M.SC. AI 1st Semester

PYTHON PROGRAMMING & AI LAB

Course Details			
Course Title: Python PROGRAMMING & AI LAB			
Course Code:	CAI81DC00104	**Credits**	4
L + T + P	3 +0+1	**Course Duration**	One Semester
Semester	I	**Contact Hours**	45 (L) + 30 (L) Hours
Course Type	Discipline-Based Core Elective	**Nature of the Course**	Skill Based
Methods of Content Interaction	Lectures, Programming, Assignments, Class Tests, Mini Project and viva		
Assessment and Evaluation	• 50% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 50% - End Term External Examination (University Examination)		

Course Prerequisites: Knowledge of at least one of the programming languages

Course Objectives

- To introduce students about characteristics and advantages of Python
- To introduce them with data types, variables, operators, decision making and looping structures
- To introduce them with the details of inbuilt data structures supported by Python such as array, list, dictionary etc.
- To introduce students with user-defined functions and the concept of modules and packages in Python.
- To introduce students to object-oriented programming concepts in Python with error handling, file handling and I/O.
- To introduce students to the libraries and functions offered by Python for doing scientific computations.
- To make them understand how they can access and update databases in Python.
- To introduce students about some important libraries required for data analysis
- To introduce students about machine learning and libraries
- To understand the AI with practical skills.

Course Learning outcomes

After the course the students:

- would understand the syntax and usages of basic constructs of Python.
- would be able to write programs using decision-making and looping structures.
- would be able to write programs based on object-oriented programming paradigms.

- would be able to connect, access, and update data stored in the database
- would be able to solve data analytics and machine learning problems by employing scientific computing, machine learning libraries and packages in Python.

Course Contents:

UNIT I Python Basics (20% Weightage)

Introduction: History and introduction to Python, features of Python.

Python Data types and control structures: Python Data types, variables, basic operators, expressions, decision-making and loop structures, break, continue and pass statements, strings, arrays, lists, dictionaries, tuples and dates.

Python Functions: Function in Python, local and global variables, passing parameters to functions, return statement library functions, Python modules and packages.

Error Handling: Errors and Exception handling

UNIT-II (15% Weightage)

Input-Output in Python:

Input/ Output in Python, creating files, opening an existing file, reading and writing into a file, file opening modes, closing a file,

UNIT III (10% Weightage)

Object-Oriented Programming: Defining a class in Python, creating an object, initialising an object, defining member function, accessing member function and class data, the *init* method, built-in class attributes, Inheritance, function and operator overloading.

UNIT IV Introduction to Scientific Computation in Python (35% Weightage)

Introduction to NumPy, Pandas, Scikit-Learn and Matplotlib, NetworkX library

UNIT V: Logic Programming: Prolog (20% Weightage)

Introduction to Prolog, comparison with procedural Languages, Instantiation, Monkey banana problem using Prolog, Lists in Prolog- Membership, Concatenation, Add, Delete, Sub lists in Prolog, Permutation in List, Arithmetic Operators, Logical Operators, Sequence of Control in Prolog

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-1	History and introduction to Python, features of Python.
2-2	Python Data types, variables, basic operators, expressions
3-4	decision making and loop structures, break, continue and pass statements
4-5	strings, arrays, list, dictionary, tuples and dates
6-7	Function in Python, local and global variables, passing parameters to functions, return statement library functions, Python modules and packages
8-8	Errors and Exception handling
9-11	Input/ Output in Python, creating files, opening an existing file, reading and writing into a file, file opening modes, closing a file
12-15	Defining a class in Python, creating an object, initializing an object, defining member function, accessing member function and class data, the *init* method
16-17	built-in class attributes, Inheritance, function and operator overloading
18-20	Connecting with database, retrieving records from database using a select query, processing records retrieved from a database
21-23	modifying database using insert, delete and update queries, and closing the connection with a database.
24-26	Introduction to NumPy
27-29	Pandas
30-33	Scikit-Learn and Matplotlib
34-36	NetworkX library
37-45	Logic Programming: Prolog
30 Hours	Programming Lab

Essential Readings:

1. Python: The Complete Reference, Martin C. Brown, 4th edition, McGraw Hill Education, ISBN-10: 9789387572942

2. Python Cookbook, Third edition 3rd Edition, O'Reilly Media, ISBN-13: 978-1449340377
3. Learning Python, 5th Edition by Mark Lutz O'Reilly Media ISBN-13: 978-1449355739.
4. Python Documentation: https://www.Python.org/
5. Scikit-learn Machine Learning in Python, https://scikit-learn.org/stable
6. Pandas' documentation, https://pandas.pydata.org/docs
7. Matplotlib: Visualization with Python, https://matplotlib.org
8. NetworkX, Network Analysis in Python, https://networkx.org
9. NumPy documentation, https://numpy.org/doc/stable
10. E. Rich and K. Knight, Artificial Intelligence, Tata McGraw Hill.
11. S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Pearson Education.
12. N.J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann.

Suggesting Reading:

1. Python 3 Object-oriented Programming - Second Edition: Packt Publishing ISBN-13: 978-1784398781
2. Python for Everybody: Exploring Data in Python 3, Dr. Charles Russell Severance, CreateSpace Independent Publishing Platform, ISBN-10: 1530051126
3. Programming Python, 4th Edition by Mark Lutz O'Reilly Media, ISBN: 978-0-596-15810-1.
4. Python in a Nutshell, Second Edition by Alex Martelli, O'Reilly Media, ISBN-13: 978-0596100469.

ARTIFICIAL INTELLIGENCE

Course Details			
Course Title: ARTIFICIAL INTELLIGENCE			
Course Code	CAI81DC00204	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	I	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline based Core Course		
Nature of Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students,		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To understand basics to modern paradigm of Artificial Intelligence
- To understand how to set computational goals an achieving strategies.
- To go beyond the traditional learning and cover the advanced.
- To understand the AI with practical skills.

Course Learning Outcomes

After completion of the course the learners will be able to:

- Understand the meaning of intelligence and its association with computers
- Understand various search methods.
- Problem solving with search methods.
- Understand the modern concepts of AI.
- Design and develop the AI as per modern requirement.

Course Contents

UNIT I: Introduction to AI: (20% Weightage)

Introduction to AI, Meaning of intelligence, Definitions: Turing Test Approach, Cognitive modeling Approach, law of thought approach, Rational Agent Approach; Goals of AI, AI Approaches, AI Techniques, Branches of AI, Applications of AI, Discussion on some problems: Water Jug problem, Crypto arithmetic problem, Missionary Cannibal problem and other similar problems.

UNIT II: Intelligent Agents: (5% Weightage)

Meaning of Agent, Vacuum cleaner world problem, Agent Program, Agent function, Performance Measure, Nature of Environment, Structure of Agents

UNIT III: Problem-Solving by Uninformed Searching: (20% Weightage)

AI Problem Solving: Meaning of State Space, Problem-solving as state space search, production system, control strategies and problem characteristics; Search techniques: Breadth

First and Depth-first, Depth Limited Search, Iterative deepening depth-first search, Comparing Uninformed search strategies, Working with examples.

UNIT IV: Problem-Solving by Informed Searching: (25% Weightage)

Hill-climbing, Notion of Heuristics, Manhattan Distance as heuristics, Application of Heuristics for TSP, Branch and Bound Technique, Best-First Search, A* algorithm, Iterative Deepening A* Algorithm, Problem reduction and AO* algorithm

Game Playing: Overview, Zero Sum Game Trees, Mini-Max search procedure, Game playing with Mini-Max, Alpha-Beta pruning.

UNIT V: Fundamentals: Learning and Expert System (15%Weightage)
Learning: What is learning, Learning from example: Induction, Explanation Based Learning (EBL), Discovery, Clustering, Analogy, Supervised, Unsupervised, Reinforcement learning.
Expert System: Introduction, Knowledge acquisition, Knowledge base, Working memory, Inference engine, Expert system shells, Explanation, Application of expert systems.

