 2012.

UE19CS561

MILLION WAY PARALLELISM (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to
- Introduce the various parallel programming models required to scale
- Introduce applications that benefit from scalability
- Introduce different types of hardware such as multi-core CPUs, GPUs and FPGAs
- Understand and use the tools to analyze these applications.
- Understand the impact of role of various other system components on extracting performance in parallel programs.

Course Outcomes:

At the end of the course the student will be able to
- Choose the right programming model for a problem
- Demonstrate development of applications on different types of hardware
- Evaluate choice of the right type of hardware to solve the problem.
- Demonstrate use of tools for developing parallel applications and debugging them
- Analyze systems for issues in performance

Course Content:

1. **Introduction and Parallel program design**– Multicore, Taxonomy, Performance Metrics, Amdahl's Law, Gustafson's law, Decomposition patterns, Program structure patterns. Matching program structure with decomposition
2. **Shared Memory Programming–**, Threads, design concerns, semaphores, applying semaphores, debugging multithreaded applications, OpenMP- loop level

parallelism, Task level parallelism, Synchronization, Correctness and Optimization. Case Study.

3. **GPU Programming –** GPU architecture, CUDA - programming model, execution model, Memory hierarchy. Optimization techniques, Debugging,
4. **GPU Programming Considerations:** performance considerations – thread execution, memory bandwidth, dynamic partitioning, data prefetching, instruction mix, thread granularity, Floating point considerations, format, representation, precision, accuracy, rounding, Case Study
5. **Misc and Trends –** Accelerators , power considerations, memory systems (3D), Interconnection Networks.

Reference:

- Multicore and GPU Programming: An Integrated Approach, GerassimosBarlas, Morgan Kaufmann, 2015
- Programming Massively Parallel Processors: A Hands On Approach, David B Kirk and Wen-mei W Hwu, .

UE19CS562

SPEECH AND NATURAL LANGUAGE PROCESSING (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce the student to advances in multimedia technologies relevant to Big Data
- Understand the business relevance of speech and natural language technologies
- Introduce the basic models used for processing speech and natural language
- Work with tools to perform speech/natural language processing
- Gain a practical insight into solving these problems

Course Outcomes:

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

- Demonstrate the use of speech/natural language processing in solving real-life problems
- Demonstrate the use of tools for performing speech/NLP
- Demonstrate capability to perform analysis and compare various models
- Work in a team to solve related problems
- Communicate the solution to the instructor using a report.

Course Content:

1. Introduction - Business relevance, Survey of English Morphology (inflectional and derivational morphology), Finite State Morphological parsing, Porter Stemmer, Word and Sentence Tokenization, Detection and Correction of Spelling Errors, Minimum Edit Distance

2. **Ngrams** – Word Counting in Corpora, Simple (unsmoothed) N-Grams, Training and Test Sets, Evaluating N-Grams. Part of Speech Tagging – English Word Classes, Tagsets for English, Part-of-Speech Tagging

3. Hidden Markov and Maximum Entropy Models – Markov Chains, Hidden Markov Model, Likelihood Computation, Decoding, HMM Training, Maximum Entropy Models. Phonetics – Speech Sounds and Phonetic Transcription, Articulatory Phonetics, Phonological Categories and Pronunciation Variation, Acoustic Phonetics and Signals, Automatic Speech Recognition – Speech Recognition Architecture, HMM Applied to Speech, Feature Extraction: MFCC Vectors, Acoustic Likelihood Computation, Lexicon and Language Model, Search and Decoding, Embedded Training, Word Error Rate.

4. Syntactic Parsing – Parsing as Search, Ambiguity, Search in the Face of Ambiguity, Dynamic Programming Parsing Methods, Partial Parsing, Statistical Parsing – Probabilistic CFGs, Probabilistic CKY Parsing, Ways to Learn PCFG, Rule Probabilities, Problems with PCFGs, Improving PCFGs, Probabilistic Lexicalized CFGs, Evaluating Parsers.

5. **Lexical Semantics** – Word Senses, Relation between Senses, Wordet: Database of Lexical Relations, Event Participants, Primitive Decomposition, Metaphor, Computational Lexical Semantics – Word Sense Disambiguation, Supervised Word Sense Disambiguation, WSD Evaluation, Minimally Supervised WSD, Word Similarity, Semantic: Role Labeling.

Reference Books:

- "Speech and Language Processing: An Introduction to Natural Language Processing", Daniel Jurafsky and James H. Martin, Prentice Hall, 2009.(Draft copy ,3rd Edition,2018 can be referred)
- "Computational Linguistics and Speech Recognition", Dan Jurafsky, James H. Martin, Prentice Hall, 2nd Edition, 2008.
- "Foundations of Statistical Natural Language Processing", Christopher D. Manning and Hinrich Schütze, MIT Press, 1999.
- "Natural Language Understanding",James Allen, Benjamin/Cummings publishing Company, 2nd edition, 1995.
- "Digital Processing of Speech Signals", Lawrence R. Rabiner, Ronald W. Schafer, Prentice Hall, 1978.

UE19CS563

BIO INSPIRED COMPUTING (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce fundamental topics in bio-inspired computing,
- Build up their proficiency in the application of various algorithms in real-world problems.
- Provide an understanding of a range of features from the biological world that have influenced the world of computing
- Foster a basic understanding of the nature biological inspiration for AI and Computing - the goals and motivations
- Develop an understanding of simple computer modelling of biological systems- **HOW?**
- Provide an historical context for biologically inspired systems
- Develop a foundation for biological learning models and self-organisation

- Provide experience of collaborative work that develops biologically inspired solutions to practical problems.
- To encourage curiosity and motivate further research in biologically inspired research

Course Outcomes:

At the end of the course we expect students to:

- understand some of the essential features of biologically inspired systems
- work effectively in a group environment to select and apply specific bio-inspired computing approaches to solve practical problems

Course Content:

1. Introduction: Natural Computing Algorithms: An Overview, **Evolutionary Computing:** Introduction to Evolutionary Computing, Evolutionary Algorithms: **Genetic Algorithm:** Canonical Genetic Algorithm, Design Choices in Implementing a GA, Choosing a Representation, Initialising the Population, Measuring Fitness, Generating Diversity, choosing Parameter Values
Extending the Genetic Algorithm: Dynamic Environments, Structured Population Gas, Constrained Optimisation, Multiobjective Optimisation, Memetic Algorithms, Linkage Learning, Estimation of Distribution Algorithms

2. Evolution Strategies and Evolutionary Programming: The Canonical ES Algorithm, Evolutionary Programming, **Differential Evolution:** Canonical Differential Evolution Algorithm, Extending the Canonical DE Algorithm, Discrete DE, **Genetic Programming:** Genetic Programming, Bloat in GP, More Complex GP Architectures, GP Variants, Semantics and GP.