UNIT IV: Planning: (15% Weightage)
Introduction, Differentiating Planning with Search Problem, Representation of Planning Problem, Situation Calculus, Planning Algorithms: Partial Order Planning, Graph Plan, SATPlan

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-3	Introduction to AI, Meaning of intelligence, Definitions: Turing Test Approach, Cognitive modelling Approach, the law of thought approach, Rational Agent Approach;
4-5	Goals of AI, AI Approaches, AI Techniques, Branches of AI, Applications of AI.
6-10	Discussion on some problems: Water Jug problem, Crypto arithmetic problem, Missionary Cannibal problem and other similar problems.
11-13	Meaning of Agent, Vacuum cleaner world problem, Agent Program
14-15	Agent function, Performance Measure, Nature of Environment, Structure of Agents
16-17	AI Problem Solving: Meaning of State Space, Problem-solving as state space search, production system, control strategies and problem characteristics
18-23	Search techniques: Breadth First and Depth-first, Depth Limited Search, Iterative deepening depth-first search
24-25	Comparing Uninformed search strategies, Working with examples.
26-28	Hill-climbing, Notion of Heuristics, Manhattan Distance as heuristics, Application of Heuristics for TSP

29-32	Branch and Bound Technique, Best-First Search, A* algorithm, Iterative Deepening A* Algorithm, Problem reduction and AO* algorithm
33-35	Game Playing: Overview, Zero Sum Game Trees, Mini-Max search procedure, Game playing with Mini-Max, Alpha-Beta pruning.
36-37	**Learning:** What is learning, Learning from example: Induction, Explanation Based Learning (EBL), Discovery, Clustering, Analogy, Supervised, Unsupervised, Reinforcement learning.
38-40	**Expert System:** Introduction, Knowledge acquisition, Knowledge base, Working memory, Inference engine, Expert system shells, Explanation, Application of expert systems.
41-43	Introduction, Differentiating Planning with Search Problem, Representation of Planning Problem, Situation Calculus
44-45	Planning Algorithms: Partial Order Planning, Graph Plan, SATPlan
15 Hours	*Tutorials*

Essential Readings:

- E. Rich and K. Knight, Artificial Intelligence, Tata McGraw Hill.
- S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Pearson Education.
- N.J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan Kaufmann.
- Introduction to Artificial Intelligence by Philip C Jackson

Additional/Advance/Further Readings:

- "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, (2002), Prentice Hall, Chapter 1-27, page 1-1057.
- "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", by George F. Luger, (2002), Addison-Wesley, Chapter 1- 16, pages 1-743.
- "AI: A New Synthesis", by Nils J. Nilsson, (1998), Morgan Kaufmann Inc., Chapter 1-25, Page 1-493.
- "Computational Intelligence: A Logical Approach", by David Poole, Alan Mackworth, and Randy Goebel, (1998), Oxford University Press, Chapter 1-12, pages 1-608.

Mathematical Foundation for AI

Course Details			
Course Title: Mathematical Foundation for AI			
Course Code:	CAI81DC00304	**Credits**	4
L + T + P	3 +1+0	**Course Duration**	One Semester
Semester	I	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline-Based Core Course	**Nature of the Course**	Core

Methods of Content Interaction	Lectures, Programming, Assignments, Class Tests, Mini Project and viva
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)

Course Prerequisites:
Course Objectives

- To provide the mathematical foundations for the optimization and data manipulation algorithms
- To develop the understanding towards the mathematical Logic
- To understand the statistical and mathematical tools.

Course learning outcomes
After the course the students:

- will be able to understand matrix operations
- will be able to understand logic and perform logic programming
- will have knowledge of statistical inference

Course Contents:

UNIT I Logic and Inference Rules [25% Weightage]
Introduction to Logic, Types of Logic, Propositional Logic, Inference Rules- Modes Ponens, Unit Resolution, Resolution, Automated Reasoning, Horn Sentences, Satisfibility,

First Order Logic, Quantifiers, Definition, Examples, Russel's Paradox

Universal Elimination, Existential Elimination, Existential Introduction, Substitution, Unification, Generalized Modes Ponens, Introduction to Horn Logic, Completeness and decidability issues, Godel's Completeness Theorem, Validity Problem of First Order Logic, Resolution with substitution, Conversion to Normal Form, Resolution Refutation Proofs, Forward chaining and Backward Chaining

UNIT II: Theory of Probability [25% Weightage]
Axioms of Probability, Conditional Probability, Baye's Rule, Random variables: Discrete and Continuous random variables, Probability mass, density, and cumulative distribution functions, Mathematical Expectation, Variance, Standard Deviation, Moments, Moment generating function, Binomial, Poisson and Normal Distributions.

UNIT II: Descriptive Statistics [25% Weightage]
Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample.
Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.

Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes;
Measures of Central Tendency: mathematical and positional.
Measures of Dispersion: range, quartile deviation, mean deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, corrections;
Bivariate data: Definition, scatter diagram, correlation, rank correlation. Simple linear regression, principle of least squares and fitting of polynomials

UNIT III: Matrices [25% Weightage]

Linear and Orthogonal Transformations, Linear independence and dependence of vectors, Characteristics equation, Eigen values and Eigen vectors, Statement and Verification of Cayley-Hamilton Theorem [statement Only], Reduction to Diagonal form, Reduction of Quadratic form to Canonical form by Orthogonal Transformation

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-4	Introduction to Logic, Types of Logic, Propositional Logic, Inference Rules- Modes Ponens, Unit Resolution, Resolution, Automated Reasoning, Horn Sentences, Satisfibility,
5-6	First Order Logic, Quantifiers, Definition, Examples, Russel's Paradox
7-9	Universal Elimination, Existential Elimination, Existential Introduction, Substitution, Unification, Generalized Modes Ponens, Introduction to Horn Logic
10-14	Completeness and decidability issues, Godel's Completeness Theorem, Validity Problem of First Order Logic, Resolution with substitution, Conversion to Normal Form, Resolution Refutation Proofs, Forward chaining and Backward Chaining
15-16	Axioms of Probability, Conditional Probability, Baye's Rule,
17-19	Random variables: Discrete and Continuous random variables, Probability mass, density, and cumulative distribution functions,
20-25	Mathematical Expectation, Variance, Standard Deviation, Moments, Moment generating function, Binomial, Poisson and Normal Distributions.
26-29	Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio.
30-33	Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes;
34-37	Measures of Central Tendency: mathematical and positional.Measures of Dispersion: range, quartile deviation, mean deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, corrections; Bivariate data: Definition, scatter diagram,

	correlation, rank correlation. Simple linear regression, principle of least squares and fitting of polynomials
38-40	Linear and Orthogonal Transformations, Linear dependence of vectors, Characteristics equation,
41-43	Eigen values and Eigen vectors, Statement and Verification of Cayley-Hamilton Theorem,
44-45	Reduction to Diagonal form, Reduction of Quadratic form to Canonical form by Orthogonal Transformation
15 Hours	Tutorial

Essential Readings:

1. An Introduction to Probability and Mathematical Statistics, V.K. Rohatgi,Wiley Eastern
2. Discrete Mathematical Structures with Applications to Computer Science, J.P. Trembley and R.P.Manohar McGraw Hill
3. Discrete Mathematics, R. Johnsonbaugh, Pearson Education
4. Higher Engineering Mathematics by B.S. Grewal, 40th Edition, Khanna Publication
5. Advanced Engineering Mathematics by Erwin Kreysizig, 8th Edition, Wiley India
6. Applied Mathematics for Engineers & Physicist by L.R. Pipes and Harville
7. Theory & Problems of Probability and Statistics by M.R. Spiegal ,Schaum Series, McGraw Hills.

Suggestive Readings:

1. Introduction to Probability and its Applications, W. Feller ,Wiley Eastern
2. Artificial Intelligence: A Modern Approach, S. Russell, P. Norvig, Pearson Education.
3. Artificial Intelligence: A New Synthesis, N.J. Nilsson, Morgan Kaufmann.
4. Foundation Mathematics for Computer Science, John Vince, Springer.
5. Probability and Statistics with Reliability, Queuing, and Computer Science Applications. K. Trivedi, Wiley.
6. Applied Combinatorics, Alan Tucker, Wiley

HUMAN VALUES AND PROFESSIONAL ETHICS

Course Details			
Course Title: HUMAN VALUES AND PROFESSIONAL ETHICS			
Course Code		**Credits**	2
L + T + P	2 + 0 + 0	**Course Duration**	One Semester
Semester	I	**Contact Hours**	30 (L)
Course Type	Discipline Based Core Course		
Nature of Course	Theory		
Special Nature of Course	Value Based		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students.		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

- To acquaint the students with foundational knowledge of ethics, human values and moral values.
- To develop in a sense of responsibility as an individual to nature and society.
- To develop holistic perspective among students.
- To develop ethical and professional conduct.

Course Learning Outcomes

After completion of the course the learners will be able to:

- Students will develop ability in itself for self-exploration.
- Incorporate technical education with human values.

- Students will be able do verification on basis of natural acceptance and experimental validation.
- Students will be able do understand harmony between different components.
- Students will be able do understand ethical professional behaviour.

Course Contents:

UNIT I: Fundamentals: (30% Weightage)

Value Education: Definition, Need, Understanding value education, Self-exploration, continuous happiness and prosperity, Understanding human being as coexistence of self and body

UNIT II: Harmony (40% Weightage)

Harmony in Self (I) - understanding self, harmony in body, harmony in family – understanding values in human relationship, harmony in society – concept of world family, harmony in nature- mutual fulfilment, harmony in existence.