3. Social Computing: Particle Swarm Algorithms: Search, Particle Swarm Optimisation Algorithm, Comparing PSO and Evolutionary Algorithms, Maintaining Diversity in PSO, Hybrid PSO Algorithms, Discrete PSO, Evolving a PSO Algorithm. Quantum PSO, convergence and optimization.

4.Ant Algorithms: A Taxonomy of Ant Algorithms, Ant Foraging Behaviours, Ant Algorithms for Discrete Optimisation, Ant Algorithms for Continuous Optimisation, Multiple Ant Colonies, Hybrid Ant Foraging Algorithms, Ant-Inspired Clustering Algorithms, Classification with Ant Algorithms, Evolving an Ant Algorithm.
Other Foraging Algorithms: Honeybee Dance Language, Honeybee Foraging, Designing a Honeybee Foraging Optimisation Algorithm, Bee Nest Site Selection, Honeybee Mating Optimisation Algorithm**;** Non-uniform Oscillators and Firefly, the model and optimization

5. **Applications and performance metrics:** Usage of some metaheuristic pipelines, psopy, solution to Convex optimization problems(constrained and unconstrained) using GA, PSO and ACO, solution to non-convex/non-concave optimization problems(constrained and unconstrained) using GA, PSO and ACO, derivative-free optimization, single-objective and bi-objective optimization, performance comparison of metaheuristics, benchmark functions (Mishra, Rosenbrock etc), Metric computation-generational distance, purity, hypervolume, discussion on local and global convergence.
The Future of Natural Computing Algorithms, Looking Ahead, Open Issues.

Reference Books:

- Natural Computing Algorithms, Anthony Brabazon, Michael O'Neill, Seán McGarraghy, Springer, Natural Computing Series

- *Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications*. Nunes de Castro, Leandro [2006]. Chapman & Hall.
- Handouts and codebase on PSO by Snehanshu Saha

UE19CS564

Cryptography

Course Objectives:

The objective(s) of the course is to
- Introduce classical cryptographic techniques
- Discuss about Modern cryptography computational complexity
- Analyze the design of various protocols using cryptographic techniques
- Provide practical assignments to help gain deeper insight into cryptography

Course Outcomes:

At the end of the course the student will be able to
- Appreciate the impact of cyber attacks on the society and the necessity of cryptography
- Analyze Cryptographic techniques using the mathematical foundations of cryptography
- Design applications/protocols using cryptographic techniques
- Apply cryptanalysis to solve real time problems

Course Content:

1. Introduction to Cryptography: Why Cryptography?, Security trends – legal, ethical and professional aspects of security, Basic Cryptographic primitives (encryption, decryption, signatures, authentication), Classical encryption techniques : substitution technique, transposition techniques, Steganography, Historical Ciphers and their cryptanalysis, Classical vs Modern cryptography.

2. Modern Cryptography: Principles of Modern cryptography, Perfectly-secret encryption – Vernam's One-time-pad encryption – Limitations, Shannon's theorem, Stream Ciphers, Block cipher design principles, Block Vs Stream cipher.

3. Private Key Cryptography: Mathematical Modular arithmetic-Euclid's algorithm, Congruence and matrices, Algebraic structures: Groups, Rings, Fields- Finite fields, Pseudorandom Generators (PRNG), Private/Symmetric Key Ciphers: Fiestel network, DES, AES, Cryptanalysis: Block cipher mode of operation, Chosen-Ciphertext Attacks, , Differential and linear cryptanalysis.

4. Public Key Cryptography: Mathematics of Public Key Cryptography: Primes, Factorization, Chinese Remainder Theorem, Key Management and the Public Key Revolution: Key distribution and Key Management, Diffie Hellman Protocol, Elgamal encryption, RSA Encryption : Algorithm, Implementation issues and Pitfalls, Rabin Encryption Scheme: Trapdoor, Scheme, Digital Signature: Certificates and Public Infrastructure, Attacks, Scheme, Applications, Signatures from Hash Functions.

5. MAC and Hash: Message Authentication Code (MAC) – Definition, Message Integrity, Cipher Block Chaining (CBC-MAC), Constructing Secure message Authentication codes, Authenticated Encryption, Hash Functions and Applications: MAC using Hash functions

HMAC, Generic Attacks on Hash Functions, Random Oracle Model, Applications, Hash functions: MD5, SHA, collision resistant hashing, Merkle-Damgrad and Davies Meyer.

Reference Books:

1. Jonathan Katz, Yehuda Lindell, Introduction to Modern Cryptography, CRC Press, 2018
2. Behrouz A.Foruzan, Cryptography and Network Security, Tata McGraw Hill 2007.

UE19CS565

TOPICS IN COMPUTER and NETWORK SECURITY (3-2-0-0-4)

Course Objectives:

The objective(s) of this course is to,

- Understand the security issues in network, cloud and wireless environment.
- Introduction of Perimeter Security (Firewall, IDS, IPSEC).
- Understand various access roles of an organization

Course Outcomes:

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

- Fetch or secure the network user's information
- Perform various network attacks and their mitigation strategies
- Aware of the responsibilities of security management
- Assess the risks involved in an organization

Course Content:

1. Introduction and Network Security Analysis: Computer Security Concepts, Requirements, Architecture, Trends, Strategy. Perimeter Security: Firewalls, Intrusion Detection, Intrusion Prevention Systems, Honey pots. Analysis of TCP SYN flood DoS **attack.** Network packet Analysis: Usage of Banner grabbing tools like nmap, Wireshark**.** Man-in-the-Middle attacks

2. Authentication and Access Control: User Authentication: Password, Password - Based, Token - Based, Biometric, Remote User Authentication. Access Control: Principles, Access Rights, Discretionary Access Control, UNIX File Access Control, Role Based Access Control. Internet Authentication Applications: Kerberos, X.509, PKI, Federated Identity Management. Case study: Access control list for PES University.

3. Human Factors: Security Awareness, Training and Education, Organization Security Policy, Employment Practices and Policy. IT Security Management and Risk Assessment: IT Security Management, Risk Assessment, Analysis of IT Security Controls. Plans and Procedures: IT Security Management Implementation, Security Controls, Plan, Implementation of Controls. Case Study: iPremier

4. Cloud Security: Cloud Computing Service Models and Layers, Security Issues in Cloud Computing. Bluetooth Security: Bluetooth Protocol Stack, Multiple Security Modes. Mobile Security: Security Concepts, Requirements, Architecture.

5. Wireless Network Security: Wireless Communications and 802.11 WLAN Standards Wireless Protected Access (WPA), IEEE 802.1x, 802.11i/ WPA2, Wireless Network Threats, ZigBee Security, Wireless Mesh Network Security.

Reference Books:

1. "Computer Security: Principles and Practice", William Stallings, Lawrie Brown, Indian Edition, Pearson, Nov 2015, Pearson.
2. Securing The Cloud: Cloud Computing Security Techniques and Tactics by Vic (J.R.) Winkler
   (Syngress/Elsevier) – 978-1-59749-592-9
3. Android Security Internals: An In-Depth Guide to Android's Security Architecture, Author:
   Nikolay Elenkov , No Starch Press, First Edition, Nov. 2014
4. Wireless Security – Models, Threats, and Solutions," by Nichols and Lekkas, McGraw-Hill, 2002, ISBN 0071380388

UE19CS571

ADVANCED CLOUD COMPUTING and SECURITY (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce students to various aspects of cloud security
- Equip students for better appreciation of technology, human and societal aspects of security with respect to the cloud
- Introduce challenges of security with various models of cloud such as IaaS, PaaS and SaaS
- Introduce the student to threat analysis and modelling in the cloud.

Course Outcomes:

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

- Understand various security issues in the cloud.
- Design appropriate security for various cloud models.
- Analyze security from both technology and legal perspective
- Design mechanisms for security for access control and data

Course Content:

1. **Introduction and IaaS Security–** Cloud Network security – data confidentiality, integrity availability of internet facing resources, Domain model, IaaS Host Security, Virtualization Software Security, Virtual Server Security

2. **PaaS and SaaS Security–** PaaS Host Security, Application level security threats, DoS and EDoS PaaS application Security, PaaS application containers, customer deployed application security, SaaS Host Security, SaaS Application Security,

3. **Data Secuity and IAM:** Public cloud security limitations, aspects of Data security, mitigation, Provider Data and it's security.IAM– Challenges, Architecture, IAM in Cloud - Google, Azure, SaaS.

4. **Privacy, Audit and Compliance:**Privacy concerns, Responsibility, Priniciples, Laws, Compliance, Governance, Risk, security policy, Organization of information security, Asset Management, Human resources, Physical and Environmental security, Regulatory compliance – Sarbannes Oxley, HIPAA, Auditing the cloud.

5. **Threat models –** what is a thread model, finding threats – STRIDES and attack trees. Privacy Tools, Managing and Addressing Threats

Reference Books:

1. "Cloud Security and Privacy",Tim Mather, Subra Kumaraswamy and Shahed Latif, O'Reilly, 2009
2. "Threat Modeling: Designing for Security", Adam Shostack, 2014, Wiley

UE19CS572

CLOUD COMPUTING FUNDAMENTALS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Provide an overview of the Cloud Computing Fundamentals.
- Understand the business need for using Cloud Computing.
- Understand the fundamental concepts of a data center.
- Understand various cloud programming models and their relevance.
- Through case studies, understand the design principles of cloud computing.

Course Outcomes:

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

- Demonstrate the business drivers for different cloud computing models.
- Apply the fundamental concepts in datacenters to understand the tradeoffs in power, efficiency and cost.
- Design system virtualization and outline its role in enabling the cloud computing system model.
- Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems.
- Analyze various cloud programming models and apply them to solve problems on the cloud.

Course Content:

1. **Introduction and Virtualization:** What is Cloud Computing? Data centers, Challenges with Data centers, Components of Data centers. Business drivers for virtualization, Virtualization, Layering and virtualization, Virtual Machine Monitors, Virtual Machines, Software virtualization – shadow page tables, Hardware support for virtualization – nested page tables, Lightweight virtualization – containers – namespaces.

2. **Cloud computing Models:** IaaS/PaaS/SaaS, differences, deployment, message queues, resource management – scheduling algorithms. Multitenancy, Multitenant databases.

3. **Serverless compute:** Case study of Kubernetes architecture, Custom Resource Descriptions, Deploying applications – istio, Operators, Continuous Integration and deployment pipelines, Application Logging, Security.

4. **Storage :**CAP Theorem, NoSQL databases, Block and Object Storage, Scaling storage, Shared storage – stateful applications.

5. **Network and Cluster:** introduction, configuration, liveness, health check, load balancing, cluster coordination - algorithms.

Reference Books:

1. "Cloud Computing Theory and Practice", Dan C Marinescu, Morgan Kaufmann, 2013.
2. "Moving to the Cloud", Dinkar Sitaram, Geetha Manjunath, Elsevier Publications, 2011.
3. "Cloud Computing Principles and Paradigms", Rajkumar Buyya, James Broberg, Andrzej Goscinski, Willey, 2014
4. DevOps with Kubernetes: Accelerating software delivery with container orchestrators, Hideto Saito, Hui-Chuan Chloe Lee and Cheng-Yang-Wu, Packt Publishers, 2019, 2nd Edition

UE19CS573

ADVANCED BIG DATA ANALYTICS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce alternative techniques to perform big data processing
- Introduce applications of Big Data Processing
- Use tools and techniques to analyze a large data corpus
- Technologies for performing processing at large scale
- Perform a group-based activity to apply tools and techniques learnt to a real world problem.

Course Outcomes:

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

- Motivate and explain trade-offs in big data processing technique design and analysis in written and oral form.
- Demonstrate the usage of tools to design Big Data applications.
- Demonstrate development of analytics applications using alternative technologies to Hadoop.
- Demonstrate ability to work in a small team to solve a real world problem with applications to the society
- Communicate the design through a presentation and build a prototype to showcase the design.

Course Content:

1. **Introduction and MapReduce:** Introduction, Hadoop ecosystem overview, HDFS overview, formats, MapReduce architecture,YARN, limitations of MapReduce,

Algorithms: PageRank.

2. **In Memory processing:** , Alternatives to Map Reduce – Iterative, Workflow processing - PIG, Graph Processing, In-memory computation., Workflow model case study – Apache Spark – RDDs, Scala Performance advantages.

3. **Other models and algorithms:** Graph model case study – Pregel/Graph. Computation model. Introduction to machine learning. Machine learning with Spark, Clustering, Collaborative filtering Algorithms applied to Big Data. Case study – Tensorflow, Watson.

4. **Timeseries analysis:** Business applications of timeseries data, challenges/tools to process timeseries data. Searching/Matching algorithms.