UNIT III: Ethics and Professionalism (30% Weightage)

Basis for values and ethical conduct, ethics in light of right understanding, vision of holistic technologies, production and management, concept of holistic alternative.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-4	Value Education: Definition, Need, Understanding value education
5-9	continuous happiness and prosperity, Understanding human being as coexistence of self and body
10-15	Harmony in Self (I) - understanding self, harmony in body,
16-19	harmony in nature- mutual fulfilment, harmony in nature – coexistence.
20-21	Basis for values and ethical conduct

21-22	ethics in light of right understanding
23-28	vision of holistic technologies, production and management
28-30	concept of holistic alternative

Essential Reading :

1. R. R. Gaur, R Sanghal, G P Bagaria, 2009, "A Foundation Course in Human Values and Professional Ethics" Excel Books Private Limited, New Delhi

Additional/Advance/Further Readings:

1. R. R. Gaur, R Sanghal, G P Bagaria, 2009, *"Teacher's Manual: A Foundation Course in Human Values and Professional Ethics"* Excel Books Private Limited, New Delhi
2. Sussan George, 1976, "How the Other Half Dies", Penguin Press, Reprinted 1986, 1991
3. A N Tripathy, 2003, "Human Values", New Age International Publisher
4. E G Seebaur & Robert L Berry, 2000, "Fundamental of Ethics for Scientists and Engineers", Oxford University Press

INDIAN KNOWLEDGE SYSTEM IN COMPUTER SCIENCE

Course Details			
Course Title: INDIAN KNOWLEDGE SYSTEM IN COMPUTER SCIENCE			
Course Code:		**Credits**	2
L + T + P	2 +0 +0	**Course Duration**	One Semester
Semester	I	**Contact Hours**	30 (L)
Course Type	Discipline-Based Core	**Nature of the Course**	Indian Knowledge System
Methods of Content Interaction	Lectures, Assignments, Class Tests, Student Presentations, Self-study		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Prerequisites: No prerequisite required

Course Objectives

- To introduce students to the contribution of Indians in the area of Computation
- To introduce them to some eminent Indian scientists and their contribution in the field
- To introduce make students aware about the ecosystem exist in India

Course Learning outcomes

After the course the students:

- Would become familiar with the contribution of India in the domain.
- would know about Indians who have contributed significantly to the domain.
- would become familiar with the research and development ecosystem that exists in India in computer science.

Course Contents:

UNIT 1 Contribution of Indians to Computation (50% Weightage)
Invention of Zero, Decimal and Binary Number System, Fibonacci Series and Golden Ratio and their history, biography of Indians and their contribution to Computer Science

UNIT 2 Ecosystem for Computer Science in India (50% Weightage)
Indian IT industry and its contribution to Computer Science, Introduction to R&D entities in India and their contribution to computer science

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-4	Invention of Zero, Decimal and Binary Number System
5-8	Fibonacci Series and Golden Ratio and their history
9-15	biography of Indians and their contribution to Computer Science
16-22	Indian IT industry and its contribution to Computer Science
22-30	Introduction to R&D entities in India and their contribution to computer science

Suggested Readings:

1. The Aryabhatiya of Aryabhata: An Ancient Indian Work on Mathematics and Astronomy, Walter Eugene Clark, Kessinger Pub Co, ISBN-10 1425485995 :
2. Number Words and Number Symbols: A Cultural History of Numbers, Karl Menninger, Dover Publications, 1992
3. Carl B. Boyer, Uta C. Merzbach Boyer, C. B. History of Mathematics. Wiley; 2nd edition
4. D. Knuth. The Art of Computer Programming. Volume 2, 3rd Ed. Addison–Wesley. pp. 194–213, "Positional Number Systems".
5. Georges Ifrah. The Universal History of Numbers : From Prehistory to the Invention of the Computer, Wiley, 1999. ISBN 0-471-37568-3.
6. Ram, B. (December 2009). Computer Fundamentals, Architecture & Organisation. New Age International

Additional/Advanced/Further Readings:

1. Livio, M. The Golden Ratio: The Story of Phi, the World's Most Astonishing Number. New York: Broadway Books, 2002.
2. A Mathematical History of the Golden Number, Roger Herz-Fischler, Dover Publications; Unabridged edition
3. https://math.temple.edu/~reich/Fib/fibo.html
4. https://fibonacci.com/golden-ratio
5. https://mathworld.wolfram.com/GoldenRatio.html
6. The Divine Proportion: A Study in Mathematical Beauty

7. Bhatkar, V.P. (April 1994). "PARAM parallel supercomputer: architecture, programming environment, and applications". Proceedings of 8th International Parallel Processing Symposium
8. https://www.serc.iisc.ac.in/supercomputer/for-traditional-hpc-simulations-param-pravega

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M.SC. AI 1st Semester-Electives

DISTRIBUTED SYSTEMS

Course Code		**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester		**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		
Methods of Content Interaction	*Lecture, Tutorials, seminar, presentations by students.*		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives:

- To learn and analyze how a set of connected computers can form a functional, usable and high-performance distributed systems.
- To learn the principles, architectures, algorithms and programming models used in distributed systems.
- To examine state-of-the-art distributed File systems.
- To design and implement sample distributed systems.

Course Learning Outcomes:

- Students will identify the core concepts of distributed systems: the way in which several machines orchestrate to correctly solve problems in an efficient, reliable and scalable way.
- Students will examine how existing systems have applied the concepts of distributed systems in designing large systems, and will additionally apply these concepts to develop sample systems.

- Students will learn the core concepts underlying distributed systems designs. They will understand the system constraints, trade-offs and techniques in distributed systems to best serve the computing needs for different types of data and applications.

Prerequisites: **Fundamental of Operating System**

Course Contents:

UNIT I
Fundamentals: Definition, Evolution of distributed Computing System Distributed Computing System Models, Distributed Operating System, Designing a distributed Operating System, Introduction of distributed computing environment.

(12 % Weightage)

UNIT II
Message Passing: Introduction, Desirable features, Issues in IPC by message passing, synchronization, Buffering, Multi datagram messages, encoding and decoding message data.

(18 % Weightage)

UNIT III
Clock Synchronization and Mutual Exclusion : Introduction, Clock synchronization, Mutual exclusion in Distributed systems, Deadlocks, Deadlocks in Distributed systems.

(20 % Weightage)

UNIT IV
Remote Procedure Calls: Introduction, The RPC Model, Transparency of RPC, Implementing RPC mechanism RPC messages server management, parameter-passing and call semantic, Communication protocols for RPC's.

(10 % Weightage)

UNIT V
Distributed Shared Memory: Introduction, Architecture of DSM Systems Design and implementation, granularly, structure of shared memory space Consistency models, replacement strategy, Thrashing.

(10 % Weightage)

UNIT VI
Resource Management: Desirable feature, Task assignment approach, Load-balancing approach, Load-sharing approach.

(12 % Weightage)

UNIT VII
Process Management: Introduction, Process Migration, Threads.

(08 % Weightage)

UNIT VIII

Distributed File Systems: Intakes, Desirable features, File models, File accessing models, file-sharing semantic, File- caching schemes, File replication Fault tolerance, Automatic Transactions, Design principle.

(10 % Weightage)

Content Interaction Plan

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-2	**Fundamentals:** Definition, Evolution of distributed Computing System Distributed Computing System Models, Distributed Operating System,
3-6	Designing a distributed Operating System, Introduction of distributed computing environment.
7 -12	**Message Passing:** Introduction, Desirable features, Issues in IPC by message passing, synchronization, Buffering, Multi datagram messages, encoding and decoding message data.
13-14	**Clock Synchronization and Mutual Exclusion :** Introduction, Clock synchronization, Mutual exclusion in Distributed systems
15-18	Deadlocks, Deadlocks in Distributed systems
19-20	**Remote Procedure Calls:** Introduction, The RPC Model, Transparency of RPC
21-23	Implementing RPC mechanism, RPC messages server management, parameter-passing and call semantic, Communication protocols for RPC's.
24-29	**Distributed Shared Memory:** Introduction, Architecture of DSM Systems Design and implementation, granularly, structure of shared memory space Consistency models, replacement strategy, Thrashing.
30-34	**Resource Management:** Desirable feature, Task assignment approach, Load-balancing approach, Load-sharing approach.
35-39	**Process Management:** Introduction, Process Migration, Threads.
40-45	**Distributed File Systems:** Intakes, Desirable features, File models, File accessing models, file-sharing semantic, File- caching schemes, File replication Fault tolerance, Automatic Transactions, Design principle.
15 Hours	***Tutorials***

Essential Readings:

1. Distributed Operating Systems Concepts and Design – P.K. Sinha (PHI)
2. Distributed Systems concepts and Design – G. Coulouris, J. Dollimore & T. Kindberg
3. Distributed Systems Concepts & Design by George Coulouris, Jean Dollimore & Tim Kindberg
4. Modern Operating Systems – A. S. Tanenbaum (PHI)
5. Modern Operating Systems – Singhal

THEORY OF COMPUTATION

Course Details			
Course Title: THEORY OF COMPUTATION			
Course Code		Credits	4
L + T + P	3 + 1 + 0	Course Duration	One Semester
Semester		Contact Hours	45 (L) + 15 (T) Hours
Course Type	Discipline based Elective		
Nature of Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, self-study, assignments.		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

- Students become familiar to mathematical foundation of computer.
- Students become formal languages and grammar
- Becomes known to the meaning of algorithm and complexity
- Become known to decidability problems.

Course Learning Outcomes:

The student will be able to:

- Understand the meaning of algorithms and complexity.
- Understand the key factors like computability, reducibility, NP problems etc.
- Able to understand models of computation, the formal languages and grammar.
- Understand and design the finite automata, pushdown automata, Turing machine etc.
- Able to determine whether a language belong to proper language family.

Pre-requisites: Discrete Mathematics

Course Contents:

UNIT : I **[20% Weightage]**

Introduction to Automata: Study and Central concepts of automata theory, An informal picture of finite automata, deterministic and non-deterministic finite automata, application of finite automata, finite automata with epsilon transitions, Mealy and Moore machine.

UNIT : II **[20% Weightage]**

Regular Expression and Languages: Chomsky's classification- type 0, type 1, type 3 and type 4 languages, Regular expression, finite automata and regular expressions, applications of regular expressions, algebraic laws of regular expressions

UNIT : III **[20% Weightage]**

Properties of Regular Language: Proving languages not to be regular, closure properties of regular languages, equivalence and minimization of automata.

Context-free Grammars and Languages: Parse trees, Applications of context free grammars, Ambiguity in grammars and languages.

UNIT : IV **[20% Weightage]**

Pushdown Automata: Pushdown automation (PDA), the language of PDA, equivalence of PDA's and CFG's, deterministic pushdown automata

Properties of Context-Free Languages: Normal forms of context free grammars, pumping lemma for context free languages, closure properties of context free languages.

UNIT : V **[20% Weightage]**

Introduction to Turing Machine: The Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine, restricted Turing Machines, Turing machines and Computers, Undecidable Problem about Turing Machine.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**

1-2	Study and Central concepts of automata theory
2-6	An informal picture of finite automata, deterministic and non-deterministic finite automata
6-9	Application of finite automata, finite automata with epsilon transitions, Mealy and Moore machine
10-11	Chomsky's classification- type 0, type 1, type 3 and type 4 languages
12-13	Regular expression
14-18	finite automata and regular expressions, applications of regular expressions, algebraic laws of regular expressions
19-21	Proving languages not to be regular, closure properties of regular languages,
22-24	Equivalence and minimization of automata.
25-27	Parse trees, Applications of context free grammars, Ambiguity in grammars and languages.
28-29	Pushdown automation (PDA), the language of PDA,
30-31	equivalence of PDA's and CFG's, deterministic pushdown automata
32-36	Normal forms of context free grammars, pumping lemma for context free languages, closure properties of context free languages.
37-42	The Turing machine, programming techniques for Turing machine, extensions to the basic Turing machine, restricted Turing Machines,
43-45	Turing machines and Computers, Undecidable Problem about Turing Machine.
15 Hours	*Tutorials*

Essential Readings:

1. Introduction to Automata Theory, Languages, and Computation, by John E. Hopcroft, Rajeev Motwani, and Jeffery D. Ullman, Pearson Education
2. Theory of Computer Science (Automata, Languages and Computation), 2e, K. L. P. Mishra and N. Chandrasekharan, Pearson Education.

Further Readings:

1. Introduction to formal languages, Automata Theory and Computation by Kamla Krithivasan and Rama R, Pearson Education.

DESIGN AND ANALYSIS OF ALGORITHMS

Course Code	CAI81DE00904	**Credits**	4
L + T + P	3 + 1 +0	**Course Duration**	One Semester
Semester	I	**Contact Hours**	45 (L) + 15(T) Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		
Special Nature/ Category of the Course (*if applicable*)	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, individual and group drills, group and individual field based assignments followed by workshops and seminar presentation.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- Ability to analyze a problem and design the appropriate algorithm for the problem.
- This course aims to introduce the classic algorithms in various domains
- The course aims to introduce the techniques for designing efficient algorithms.
- Comparing different algorithms based on efficiency and performance.
- Introduction to some Non Polynomial time solvable computational problems.

Learning Outcomes

After completion of the course the learners will be able to:

- Design algorithms for classical computational problems.
- Compare two different algorithms based on efficiency.
- Choose correct algorithm based on case.
- Differentiate between polynomial and non-polynomial time solvable computational problems.
- Identify the open challenges in computer algorithms.

Course Contents

UNIT I: Introduction and basic concepts (25% Weightage)

Complexity measures, worst-case and average-case complexity functions, problem complexity, quick review of common algorithm design principles.

UNIT II: Searching, Sorting and Hashing (25% Weightage)

Sorting and selection: Finding maximum and minimum, k largest elements in order; Sorting by selection, heap sort methods, lower bound for sorting, other sorting algorithms - radix sort, quick sort, merge sort.

Searching and set manipulation: Searching in static table - binary search, path lengths in binary trees, and applications, Huffman tree, binary search trees, AVL and (a, b) trees.

Hashing: Basic ingredients, analysis of hashing with chaining and with open addressing,

UNIT III: Graph problems (25% Weightage)

Graph searching - BFS, DFS, shortest first search, topological sort; connected and biconnected components; minimum spanning trees - Kruskal's and Prim's algorithms, Single-Source Shortest Path, All-Pairs Shortest Paths. Backtracking: n-Queens Problem.

UNIT IV: Introduction to NP-completeness (25% Weightage)
Informal concepts of deterministic and nondeterministic algorithms, P and NP, NP-completeness, statement of Cook's theorem, some standard NP-complete problems.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-4	Complexity measures, worst-case and average-case complexity functions, problem complexity,
5-7	quick review of common algorithm design principles.
8-12	**Sorting and selection:** Finding maximum and minimum, k largest elements in order; Sorting by selection, heap sort methods, lower bound for sorting.
13-17	Other sorting algorithms - radix sort, quick sort, merge sort
18-22	**Searching and set manipulation:** Searching in static table – binary search, path lengths in binary trees, and applications
23-27	Huffman tree, binary search trees, AVL and (a, b) trees.
28-31	**Hashing:** Basic ingredients, analysis of hashing with chaining and with open addressing,
32-35	Graph searching - BFS, DFS, shortest first search, topological sort; connected and biconnected components;
36-40	Minimum spanning trees - Kruskal's and Prim's algorithms, Single-Source Shortest Path, All-Pairs Shortest Paths. Backtracking: n-Queens Problem.
41-45	Informal concepts of deterministic and nondeterministic algorithms, P and NP, NP-completeness, statement of Cook's theorem, some standard NP-complete problems.
15 Hours	*Tutorials*

Essential Readings:

- T. H. Cormen, C.E. Leiserson and R.L.Rivest: Introduction to Algorithms, Prentice Hall of India, New Delhi, 1998.
- Aho, J. Hopcroft and J. Ullman; The Design and Analysis of Computer Algorithms, A.W.L, International Student Edition, Singapore, 1998.
- S. Baase: Computer Algorithms: Introduction to Design and Analysis, 2nd ed., Addison-Wesley, California, 1988.
- E. Horowitz and S. Sahni: Fundamental of Computer Algorithms, Galgotia Pub./Pitman,New Delhi/London, 1987/1978.
- K. Mehlhorn: Data Structures and Algorithms, Vol. 1 and Vol. 2, Springer-Verlag, Berlin, 1984.
- Borodin and I. Munro: The Computational Complexity of Algebraic and Numeric Problems, American Elsevier, New York, 1975.

M.SC. AI 2nd Semester

MACHINE LEARNING

Course Code	CAI82DC01004	**Credits**	4
L + T + P	3 + 0 +1	**Course Duration**	One Semester
Semester	II	**Contact Hours**	45 (L) + 30 Lab Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, Group discussion; self-study, seminar, presentations by students, assignments.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- This course will serve as a comprehensive introduction to various topics in machine learning.
- Enabling students to solve various real-life problems using machine learning techniques.

Course Learning Outcomes

On completion of the course students will be expected to:

- Have a good knowledge of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
- Have an understanding of issues of many popular machine learning approaches.
- Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
- Be able to design and implement various machine learning algorithms in a range of real-world applications.

Prerequisites: Machine Learning is a mathematical discipline, and students will benefit from a good background in probability, linear algebra and calculus. Programming experience is essential.

Course Contents:

UNIT-I: [30% Weightage]

Basic definitions, Types of Learning, Designing a learning System, Feature extraction, Feature Selection, Linear Regression, Logistic Regression, Decision Tree Representation, Linear Classification

UNIT-II: [25% Weightage]

Support Vector Machines, Artificial Neural Networks, Bayesian Learning and Decision Trees.