5. **Multimedia –Speech Processing:** Variety in Big data, Business cases for Multimedia-Speech processing. Hidden Markov Models, Case study: Sphinx. Video Processing

Reference Books:

1. "Big Data Analytics Beyond Hadoop": Real-Time Applications with Storm, Spark, and More Hadoop Alternatives, Vijay Srinivasa Agneeswaran PhD, 1st Edition, Pearson, 2014
2. "Mining of Massive Datasets", Anand Rajaraman, Jure Leskovec, Jerey D. Ullman, 2nd Edition, Cambridge University Press, 2014
3. Abu-El-Haija, Sami, Nisarg Kothari, Joonseok Lee, Paul Natsev, George Toderici, Balakrishnan Varadarajan, and SudheendraVijayanarasimhan. "Youtube-8m: A large-scale video classification benchmark." arXiv preprint arXiv:1609.08675 (2016).
4. Huang, Qi, Petchean Ang, Peter Knowles, Tomasz Nykiel, IaroslavTverdokhlib, Amit Yajurvedi, Paul Dapolito IV et al. "SVE: Distributed video processing at Facebook scale." In Proceedings of the 26th Symposium on Operating Systems Principles, pp. 87-103. ACM, 2017.

UE19CS574

FOUNDATIONS OF IoT & STREAMING ANALYSIS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- The objective of the course is to give an overview of the Internet of Things (IOT) and Cyber physical systems.
- Introduce different types of IoT through real-world case studies.
- Introduce an IoT design methodology.
- Introduce how IoT devices are monitored and manage.
- Understand how Big Data analysis can be performed on IoT.

Course Outcomes:

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

- Design, define and plan software and hardware requirements comprising an IoT system.

- Demonstrate how to select and design IoT hardware components.
- Demonstrate connectivity to IoT systems to the cloud.
- Perform basic analytics with IoT systems.
- Design and develop an IoT system in a team for a real-world problem.

Course Content:

1. **IOT Introduction:** Defining the Internet of Things, panoramic view of IOT/CPS applications, IoT Applications, IoT solution architecture, IoT Devices and Operating Systems.
2. **IOTTechnologies**: Processor (Arduino), Sensors, Programming on Arduino/Raspberry Pi, Wireless Technologies, WAN Technologies.
3. **IOT Middleware:** Overview, M2M, SCADA, RFID and WSN middleware, Protocols: MQTT, CoAP
4. **Streaming analytics:** Data stream model, Apache Storm – architecture and programming model. Analysis of streams using Storm.
5. **Streaming Techniques:** Sampling algorithms, Estimating number of unique elements in streams, averaging.

Reference Books:

1. "Analytics for the Internet of Things", Andrew Minteer, Packt Publishers, 2017
2. "Internet of Things", Shriram Vasudevan, Abhishek Nagarajan, RMD Sundaram, Wiley 2019
3. "The Internet of Things in the Cloud: A Middleware Perspective", Honbo Zhou, CRC Press, 2012.
4. "Precision", Principles, Practices and solutions for the Internet of Things", Timothy Chou, McGraw Hill,2016.
5. "Internet of Things", Architecture and Design Principles, Raj Kamal, McGraw Hill, 2017
6. Mining of Massive Datasets, Anand Rajaraman, Jure Leskovec, Jerey D. Ullman, 2nd Edition, Cambridge University Press, 2014

UE19CS575

Virtual Reality (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- To create an adaptive 3D the virtual environment that meets the needs of trainee interpreters and those who need to learn about how to work with interpreters;
- To develop a range of interpreting scenarios (e.g. a business meeting room, a court room, a tourist office, a community centre) that can be run in different modes ('interpreting practice', 'exploration' and 'live');
- To develop multilingual content for use in the interpreting scenarios of the virtual environment (as source texts for interpreting practice), by using and adapting existing multimedia corpora from the LLP project BACKBONE [1] and the ELISA corpus [2], and creating three new corpora in Greek, Russian and Hebrew;
- To create pedagogical activities for interpreting students and users of interpreting services (e.g. interpreting skills, awareness-raising activities);
- To test and evaluate the virtual environment and the pedagogic content (the multilingual material and the pedagogical activities) from both functional and pedagogical perspectives;

Course Outcomes:

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

- Differentiate between Virtual, Mixed and Augmented Reality platforms
- Identify appropriate design methodologies for immersive technology development, especially from a physiological perspective
- Demonstrate foundational literacy in game engine use.
- Effectively categories the benefits/shortcomings of available immersive technology platforms.

1. INTRODUCTION and INTRODUCTION
INTRODUCTION: The Three I's of Virtual Reality, A Short History of Early Virtual Reality, Early Commercial VR Technology, VR Becomes an Industry, The Five Classic Components of a VR System, Review Questions.
INPUT DEVICES: TRACKERS, NAVIGATION, AND GESTURE INTERFACES: Three-Dimensional Position Trackers ,Tracker Performance Parameters, Mechanical Trackers, Magnetic Trackers, Ultrasonic Trackers, Optical Trackers, Hybrid Inertial Trackers, Navigation and Manipulation Interfaces, Tracker-Based Navigation/Manipulation Interfaces, Trackballs, Three-Dimensional Probes, Gesture Interfaces, The Pinch Glove, The 5DT Data Glove, The Didjiglove, The CyberGlove.

2. OUTPUT DEVICES: GRAPHICS, THREE-DIMENSIONAL SOUND, AND HAPTIC DISPLAYS
Graphics Displays, The Human Visual System, Personal Graphics Displays, Large-Volume Displays, Sound Displays, The Human Auditory System, The Convolvotron, Speaker-Based Three-Dimensional Sound, Haptic Feedback, The Human Haptic System , Tactile Feedback Interfaces, Force Feedback Interfaces
COMPUTING ARCHITECTURES FOR VR: The Rendering Pipeline, The Graphics Rendering Pipeline, The Haptics Rendering Pipeline, PC Graphics Architecture, PC Graphics Accelerators, Graphics Benchmarks, Workstation-Based Architectures, The Sun Blade 1000 Architecture, The SGI Infinite Reality Architecture, Distributed VR Architectures, Multi pipeline Synchronization, Colocated Rendering Pipelines , Distributed Virtual Environments.

3. **MODELING**
Geometric Modeling, Virtual Object Shape, Object Visual Appearance
Kinematics Modeling, Homogeneous Transformation Matrices, Object Position, Transformation Invariants, Object Hierarchies ,Viewing the Three-Dimensional World, Physical Modeling, Collision Detection, Surface Deformation, Force Computation, Force Smoothing and Mapping, Haptic Texturing, Behavior Modeling, Model Management , Level-of-Detail Management,Cell Segmentation.
VR PROGRAMMING: Toolkits and Scene Graphs ,WorldToolKit ,Model Geometry and Appearance, The WTK Scene Graph, Sensors and Action Functions, WTK Networking,Java 3D, Model Geometry and Appearance,Java 3D Scene Graph, Sensors and Behaviors, Java 3D Networking, WTK and Java 3D Performance Comparison, General Haptics Open Software Toolkit, GHOST Integration with the Graphics Pipeline, The GHOST Haptics Scene Graph, Collision Detection and Response, Graphics and PHANToM Calibration, PeopleShop,DI-Guy Geometry and Path, Sensors and Behaviors, PeopleShop Networking.