UNIT-III: **[25% Weightage]**

Evaluation Measures, Hypothesis Testing, Ensemble Methods, k-means clustering, Gaussian Mixture Modeling, EM-algorithm, Graphical Models

UNIT-IV: **[20% Weightage]**

Learning Theory and Expectation Maximization, Introduction to Reinforcement Learning

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-3	Basic definitions, Types of Learning, Designing a learning System, Feature extraction, Feature Selection
4-8	Linear Regression, Logistic Regression,
9-13	Decision Tree Representation, Linear Classification,
14-17	Support Vector Machines , Artificial Neural Networks
18-23	Bayesian Learning and Decision Trees.
24-26	Evaluation Measures, Hypothesis Testing
27-31	Ensemble Methods
32-36	k-means clustering, Gaussian Mixture Modeling, EM-algorithm,
37-40	Graphical Models
41-45	Learning Theory and Expectation Maximization, Introduction to Reinforcement Learning
30 Hours	*Lab*

Essential Readings:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

Further Readings:

1. "Techniques in Computation Learning"- C.J. Thorton, Chapman & Hall
2. "Machine Learning – An AI Approach" – Michalski, Carbonell, & Mitchell (Eds.)- vol(1,2,3), Morgan Kaufman
3. "Introduction to Machine Learning"- Ethem Alpaydin, MIT Press
4. "Machine Learning" – Tom M. Mitchell, McGraw hill Publication

RESEARCH METHODOLOGY

Course Code	CAI82DC01104	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	II	**Contact Hours**	45 (L) + 15 (T) Hours

Course Type	Discipline Based Core
Nature of the Course	Theory
Methods of Content Interaction	Lecture, Tutorials, self-study, assignments.
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)

Course Objectives

- To develop understanding of the basic framework of research process.
- To develop an understanding of various research techniques and modeling simulation techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of sampling and probability distribution.

Learning Outcomes

- To be able to understand a general definition of research and its design.
- To be able to identify the overall process of designing a research study from its inception to its report.
- To be able to formulate a research hypothesis and test the hypothesis using appropriate testing procedures.
- To be familiar with conducting a literature review and writing a report.
- Students should be able to distinguish between a population and a sample.

Pre-requisites: Basic knowledge of probability

Course Contents:

UNIT I **(15% Weightage)**

Philosophy of science, research ethics, IPR, research design, case study.

UNIT II **(20% Weightage)**

Hypothesis, Sources of Data, fundamentals of data collection methods, sampling and analysis.

UNIT III **(25% Weightage)**

Probability Distribution, Binomial, Poisson, Uniform, Exponential and Normal Distribution, Error Analysis.

UNIT IV **(20% Weightage)**

Steps of Modeling, Applications of Models, Need and Types of Simulation, Simulation Language.

UNIT V **(20% Weightage)**

Structure and components of research report, types of report, layout of research report, mechanism of writing a research report, writing a paper and self-evaluating, performing research reviews.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-4	Philosophy of science, research ethics, IPR, research design, case study.
5-13	Hypothesis, Sources of Data, fundamentals of data collection methods, sampling and analysis.
14-28	Probability Distribution, Binomial, Poisson, Uniform, Exponential and Normal Distribution, Error Analysis..
29-35	Steps of Modelling, Applications of Models, Need and Types of Simulation, Simulation Language.
36-45	Structure and components of research report, types of report, layout of research report, mechanism of writing a research report, writing a paper and self-evaluating, performing research reviews..
15 Hours	*Tutorials*

Essential Readings:

1. R. Panneerselvam, Research Methodology, PHL Learning Private Ltd. New Delhi
2. C.R. Kothari, Research Methodology : Methods and Techniques, 2nd revised edition, New Age International (P) Limited Publishers, New Delhi.

Further Readings:

1. Anderson J., Berry H.D., Poole M., Thesis and assignment writing, Wiley Eastern Limited, New Delhi.
2. Case Study Research: Design and Methods (Applied Social Research Methods) by Robert K. Yin

M.SC. AI 2nd Semester - Electives

COMPUTER GRAPHICS

Course Details			
Course Title: COMPUTER GRAPHICS			
Course Code	CAI82DE01204	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester		**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline based Elective		
Nature of Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, self-study, seminar, presentations by students, assignments.		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

- To learn the basic principles and components of a computer graphics system.
- Provide an understanding of raster scanning techniques for basic geometrical primitives.
- Provide an understanding of two and three dimensional geometric transformations for images/pictures.
- To be able to discuss the application of computer graphics concepts in some of the real applications.

Course Learning Outcomes

- To provide comprehensive introduction about computer graphics system, design algorithms and two dimensional transformations.
- To make the students familiar with techniques of clipping, three dimensional graphics and three dimensional transformations.
- To make the student familiar with multimedia and its applications.

Pre-requisites: Computer Organization

Course Contents:

UNIT I

The origin of computer graphics, Interactive graphics display, new display devices, Points and Lines, DDA, Bresenham's Algorithms, Circles and Ellipse drawing algorithms

UNIT II
Two Dimensional Geometric Transformations: Basic Transformations – Matrix Representations - Composite Transformations. Two Dimensional Viewing: Line Clipping – Polygon Clipping – Curve Clipping – Text Clipping.

UNIT III
Three-Dimensional Concepts - Three Dimensional object Representations - Fractal Geometry Methods – Three Dimensional Geometric and Modeling Transformations: Translation – Rotation – Scaling. Three Dimensional Viewing: Viewing Pipeline – Viewing Coordinates – Projections – Clipping.

UNIT IV
Visible–Surface Detection Methods, Classification of Visible Surface Detection Algorithms – Back Face Detection - Depth-Buffer Method - A-Buffer Method.Color Models and Color Applications: RGB – YIQ – CMY – HSV.

UNIT V
Introduction to multimedia, multimedia applications, multimedia hardware, multimedia tools, lossless and lossy compression, Huffman coding.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-10	The origin of computer graphics, Interactive graphics display, new display devices, Points and Lines, DDA, Bresenham's Algorithms, Circles and Ellipse drawing algorithms.
11-23	Two Dimensional Geometric Transformations: Basic Transformations – Matrix Representations - Composite Transformations. Two Dimensional Viewing: Line Clipping – Polygon Clipping – Curve Clipping – Text Clipping.
24-34	Three-Dimensional Concepts - Three Dimensional object Representations - Fractal Geometry Methods – Three Dimensional Geometric and Modeling Transformations: Translation – Rotation – Scaling. Three Dimensional Viewing: Viewing Pipeline – Viewing Coordinates – Projections – Clipping.
35-40	Visible–Surface Detection Methods, Classification of Visible Surface Detection Algorithms – Back Face Detection - Depth-Buffer Method - A-Buffer Method.Color Models and Color Applications: RGB – YIQ – CMY – HSV.

41-45	Introduction to multimedia, multimedia applications, multimedia hardware, multimedia tools, lossless and lossy compression, Huffman coding.
15 Hours	*Tutorials*
	Essential Readings: 1. Donald Hearn and M. Pauline Baker, 'Computer Graphics C Version', Prentice – Hall of India, Second Edition. 2. Hill, Francis S., Computer Graphics Using OpenGL, Prentice-Hall, 2001. 3. Prabhat K Andleighand KiranThakrar, "Multimedia Systems and Design", PHI, 2003. 4. Tay Vaughan " Multimedia: making it work" Tata McGraw Hill 1999, 4th Edition **Further Readings:** 1. Steven Harrington, "Computer Graphics – A Programming Approach", McGraw Hill, second edition. 2. Multimedia Computing, Communication & Applications, Ralf Steinmetz and KlaraNashtedt. Prentice Hall.1995(TB2) 3. OpenGL programming guide by Woo, Neider, Davis &Shreiner, 3rd Edition 2000, Pearson Education Asia. 4. Judith Jeffcoate, "Multimedia in practice technology and Applications", PHI,1998. 5. D.D. Hearn, M.P. Baker, Computer Graphics with OpenGL, 3/e, pearson

WIRELESS SENSOR NETWORKS

Course Details			
Course Title: WIRELESS SENSOR NETWORKS			
Course Code:	CAI82DE01304	**Credits**	4
L + T + P	3 + 1 +0	**Course Duration**	One Semester
Semester		**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core Elective	**Nature of the Course**	Theory
Methods of Content Interaction	Lecture, Assignments, Class Tests, Student Presentations		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

- To introduce students about basics wireless sensor networks, their applications
- To introduce students about hardware and software architecture of WSN and associated design challenges
- To introduce students about deployment and management of sensor nodes in a WSN
- To introduce students about how sensor nodes gather, process, aggregates and transmit the data.

- To introduce students about security issues and challenges unique to sensor networks.

Course Learning outcomes

After the course the students will be able to:

- understand the architecture, applications and design challenges unique to WSN
- understand the data gathering, processing, aggregation and routing mechanisms used by WSN
- understand software and hardware related design challenges associated with WSN

Course Contents:

UNIT 1 **(25% Weightage)**

Introduction to wireless sensor networks (WSNs) and their applications, Sensor definition, Examples of available sensor nodes, Design challenges, Performance metrics, Contemporary network architectures, Operational and computational models, Software and hardware setups

UNIT 2 **(20% Weightage)**

Network Bootstrapping: Sensor deployment mechanisms, Issues of coverage, Node discovery protocols, Localization schemes, Network clustering

UNIT 3 **(25% Weightage)**

Data dissemination and routing: Query models, In-network data aggregation, Robust route setup, Coping with energy constraints.

UNIT 4 **(30% Weightage)**

Physical and Link layers: Radio energy consumption model, Power management, medium access, arbitration, Optimization mechanisms.

Dependability Issues: Security challenges, Threat and attack models, Quality of service provisioning, Clock synchronization, Supporting fault tolerant operation.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-2	Introduction to wireless sensor networks (WSNs) and their applications
3-3	Sensor definition, Examples of available sensor nodes
4-5	Design challenges, Performance metrics
6-7	Contemporary network architectures
8-10	Operational and computational models,
11-12	Software and hardware setups
13-13	Sensor deployment mechanisms
14-15	Issues of coverage
16-18	Node discovery protocols
19-21	Localization schemes
22-24	Network clustering
25-26	Query models
27-29	In-network data aggregation
30-33	Robust route setup
34-34	Coping with energy constraints

35-38	Radio energy consumption model, Power management
39-42	Medium access, arbitration, Optimization mechanisms
43-43	Security challenges, Threat and attack models
44-44	Clock synchronization
45-45	Supporting fault tolerant operation
15 Hours	Tutorials

Essential Readings:

1. Azzedine Boukerche, Handbook of Algorithms for Wireless Networking and Mobile Computing, Chapman & Hall/CRC, 2006**.**
2. Protocols and Architectures for Wireless Sensor Networks Holger Karl, Andreas Willig, Wiley, ISBN:0-470-09510-5, June 2005

Suggested Readings:

1. Mohammad Ilyas and Imad Mahgoub, Handbook of Sensor Networks: Compact Wireless and Wired sensing systems, CRC Press, 2005.
2. Wireless Sensor Networks Cauligi S. Raghavendra, Krishna Sivalingam, Taieb M. Znati, Springer, ISBN:1-4020-7883-8, August 2005.
3. Jr., Edgar H. Callaway, Wireless Sensor Networks: Architecture and Protocols, Auerbach, 2003.
4. Anna Hac, Wireless Sensor Networks Designs, John Wiley & Sons Ltd., 2003.
5. Nirupama Bulusu and Sanjay Jha, Wireless Sensor Networks: A systems perspective, Artech House, August 2005.

Software Engineering

Course Code	CAI82DE0104	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	II	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		
Special Nature/ Category of the Course (*if applicable***)**	Skill Based		
Methods of Content Interaction	*Lecture, Tutorials, Group discussion, seminar, presentations by students*		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives:

- Realize the importance of systematic and disciplined approach to software development.
- Choose the appropriate software process model for a given problem.
- Identify the requirements for given problem through customer interaction.
- Analyze the customer requirements using different problem Analysis methods, create the Software Requirement Specification Document (SRS) and demonstrate the skill to develop high quality software.
- Discuss the importance of testing in s/w development life cycle.

Course Learning Outcomes:

- Explain the importance of systematic approach in engineering the software.
- Estimate the cost of choosing a particular software process model.
- Recognize software requirements through customer interaction.
- Write software requirements specification (SRS) document.
- Identify and choose the suitable Architecture for problem.
- Evaluate the chosen Architecture for the problem.
- Distinguish between different tests that are to be done to validate software.
- Plan test cases well before testing starts.
- Apply new models to software development of new type of problems.

Prerequisites: Basic of Computer science, 'C' Programming concept.

Course Contents :

UNIT – I :

Introduction to Software Engineering, The software Process, Examples and Characteristics of software Failures, Software Engineering Profession and Ethics.

[05% Weightage]

UNIT – II

Software Process Models : A Generic Process Model, **Prescriptive Process Models *:*** *The* Waterfall, Prototyping, Evolutionary, Spiral and Unified Process Model, **New and Emerging Process Models *:*** *Extreme Programming (XP), Crystal, Scrum, Agile Unified Process (AUP), Adaptive Software Development (ASD), Microsoft Solution Framework.*

[12% Weightage]

UNIT – III :

Requirements Engineering, Types of Requirements, Feasibility Studies, Requirements Elicitation, Requirements Analysis, Use Case Diagrams, *Data Flow Diagrams,* Requirements Documentation (SRS), An Example of SRS.

[18% Weightage]

UNIT – IV

Introduction to Design, Outcome of Design Process, Cohesion and Coupling, Strategy of Design *: Bottom-Up Design, Top-Down Design and Hybrid Design,* Architectural Design, Detailed Design. Coding Standards and Guidelines.

[10% Weightage]

UNIT – V :

Responsibilities of a Software Project Manager, Project Planning, Metrics for the Project Size Estimation, Project Estimation Technique, Empirical Estimation Techniques, A Heuristic Estimation Technique – COCOMO (Basic, Intermediate, Complete, COCOMO2).

[15% Weightage]

UNIT – VI

Scheduling : *Work Breakdown Structure, Activity Networks Method, Critical Path Method , Gantt Chart, PERT Chart, Project Monitoring and Control*. Organization and Team Structures.

[15% Weightage]

UNIT – VII :

A Strategic approach to Software Testing : Verification and Validation, Organizing for Software, Software Testing Strategy, Criteria for Completion of Testing, Level of Testing : *Unit Testing, Integration Testing, and System Testing (Recovery Testing, Security Testing, Stress Testing, Performance Testing).* Alpha and Beta Testing. **White-Box Testing :** Basis Path Testing ***(****Flow Graph Notation, Independent Program Paths,* and Control Structure Testing **(***Condition Testing, Data Flow Testing, Loop Testing).* **Black-Box Testing :** Equivalence Partitioning, Boundary Value Analysis.

[20% Weightage]

UNIT – VIII

Software Quality, Software Maintenance, Software Reuse and Emerging Trends in Software Engineering.

[05% Weightage]

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-4	Introduction to Software Engineering, The software Process, Examples and Characteristics of software Failures, Software Engineering Profession and Ethics.
5-8	**Software Process Models :** A Generic Process Model, **Prescriptive Process Models *:*** *The* Waterfall, Prototyping, Evolutionary, Spiral Unified Process Model
9-12	**New and Emerging Process Models *:*** *Extreme Programming (XP), Crystal, Scrum, Agile Unified Process (AUP), Adaptive Software Development (ASD), Microsoft Solution Framework, Open Source Software Development.*
13-17	Requirements Engineering, Types of Requirements, Feasibility Studies, Requirements Elicitation, Requirements Analysis, Use Case Diagrams, *Data Flow Diagrams,* Requirements Documentation (SRS), An Example of SRS.
18-22	Introduction to Design, Outcome of Design Process, Cohesion and Coupling, Strategy of Design *: Bottom-Up Design, Top-Down Design and Hybrid Design,*

	Architectural Design, Detailed Design. Coding Standards and Guidelines, Code Review and Software Documentation.
23-25	Responsibilities of a Software Project Manager, Project Planning, Metrics for the Project Size Estimation, Project Estimation Technique, Empirical Estimation Techniques, A Heuristic Estimation Technique – COCOMO (Basic, Intermediate, Complete, COCOMO2).
26-30	*Work Breakdown Structure, Activity Networks Method, Critical Path Method , Gantt Chart, PERT Chart, Project Monitoring and Control*. Organization and Team Structures.
31-34	A Strategic approach to Software Testing : Verification and Validation, Organizing for Software, Software Testing Strategy, Criteria for Completion of Testing, Level of Testing : *Unit Testing, Integration Testing, and System Testing (Recovery Testing, Security Testing, Stress Testing, Performance Testing).* Alpha and Beta Testing.
35-39	**White-Box Testing :** Basis Path Testing ***(****Flow Graph Notation, Independent Program Paths,* and Control Structure Testing **(***Condition Testing, Data Flow Testing, Loop Testing).*
40-42	**Black-Box Testing :** Equivalence Partitioning, Boundary Value Analysis.
43-45	Software Quality, Software Maintenance, Software Reuse and Emerging Trends in Software Engineering.
15 Hours	*Tutorials*

Essential Readings:

1. Software Engineering A Practitioner's Approach by Pressman , MGH
2. Software Engineering, by Sommerville, Pearson education.
3. Fundamentals of Software Engineering by Rajib Mall, PHI
4. Essentials of Software Engineering, by Frank Tsui and Orlando Karam
5. Software Engineering by James F. Peters, Wiley
6. Software engineering, by Jawadekar, TMH

MODELING AND SIMULATION

Course Code	CAI82DE01604	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester		**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		

Methods of Content Interaction	Lecture, Tutorials, self-study, presentations by students, assignments.
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)

Course Objectives

- The purpose of this course is to develop a model corresponding to a real system and perform simulation using model.
- Random number generation techniques will be described to perform various activities of simulations.
- Prepare to learn one of the simulation languages to implement the conceptual model.