4. HUMAN FACTORS IN VR: Methodology and Terminology, Data Collection and Analysis, Usability Engineering Methodology, User Performance Studies, Test bed Evaluation of Universal VR Tasks, Influence of System Responsiveness on User Performance, Influence of Feedback Multimodality, VR Health and Safety Issues, Direct Effects of VR Simulations on Users, Cyber sickness, Adaptation and After effects, Guidelines for Proper VR Usage, VR and Society, Impact on Professional Life, Impact on Private Life ,Impact on Public Life.
TRADITIONAL VR APPLICATIONS: Medical Applications of VR, Virtual Anatomy, Triage and Diagnostic, Surgery, Rehabilitation, Education, Arts, and Entertainment, VR in Education, VR and the Arts, Entertainment Applications of VR, Military VR Applications, Army Use of VR, VR Applications in the Navy, Air Force Use of VR.

5. EMERGING APPLICATIONS OF VR: VR Applications in Manufacturing, Virtual Prototyping, Other VR Applications in Manufacturing, Applications of VR in Robotics, Robot Programming Robot Teleoperation, Information Visualization, Oil Exploration and Well Management, Volumetric Data Visualization.

Text books:

- Virtual reality Technology, Grigore C Burdea, Philippe Coiffet, 2nd edition, Wiley publications.

UE19CS576

REINFORCEMENT LEARNING (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- To introduce Reinforcement Learning, an area of Machine Learning.
- To learn the Markov Decision Processes, Bandit Algorithms, Dynamic Programming, and Temporal Difference (TD) methods.
- introduce Value function, Bellman Equation, and Value iteration.
- learn Policy Gradient methods.
- learn to make decisions in uncertain environment.

Course Outcomes:

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

- Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning
- Given an application problem , decide if it should be formulated as a RL problem; if yes be able to define it formally.
- Describe (list and define) multiple criteria for analyzing RL algorithms and evaluate algorithms on these metrics:

1. Introduction to Reinforcement Learning :Examples ,Elements of Reinforcement Learning , Limitations and Scope ,An Extended Example: Tic-Tac-Toe ,Early History of Reinforcement Learning.Applications and case studies
Tabular Solution Methods : Multi-armed Bandits A k-armed Bandit Problem ,Action-value Methods, The 10-armed Testbed , Incremental Implementation, Tracking a Nonstationary Problem , Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandit Algorithms , Associative Search.

2. Finite Markov Decision Processes : The Agent–Environment Interface , Goals and Rewards, Returns and Episodes, Unified Notation for Episodic and Continuing Tasks , Policies and Value Functions , Optimal Policies and Optimal Value Functions, Optimality and Approximation.
Dynamic Programming :Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous, Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming,
Monte Carlo Methods :Monte Carlo Prediction, Monte Carlo Estimation of Action Values ,Monte Carlo Control, Monte Carlo Control without Exploring Starts .Off policy Prediction via Importance Sampling, Incremental Implementation , off-policy Monte Carlo Control, Discounting-aware Importance Sampling, Per-decision Importance Sampling.

3. Temporal-Difference Learning: TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0) , Sarsa: On-policy TD Control Q-learning: Off policy TD Control ,Expected Sarsa ,Maximization Bias and Double Learning, Games, Afterstates, and Other Special Cases
n-step Bootstrapping :n-step TD Prediction, n-step Sarsa, n-step Off policy Learning , Per-decision Methods with Control Variates, off policy Learning Without Importance Sampling, The n-step Tree Backup Algorithm ,A Unifying Algorithm: n-step Q(!) .
Planning and Learning with Tabular Methods : Models and Planning, Dyna: Integrated Planning, Acting, and Learning, When the Model Is Wrong , Prioritized Sweeping, Expected vs. Sample Updates, Trajectory Sampling, Real-time Dynamic Programming, Planning at Decision Time, Heuristic Search, Rollout Algorithms, Monte Carlo Tree Search.

4. Approximate Solution Methods: On-policy Prediction with Approximation, Value-function Approximation, The Prediction Objective, Stochastic-gradient and Semi-gradient Methods, Linear Methods, Feature Construction for Linear Methods , Polynomials, Fourier Basis , Coarse Coding, Tile Coding , Radial Basis Functions, Selecting Step-Size Parameters Manually, Nonlinear Function Approximation: Artificial Neural Networks, Least-Squares TD, Memory-based Function Approximation, Kernel-based Function Approximation, Looking Deeper at On-policy Learning: Interest and Emphasis .

5. On-policy Control with Approximation: Episodic Semi-gradient Control, Semi-gradient n-step Sarsa, Average Reward: A New Problem Setting for Continuing Tasks, Deprecating the Discounted Setting, differential Semi-gradient n-step Sarsa,
Policy Gradient Methods: Policy Approximation and its Advantages, The Policy Gradient Theorem, REINFORCE: Monte Carlo Policy Gradient, REINFORCE with Baseline, Actor–Critic Methods, Policy Gradient for Continuing Problems, Policy Parameterization for Continuous Actions . Text

Book:

- Reinforcement Learning, Richard S. Sutton and Andrew G. Barto, Second Edition, MIT Press, Cambridge.2018
- Neuro Dynamic Programming. Dimitri Bertsikas and John G. Tsitsiklis. Athena Scientific. 1996.

UE19CS577

Digital Video Perception and Algorithms (3-2-0-0-4)

Course Objectives:

Through this course, students are expected to

- To achieve a basic understanding of digital video compression

- To understand relevant processing tasks, such as transport issues, video streaming, error detection, recovery, and/or concealment issues.
- To evaluate more advanced or future video compression technologies
- To analyze multimedia application systems that exploit compressed video.

Course outcomes:

The students should be able to

- Implement basic Digital video compression algorithms
- Develop a video compression technology
- Model a multimedia application system

Course contents

1. Video Acquisition and Representation -Spatio Temporal Sampling - Sampling Structure Conversion - Interpolation - Color spaces - Video formats
Motion analysis -2D and 3D Motion Estimation and Compensation - Optical Flow methods - Block based - Point correspondences - Gradient based - Intensity matching - Feature matching - Frequency domain motion estimation - Depth from motion - Structure from stereo - 3D Reconstruction - Motion analysis Applications: Video Summarization, Video Surveillance, Video Watermarking, Video Mosaicing.

2. Video Object Tracking and segmentation- 2D and 3D motion tracking - blob tracking - kernel based -Contour tracking - Feature matching - Filtering - mosaicing - Video Segmentation - Mean Shift based - Active shape model - Video shot boundary detection.

3. Video Filtering: Motion Compensation - Noise Filtering - Enhancement and Restoration - Video Stabilization and Super Resolution.