Course Learning Outcomes

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

- Describe difference between model and system.
- Know the steps for developing the simulation model
- Generate random numbers and also test them for uniformity and independence properties.
- Derive various performance parameters for Queuing systems using both analytic and simulation approaches.
- Write a program using simulation language for a given problem

Prerequisites: Students should have knowledge of probability distribution and computer programming.

Course Contents:

UNIT I **(15% weightage)**

Fundamental of Modeling and Simulation: Introduction to Simulation, Merits and demerits of simulation, Areas of application, Types of systems, various types of models to represent them, Discrete and Continuous systems. Stages of a typical simulation study, Simulation Examples, Concepts of system Clocks, Event scheduling Vs Time advance algorithms.

UNIT II **(15% weightage)**

Simulation Models: Continuous Simulation, Monte-Carlo Simulation, Discrete-event simulation, Numerical computation techniques, Lag models, distributed lag model and cobweb model.

Verification and Validation of Models: Simulation Process, Guidelines for verification of models, their calibration and Validation, Face validity, Validation of model assumptions, Validating input –output transformations, Use of historical Data.

UNIT III **(25% weightage)**

Random Numbers: Roles of random numbers in simulation, pseudo random number generation techniques, properties, methods of testing PRN sequences. Random variate: Generation, Inverse transformation techniques- with exponential distributions and empirical

continuous distributions, Direct transformations with Normal distributions, Acceptance Rejection techniques, with Poisson distribution, Goodness of fit tests, Chi square test, Kolmogorov- Smirnov test

UNIT IV **(25% weightage)**

Queuing Networks: Analytical and simulation modeling of queuing system**,** M/M/1, M/M/∞, M/M/n**,** Performance evaluation.

UNIT V **(20% weightage)**

Simulation Languages: Needs of special purpose simulation Languages, Detailed study of one simulation language.

Evaluation of Simulation Experiments: sample generation, application in industry and service organization, static and dynamic stochastic simulations, elimination of transients, variance reduction techniques.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-8	**Fundamental of Modeling and Simulation:** Introduction to Simulation, Merits and demerits of simulation, Areas of application, Types of systems, various types of models to represent them, Discrete and Continuous systems. Stages of a typical simulation study, Simulation Examples, Concepts of system Clocks, Event scheduling Vs Time advance algorithms.
9-12	**Simulation Models:** Continuous Simulation, Monte-Carlo Simulation, Discrete-event simulation, Numerical computation techniques, Lag models, distributed lag model and cobweb model.
13-15	**Verification and Validation of Models:** Simulation Process, Guidelines for verification of models, their calibration and Validation, Face validity, Validation of model assumptions, Validating input –output transformations, Use of historical Data.
16-18	**Random Numbers:** Roles of random numbers in simulation, pseudo random number generation techniques, properties, methods of testing PRN sequences.
19-27	Random variates: Generation, Inverse transformation techniques- with exponential distributions and empirical continuous distributions, Direct transformations with Normal distributions, Acceptance Rejection techniques, with Poisson distribution, Goodness of fit tests, Chi square test, Kolmogorov- Smirnov test
28-38	**Queuing Networks:** Analytical and simulation modeling of queuing system**,** M/M/1 , M/M/∞, M/M/n**,** Performance evaluation.

39-45	**Simulation Languages:** Needs of special purpose simulation Languages, Detailed study of one simulation language. **Evaluation of Simulation Experiments:** sample generation, application in industry and service organization, static and dynamic stochastic simulations, elimination of transients, variance reduction techniques.
15 Hours	*Tutorials*

Essential Readings:

1. System simulation, by G. Gordon, 2nd edition, 2011, Prentice Hall

2. Simulation Modeling and Analysis, A M Law, fourth edition, 2008, TMH

Further Readings:

1. Jerry Banks, John S. Carson & Barry L. Nelson – Discrete Event system simulation PHI
2. Simulation and the Monte Carlo Method, Reuven Y Rubinstein- 1981, (John Wiley& Sons).
3. Computer Networks and Systems: Queueing Theory and Performance Evaluation , Thomas G. Robertazzi - 2000, (Springer).

INTERNET TECHNOLOGIES

Course Code:	CAI82DE01704	**Credits**	4
L + T + P	3+0+1	**Course Duration**	One Semester
Semester	II	**Contact Hours**	45 (L) + 30 Lab Hours
Course Type	Discipline Based Core Elective	**Nature of the Course**	Theory/Skill Based
Methods of Content Interaction	Lecture, Practical, Assignments, Class Tests, Student Presentations, mini projects.		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

- To introduce students about basics of common Internet Technologies

that are dominantin Internet domain such as TCP/IP and its basics and various web developmenttechnologies

- To introduce students about basics of e-commerce and how its security requirements are met.
- To introduce students about how emerging trends that have gained popularity recentlyin the Internet worlds.

Course Learning outcomes

- understand basics of how Internet and its applications works
- understand the basics of the technologies that are used to develop variety of contentsavailable on the Internet.
- understand about the security issues and challenges associated with e-commerce.
- know about recent trends in the domain of Internet Technologies
- gain insight to the some of the dominant technologies in the Internet domain.

Course Contents:

UNIT I: (25% Weightage)

Introduction to Internet, TCP/IP: addressing and routing. Internet applications: FTP, Telnet,Email, Chat.

UNIT II: (25% Weightage)

World Wide Web: HTTP protocol. Designing web pages: HTML, forms, CGI scripts,JavaScript, PHP, DHTML, XML

UNIT III: (25% Weightage)

E-Commerce and security issues including symmetric and asymmetric key, encryption anddigital signature, authentication, confidentiality, hash functions and message integrity

UNIT IV: (25% Weightage)

Emerging trends in Internet Technologies, Internet telephony, Introduction to virtual realityover the web, etc. Intranet and extranet, firewall and their types.

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-1	Introduction to Internet
2-5	TCP/IP: addressing and routing
6-12	Internet applications: FTP, Telnet, Email, Chat.
13-14	World Wide Web
15-17	HTTP protocol
18-22	Designing web pages: HTML, forms, CGI scripts
23-26	JavaScript
27-31	PHP
32-32	DHTML
33-33	XML
34-35	E-Commerce and security issues including symmetric and asymmetric key
36-37	encryption and digital signature, confidentiality
38-39	Authentication, hash functions and message integrity
40-40	Emerging trends in Internet Technologies
41-42	Internet telephony
43-43	Introduction to virtual reality over the web
44-44	Intranet and extranet
45-45	firewall design issues
30 Hours	*LAB*

Essential Readings:

1. Burdman, “Collaborative Web Development” Addison Wesley.
2. Chris Bates, “Web Programing Building Internet Applications”, 2nd Edition, WILEY, Dreamtech
3. Joel Sklar, “Principal of web Design” Vikash and Thomas Learning
4. W. Stallings, Cryptography and Network Security: Principles and Practice, 2nd Edition, Prentice Hall, 1998

Suggested Readings:

1. W3School.com
2. Hans Bergsten, “Java Server Pages”, SPD O’Reilly

M.SC. AI 3rd Semester

ARTIFICIAL NEURAL NETWORKS & DEEP LEARNING

Course Code	CAI91DC01904	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline Based Core Course		
Nature of the Course	Theory, Practical		
Special Nature/ Category of the Course (*if applicable***)**	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Group discussion, seminar, presentations by students		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives:

- To understand the context of neural networks and deep learning
- To know how to use a neural network
- To understand the theoretical foundations, algorithms and methodologies of Neural Network
- To design and develop an application using specific deep learning models
- To provide the practical knowledge in handling and analysing real world applications
- To understand use cases of artificial neural network and recurrent neural network(RNN)

Course Learning Outcomes:

After completion of this course, students will be able to:

- Understand neural networks and the learning process
- Explain various stages involved in learning and back propagation
- Train Artificial neural networks
- Recognize the characteristics of deep learning models that are useful to solve real-world problems.
- Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.