4. Video coding, representation -Video Standards: MPEG 1, 2, MPEG-4, MPEG-7, H.261, H.263, H.264. Video compression - Interframe Compression - 3D Waveform based - Motion Compensation.

5. Content based Video retrieval -Object based coding - Content based representation - Feature extraction - MPEG 7 Visual descriptors - Low to high level representation (CSS, Poly, B-Splines etc.) - Video Indexing and retrieval - search engines. Video based Rendering -Generation of mosaics from video; Detection of Video object alpha-matte and Video cut & paste for Virtual Reality applications.

Reference Books:

- The Essential Guide to video processing-Al Bovik (Alan C Bovik), Academic Press,2009
- Handbook of Image and Video processing - Al Bovik (Alan C Bovik), Academic Press, Second Edition, 2005.
- Digital Image Sequence Processing, Compression, and Analysis - Todd R. Reed, CRC Press, 2004.
- H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia- Iain E.G. Richardson, Wiley, 2003.
- Digital Video Processing - A. Murat Tekalp, Prentice Hall, 1995.
- Image and video compression fundamentals, techniques, and applications, Madhuri a. Joshi et. al, CRC Press, 2015 .

UE19CS578

Cyber Forensics (3-2-0-0-4)

Course Objectives:

The objective of the course is to

- Provide a deep understanding of security issues, digital forensics & incident response.
- Enhance knowledge and experience of various digital forensics techniques and incident response

Course Outcomes:

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

- Understanding of various digital forensics techniques and its usage for the potential countermeasures or incident response.
- Demonstrate a critical evaluation and use of digital forensics technique to do incident response with an independent project.

1. Forensics Overview: Computer Forensics Fundamentals, Benefits of Computer Forensics, Computer Crimes, Computer Forensics Evidence and the Courts, Legal Concerns and Privacy Issues, Digital Forensics Fundamentals: Introduction to Incident response, digital forensics four-step procedure, Digital forensics: Introduction – Evidential potential of digital devices: closed vs. open systems, evaluating digital evidence potential, Concepts: computer/network/Internet forensic and anti-forensics, Digital Investigation, Data Acquisition and Information Gathering.

2. Forensic Examination of Systems: Unix/Linux fundamentals: Unix/Linux incident response tools, Unix/Linux file systems (Ext2/Ext3), Unix/Linux Forensic Investigation: Unix/Linux forensics investigation steps and technologies, Unix/Linux forensics case studies, Windows Incident Response.

3. Acquisition and Duplication: Sterilizing Evidence Media, Acquiring Forensics Images, Acquiring Live Volatile Data, Data Analysis, Metadata Extraction, File System Analysis, Performing Searches, Recovering Deleted, Encrypted, and Hidden files, Internet Forensics, Reconstructing Past Internet Activities and Events, E-mail Analysis, Messenger Analysis: AOL, Yahoo, MSN, and Chats, Forensic Examination of Network Devices- Device handling: seizure issues, device identification, networked devices and contamination.

4. Mobile Device Forensics: Evidence in Cell Phone, PDA, iPod, and MP3, Evidence in DVD, USB, Flash Memory, Digital Camera, Forensic procedures- files present in SIM card, device data, external memory dump, evidences in memory card, operators systems, Mobile OS: Android forensics: Procedures for handling an android device, imaging android USB mass storage devices, logical and physical techniques, Vulnerabilities in IOT devices, Cloud storage forensics.

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

Reference Books:

1. Nelson, Phillips, Enfinger, Steuart, “Computer Forensics and Investigations”, Cengage Learning, India Edition, 2008.
2. Gregory Kipper, “Wireless Crime and Forensic Investigation”, Auerbach Publications, 2007
3. Iosif I. Androulidakis, “ Mobile phone security and forensics: A practical approach”, Springer publications, 2012
4. Andrew Hoog, “ Android Forensics: Investigation, Analysis and Mobile Security for Google Android”, Elsevier publications, 2011

Angus M.Marshall, “ Digital forensics: Digital evidence in criminal investigation”, John

UE19CS579

SOFTWARE SECURITY

Course Objectives:

The objective(s) of this course is to,

- Learn the challenges and pitfalls of Software Development and Secure Programming, across the Web, Mobile Devices and IoT.
- Learn the possible attacks and available remedies.
- Learn about security design and testing best practices.

Course Outcomes:

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

- Understand the security limitations of commonly used Operating Systems, Browsers and Mobile Operating Systems.
- Understand the security limitations of popular programming languages.
- Understand the common security pitfalls in various application development approaches, platforms and how to avoid them.
- Learn how to use some common security testing strategies and Penetration Testing.

Course Content:

1. Introduction: Software Threats and Vulnerabilities, OWASP Top 10, SANS Top 25, CVE, etc. Various Type of Attacks like Brute-Force Attacks, DDOS, Phishing, Credentials Misuse, Malware, etc. Significance/ Importance of Secure Coding, Secure Coding Terminology, Secure Coding Principles, Threat Modeling, Secure Coding Resources (Both online and offline).

2. Secure Software Development and Programming: Common Operating Systems and Their Security Limitations, Common Programming Languages and Their Security Limitations, Secure Application Development, Database Security, Ransomware, Virus, Malicious Code, Testing and Prevention, Best Practices in C++ Catastrophe, Calls to Delete, Constructors, Lack of Reinitialization, Ignorance of STL, Pointer Initialization, Testing Techniques and Defensive Measures. Failure to Handle Errors Correctly, Yielding Too Much Information, Ignoring and Misinterpreting Errors, Using Useless Return Values, Using Non-Error Return Values. Secure Boot, Measured Boot and Root of Trust, Security

threats from peripherals, e.g., DMA, IOMMU. Vulnerabilities and Exploits like Buffer Overflows, Insecure Direct Object References, Sensitive Data Exposure.

3. Web Application Security Issues: Challenges, Browser Security, SQL Injection, Cross-Site Scripting, Cross-Site Request Forgery, Session, Hijacking, TLS Stripping, Cross-Site Scripting (XSS), Broken Authentication and Session Management. HTTP Security, HSTS (HTTP Strick Transport Security), HPKP (HTTP Protocol Key Pining), XFrame-Options, X-XSS-Protection, X-Content-Type-options, CORS (Cross Origin Resource Sharing), HTTP/ 2 and Security Challenges, HTTP Security Considerations , Privacy Issues and HTTP Authentication. Executing Code with Too Much Privilege, Use of Weak Password Based Systems, Retrieval of Forgotten Passwords, Default Passwords and Replay Attacks, Storing Passwords and Alternatives, Brute-Force Attacks Against Password Verifiers.

4. Mobile Application Security - Android and iOS Security, App Security, Secure Boot, Data Exfiltration, Cloud and IoT Application Security.

5. Countermeasures - Tools, Frameworks, and Services: Secure Coding Standards, Secure Coding Best Practices/ Patterns, Intercepting Validators, Sanitization, Session Management, Authentication, Encryption, Password Management, Access Control, Error Handling and Logging, File Management, Memory Management, Microsoft Secure Development Process (SDP), Static Analysis Tools, Dynamic Analysis Tools, Web Application Security Frameworks, Java- Based Enterprise Application Security Frameworks, Outsourcing, Vulnerability Tracking.

Reference Book(s):

1. “Computer Security – Principles and Practice”, Third Edition, William Stallings, Chapters 1, 3, 4, 5, 6, 10, 11, 12, 13, 18, 19, 25, 26.

UE19CS581

TOPICS IN STORAGE AREA NETWORKS (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Introduce students to the current storage technologies.
- Equip students for better appreciation of SAN technology, its advantages, complexities and an idea as to which situations it can be gainfully utilized, its Architecture
- Related technologies like RAID, Virtualization, Network Attached Storage, IP Storage are discussed.
- Expose the Management aspects of SAN/NAS and also address key considerations like Backup, Security.

Course Outcomes:

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

- Analyze logical and physical components of a storage infrastructure.
- Design different types of RAID implementations and their benefits.
- Design Fiber Channel protocols.
- Analyze benefits of storage virtualization.

- Demonstrate the benefits of deploying a SAN.

Course Content:

1. **Introduction to storage systems, IO techniques and Intelligent Disk Systems:** Structured and Unstructured Data, Data centres, Key requirements of data centres, Storage – Centric IT Architecture and its advantages. The Physical I/O path from the CPU to the Storage System, Introduction to Storage components: Disks, Physical structure of disks, Categorization of disk subsystems. Architecture of a disk subsystem, Internal I/O channels and their design variations, RAID levels, Availability of Disk Systems

2. **Storage protocols - SCSI, FC, iSCSI:** SCSI Basics, Components, Addressing, Protocol and Functioning, Fiber Channel: FC Basics, FC Protocol Stack. Network Attached Storage: The NAS Architecture, The NAS hardware and Software Architecture.iSCSI

3. **Distributed Storage Systems -** SAN, SAN / NAS convergence, IP Storage, SAN Architecture and Hardware devices**:** Overview, Creating a Network for storage; SAN Hardware Devices. The fibre channel switch; Host Bus Adaptors. Software Components of SAN: The switch's Operating system.

4. **Storage Virtualization and Management:** Storage Virtualization - Definition of Storage virtualization; Implementation Considerations; Storage virtualization on Block or file level. Storage Management, In-band, Out-band, CIM, WEBEM, SMI-S

5. **Storage Security and Applications:** Security considerations: Information Security, Security Methods, Storage Security Technologies, Storage Security Challenges, Fibre Channel SAN Security, NAS Security, Best Practices in Security and others. Storage Applications: Backup, Recovery and Archival.

Reference Books:

1. "Storage Networks Explained", Ulf Troppens, Rainer Erkens and Wolfgang Muller, Wiley India, 2013.
2. "Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems", Marc Farley, Cisco Press, 2005.
3. "Storage Networks The Complete Reference", Robert Spalding, Tata McGraw-Hill, 2011.
4. "Storage Area Network Essentials A Complete Guide to Understanding and Implementing SANs", Richard Barker and Paul Massiglia, Wiley India, 2006.

UE19CS582

DATA ACQUISITION AND VISUALIZATION (3-2-0-0-4)

Course Objectives:

The objective(s) of the course is to

- Imparts an understanding of the challenges in data acquisition.
- Introduces collection of data from different sources.

- Introduces the need for and the need for data visualization in a Big data Environment.
- The course covers various factors influencing visualization design.
- Introduces tools and expects students to build an end-to-end solution.

Course Outcomes:

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

- Demonstrate various means of acquiring data from the environment.
- Choose amongst various visualization techniques on the most appropriate technique for solving a visualization problem.
- Demonstrate visualization of data using standard visualization techniques.
- Demonstrate use of tools.
- Develop an end-to-end acquisition and visualization solution.

Course Content:

1. **Context of Data Visualization:** Understanding the importance of visualization as a discovery tool,bedrock of visualization knowledge, defining data visualization, visualization skills for the masses, the data visualization methodology, visualization design objectives. Identifying Key Factors of visualization, eight hats of data visualization design.

2. **Taxonomy of data visualization methods**: (with implementation and examples for a few important methods using JavaScript, R, D3.js or Processing along with acquisition of Data from the web).

3. **Comparison of Categories**: Dot Plots, Bar Charts, Floating bar (or Gantt chart), Pixelated bar chart, Histogram, Slope graph (or bumps chart or table chart), Radial chart, Glyph chart, Sankey diagram, Area size chart, Small multiples (or trellis chart), Word cloud.

4. **Assessing Part whole relationships**: Pie chart, Stacked bar chart (or stacked column chart),Square pie (or unit chart or waffle chart) , Tree map , Circle packing diagram, Bubble hierarchy, Tree hierarchy. **Showing Change over time**: Line chart , Spark lines, Area chart, Horizon chart, Stacked area chart , Stream graph, Candlestick chart (or box and whiskers plot, OHLC chart) , Barcode chart , Flow map.

5. **Plotting connections and relationships**: Scatter plot, Bubble plot, Scatter plot matrix, Heat map (or matrix chart), Parallel sets (or parallel coordinates) , Radial network (or chord diagram) , Network diagram (or force-directed/node-link network), **Mapping geo-spatial data**: Choropleth map, Dot plot map, Bubble plot map, Isarithmic map (or contour map or topological map), Particle flow map , Cartogram, Dorling cartogram, Network connection map.

Reference Books:

1. “Data Visualization”: A Successful Design Process, Kirk, Andy, Packt Publishing Ltd, 2012.
2. “Interactive Data visualization for the Web“, Murray, Scott, O’Reilly Media, Inc., 2013.
3. Visualizing Data: Exploring and Explaining Data With The Processing Environment, Fry, Ben, O'Reilly Media, Inc., 2007.

4. Big Data Visualization, James D Miller, 2017

UE19CS583

Deep Learning Theory and Practices (3-2-0-0-4)

Course Objectives:

Through this course, students are expected to
- To achieve a basic understanding of deep learning
- To understand landscape of deep learning optimization and generalization
- To evaluate the deep learning architectures

Course outcomes:

The students should be able to
- Implement basic deep learning architectures like CNN,RNN etc
- Model a deep learning application

1. Introduction Historical Trends in Deep Learning **Deep Feed forward Networks** Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms, Historical Notes.
Regularization for Deep Learning : Parameter Norm Penalties , Norm Penalties as Constrained Optimization , Regularization and Under-Constrained Problems, Dataset Augmentation , Noise Robustness , Semi-Supervised Learning , Multi-Task Learning , Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout dversarial Training , Tangent Distance, Tangent Prop, and Manifold Tangent Classifier.

2. Convolutional Networks
The Convolution Operation , Motivation, Pooling , Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function , Structured Outputs , Data Types , Efficient Convolution Algorithms, Random or Unsupervised Features , The Neuroscientific Basis for Convolutional Networks , Convolutional Networks and the History of Deep Learning

3. Sequence Modeling: Recurrent and Recursive Nets
Unfolding Computational Graphs , Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures , Deep Recurrent Networks, Recursive Neural Networks ., The Challenge of Long-Term Dependencies, Echo State Networks , Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies , Explicit Memory .

4. Autoencoders: Undercomplete Autoencoders, Regularized Autoencoders, Representational Power, Layer Size and Depth, Stochastic Encoders and Decoders, Denoising Autoencoders, Learning Manifolds with Autoencoders, Contractive Autoencoders, Predictive Sparse Decomposition, Applications of Autoencoders

5. Practical Methodology: Performance Metrics , Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters , Debugging Strategies , Example: Multi-Digit Number Recognition.

Applications : Large Scale Deep Learning, Computer Vision , Speech Recognition , Natural Language Processing, Other Application.

Reference Books:

- Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville http://www.deeplearningbook.org/
- Fundamentals of Deep Learning:Designing Next-Generation Machine Intelligence Algorithms,Nikhil Buduma,O'Reilly Publications, 2016 edition.

UE19CS584

SOFT COMPUTING (3-2-0-0-4)

Course objectives:

This course will enable students to

- Explain key aspects of soft computing.
- Identify the components and building block hypothesis of Genetic algorithm.
- Analyze Neuro Fuzzy modeling and control.
- Evaluate machine learning through Support vector machines.

Course Outcomes

The students should be able to:

- Implement machine learning through neural networks.
- Design Genetic Algorithm to solve the optimization problem.
- Develop a Fuzzy expert system.
- Model Neuro Fuzzy system for clustering and classification.

1. Introduction to Soft computing: Neural networks, Fuzzy logic, Genetic algorithms, Hybrid systems and its applications. Fundamental concept of ANN, Evolution, basic Model of ANN, Terminologies used in ANN, MP model, Hebb model.

2. **Perceptron Network:** Adaptive linear neuron, Multiple adaptive linear neurons, Back propagation Network (Theory, Architecture, Algorithm for training, learning factors, testing and applications of all the above NN models).

3. **Introduction to Fuzzy Logic:** Fuzzy sets vs. Classical sets, Fuzzy relations and operations, Membership functions, Linguistic Modifiers and their fuzzy interpretations.

4. **Fuzzy Logic Applications**: Fuzzy Inference System , Fuzzy controllers, Neuro-Fuzzy Systems, Fuzzy Genetic Algorithms, Intuitionist Fuzzy Sets.

5. Genetic algorithms: Introduction, Basic operations, Traditional algorithms, Simple GA General genetic algorithms, The schema theorem, Genetic programming, applications.

Text Books:

1. Principles of Soft computing, Shivanandam, Deepa S. N, Wiley India, ISBN 13: 788126527410, 2011

Reference Books:

1. Introduction to Soft Computing Neuro-fuzzy and Genetic Algorithms by Samir Roy and Udit Chakraborthy (Pearson Publication) ,2013,first edition
2. Neuro-fuzzy and soft computing, J.S.R. JANG, C.T. SUN, E. MIZUTANI, Phi (EEE edition), 2012.

UE19CS585

Cyber Policies, Standards and Laws

Course Objectives:

The objective of the course is to

- Provide a overview of policies and standards followed for security
- Enhance knowledge about the rules, regulations and laws which are essential for every individual in the cyber world

Course Outcomes:

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

- Understand the seriousness of the vulnerabilities in cyber space
- Be aware of various cyber crimes and their legal perspectives
- Understand the human rights and Intellectual Property Rights

1. Introduction to Policies and Standards: Computers and its Impact in Society, Overview of Computer and Web Technology, Security Standards: Introduction to Security Policies and Standards: Need, Methods, Various Standards: ISO 27001, HIPA, Vertical, Security Framework Standards: ISO Standards-all, Security Mechanism Standards: Encryption, Digital Signatures, Techniques, Algorithm, Security Protocol Standards: Entity authentication protocol, Key establishment, Time stamping.

2. Cyber Law worldwide: Need for Cyber Law, Cyber Jurisprudence at International and Indian Level, Cyber Law - International Perspectives UN & International Telecommunication Union (ITU) Initiatives Council of Europe - Budapest Convention on Cybercrime, Asia-Pacific Economic Cooperation (APEC), Organization for Economic Co-operation and Development (OECD), World Bank, Commonwealth of Nations, International Treaties, Conventions and Protocols concerning cyberspace: Guidelines issued by various ministries, Alternative Dispute Resolution, Online Dispute Resolution

3. Cyber Space and Indian laws: Information Technology Amendment Act 2008-I: In Introduction: Criminal Law & Constitutional Law in brief, Information Technology Amendment Act 2008-II: Limitations, Cyberspace and IPR: Search engines, Web crawling, Indexing, searching, Ranking of web pages, Spamdexing, Cyber Torts Cyber Defamation, Different Types of Civil Wrongs under the IT Act, 2000, Electronic Evidence, Indian Context of Jurisdiction and IT Act, 2000. ,International Law and Jurisdictional Issues in Cyberspace.

4. Cyber Crimes & Legal Framework: Introduction to Computer Crimes, Conventional Crimes through Computer, Crimes and Torts committed on a Computer Network, Crimes relating to Data Alteration/ Destruction/ Theft of source code and Database: Online Dispute Resolution, theft of source code; a case study, Cyber Crimes against Individuals, Institution and State, Hacking, Digital Forgery, Cyber Stalking/Harassment, Cyber Pornography, Identity Theft, & Fraud Cyber terrorism, Cyber Defamation, Different offences under IT Act, 2000.

5. Constitutional & Human Rights: Issues in Cyberspace Freedom of Speech and Expression in Cyberspace, Right to Access Cyberspace – Access to Internet, Right to Privacy, Right to Data Protection, Intellectual Property Issues in Cyber Space Interface with Copyright Law, Interface with Patent Law, Trademarks & Domain Names Related issues

Reference Books

1. Chris Reed & John Angel, Computer Law, OUP, New York, (2007).
2. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012
3. Sudhir Naib, The Information Technology Act, 2005: A Handbook, OUP, New York,(2011)
4. S. R. Bhansali, Information Technology Act, 2000, University Book House Pvt. Ltd