- Implement different deep learning algorithms

Prerequisites: Python programming, Machine learning

Unit – I Introduction to Neural Networks [15% Weightage]

Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process

Unit - II Single Layer Perceptron [15% Weightage]
Introduction to Single Layer Perceptron, Working of Single Layer Perceptron, Perceptron Weight Adjustment, Implementation of Single Layer Perceptron, Advantages and Disadvantages of Single Layer Perceptron

Unit- III Back Propagation [20% Weightage]
Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation

Unit – IV Deep Learning [25% Weightage]
Deep learning, Training a deep neural network, Activation functions, Loss functions, Hyper parameters, Neural networks as universal function approximates, Common architectural principles of deep networks

Unit- V Convolutional and Recurrent Neural Networks [25% Weightage]
From fully connected network to convolutions, Common convolutional architectural patterns, convolutional layers, pooling layers, Transfer learning, Convolutional neural network –Batch normalisation, ResNet, DenseNet, Recurrent Neural Networks

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-6	**Introduction to Neural Networks** Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process
7-10	**Single Layer Perceptron** Introduction to Single Layer Perceptron, Working of Single Layer Perceptron, Perceptron Weight Adjustment, Implementation of Single Layer Perceptron, Advantages and Disadvantages of Single Layer Perceptron
11-16	**Back Propagation** Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation
17-29	**Deep Learning**

	Deep learning, Training a deep neural network, Activation functions, Loss functions, Hyper parameters, Neural networks as universal function approximates, Common architectural principles of deep networks
30-45	**Convolutional and Recurrent Neural Networks** From fully connected network to convolutions, Common convolutional architectural patterns, convolutional layers, pooling layers, Transfer learning, Convolutional neural network –Batch normalisation, ResNet, DenseNet, Recurrent Neural Networks
30 Hours	***Lab***

Essential Readings:

1.Deep Learning: A Practitioner's Approach by Adam Gibson and Josh Patterson
2. Deep Learning by Aaron Courville, Ian Goodfellow, and Yoshua Bengio: MIT Press
3. Neural Networks and Deep Learning: A Textbook by Charu C. Aggarwal, Springer; 1st ed. 2018 edition

BIG DATA ANALYTICS

Course Code	CAI91DC01904	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		
Special Nature/ Category of the Course (*if applicable***)**	Skill Based		
Methods of Content Interaction	*Lecture, Tutorials, Group discussion, seminar, presentations by students*		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives:

- Understand the concept and challenge of big data and why existing technology is inadequate to analyze the big data.
- Collect, manage, store, query, and analyze various forms of big data.
- Gain hands-on experience with large-scale analytics tools to solve some open big data problems.
- Understand the impact of big data on business decisions and strategy.

- Understand, and practice big data analytics and machine learning approaches, which include the study of modern computing big data technologies and scaling up machine learning techniques focusing on industry applications

Course Learning Outcomes:

- Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.
- Ability to select and implement machine learning techniques and computing environments that are suitable for the applications under consideration.
- Ability to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
- Ability to understand and apply scaling-up machine learning techniques and associated computing techniques and technologies.
- Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques.
- Ability to integrate machine learning libraries and mathematical and statistical tools with modern technologies like Hadoop and map-reduce.

Prerequisites: Basic of Computer science, Algorithms, Data structure

Course Contents:

UNIT I
INTRODUCTION TO BIG DATA
Big Data – Definition, History and Paradigms - 3V's of Big Data – Types of data – structured – Semi-Structured - Unstructured - Traditional Data Vs Big Data – Big Data value chain - Applications of Big Data - System challenges facing big data

[20% Weightage]

UNIT II
BIG DATA STORAGE
Bottlenecks of traditional storage techniques – CAP theorem– Introduction to NoSQL–Types of NoSQL– Key-value store -Column-value store-Document-value store – Graph store– Advantages of NoSQL – NoSQL challenges

[20% Weightage]

UNIT III
BIG DATA ANALYTICS
Big data and analytics – Applications – Nomenclature – Analytic Process Model - Challenges that Prevent Businesses from Capitalizing on Big Data – Importance of analytics - Data Science - Analytics application types

[20% Weightage]

UNIT IV
CLASSIFICATION OF ANALYTICS
Predictive analytics – Descriptive analytics – Survival analytics – Social network analytics – Example applications

[08% Weightage]

UNIT V
HADOOP AND MAPREDUCE FRAMEWORK

The Hadoop Framework – History of Hadoop –Advantages and Disadvantages of Hadoop – HDFS architecture– Features of HDFS– Map Reduce Framework, Feature of MapReduce, Working of MapReduce.

[20% Weightage]

UNIT VI
BIG DATA VISUALIZATION

Importance of Data Visualization–Classification of Visualization-Terminology– Visual data analysis and exploration –Basic charts and plots–Principles of perception, color and design–text data visualization – Effective visualization of big data

[12% Weightage]

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-5	**INTRODUCTION TO BIG DATA** Big Data – Definition, History and Paradigms - 3V's of Big Data – Types of data – tructured – Semi-Structured - Unstructured - Traditional Data Vs Big Data – Big Data value chain - Applications of Big Data - System challenges facing big data
6-15	**BIG DATA STORAGE** Bottlenecks of traditional storage techniques – CAP theorem– Introduction to NoSQL–Types of NoSQL– Key-value store-Column-value store-Document-value store – Graph store–Advantages of NoSQL – NoSQL challenges
16-25	**BIG DATA ANALYTICS** Big data and analytics – Applications – Nomenclature – Analytic Process Model - Challenges that Prevent Businesses from Capitalizing on Big Data – Importance of analytics - Data Science - Analytics application types
26-33	**CLASSIFICATION OF ANALYTICS** Predictive analytics – Descriptive analytics – Survival analytics – Social network analytics – Example applications
34-38	**BIG DATA VISUALIZATION** Importance of Data Visualization–Classification of Visualization-Terminology– Visual data analysis and exploration –Basic charts and plots–Principles of perception, color and design–text data visualization – Effective visualization of big data
39-45	**HADOOP AND MAPREDUCE FRAMEWORK** The Hadoop Framework – History of Hadoop –Advantages and Disadvantages of Hadoop – HDFS architecture– Features of HDFS– Map Reduce architecture
15 Hours	***Tutorials***

Essential Readings:

1. Analytics in a Big Data World: The Essential guide to data science and its applications by Bary Baesens Wiley India
2. Hadoop: The Definitive Guide, 4th Edition by Tom White O'Reilly
3. Designing Data Visualization by Noab Iliinsky, Julie Steele O'REILLY publication
4. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence by Pramod J , Martin Flower PEARSON publication
5. Big Data and Analytics by Seema Acharya and Subhasini Chellappan Wiley India
6. Effective Data Visualization From Design Fundamentals to Big Data Techniques by Jeferry Heer O'Reilly

M.SC. AI 3rd Semester - Electives

SOFT COMPUTING

Course Details			
Course Title: SOFT COMPUTING			
Course Code	CAI91DE02004	**Credits**	4
L + T + P	3 +0+1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 (Lab) Hours
Course Type	Discipline based Elective		
Nature of Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, self-study, seminar, presentations by students, assignments.		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

- To familiarize with soft computing concepts.
- To introduce the fuzzy logic concepts, fuzzy principles and relations.
- To provide the basics of ANN and Learning Algorithms.
- Discuss Genetic Algorithms and its applications to soft computing

Course Learning Outcomes

After going through this course a student should be able to:

- Understand basics of fuzzy system, genetic algorithms & their relations.
- Learn artificial neural network models and their functions.
- Apply genetic algorithms & artificial neural networks as computation tools to solve a variety of problems in various areas of interest ranging from optimization problems to text analytics.

Pre-requisites: Artificial intelligence

Course Contents:

UNIT I **[15% weightage]**

Introduction to soft computing - relevance, advantage and importance of soft computing - components of soft computing - applications of soft computing - ability of soft computing to handle uncertainty, vagueness, ambiguity - introduction to computational intelligence - relationship between computational intelligence and soft computing

UNIT II **[20% weightage]**

Introduction to fuzzy sets - t-norms - t-conorms - alpha-cuts - distance between fuzzy sets, fuzzy numbers - extension principle - interval arithmetic and alpha-cuts - properties of fuzzy arithmetic - fuzzy max and min - inequalities

UNIT III **[20% weightage]**

Introduction to fuzzy logic - applications of fuzzy logic - types of membership functions, fuzzy inference system - fuzzifier - defuzzifier - inference engine - rule base, fuzzy rules - mamdani type fuzzy rules - Takagi-Sugeno type fuzzy rules, introduction to type-2 fuzzy logic and its advantages over type-1 fuzzy logic

UNIT IV **[25% weightage]**

Introduction to genetic algorithm - applications of genetic algorithm - concepts of genes, chromosomes, population and its initialization - fitness function - types of selection mechanism, working of roulette wheel selection - types of crossover operations - working of one point, two point, multipoint and arithmetic crossovers - mutation - reinsertion - steps of simple genetic algorithm

UNIT V **[20% weightage]**

Introduction to biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-10	Introduction to soft computing - relevance, advantage and importance of soft computing - components of soft computing - applications of soft computing - ability of soft computing to handle uncertainty, vagueness, ambiguity - introduction to computational intelligence - relationship between computational intelligence and soft computing
11-21	Introduction to fuzzy sets - t-norms - t-conorms - alpha-cuts - distance between fuzzy sets, fuzzy numbers - extension principle - interval arithmetic and alpha-cuts - properties of fuzzy arithmetic - fuzzy max and min - inequalities
22-30	Introduction to fuzzy logic - applications of fuzzy logic - types of membership functions, fuzzy inference system - fuzzifier - defuzzifier - inference engine - rule base, fuzzy rules - mamdani type fuzzy rules - Takagi-Sugeno type fuzzy rules, introduction to type-2 fuzzy logic and its advantages over type-1 fuzzy logic
31-38	Introduction to genetic algorithm - applications of genetic algorithm - concepts of genes, chromosomes, population and its initialization - fitness function - types of selection mechanism, working of roulette wheel selection - types of crossover operations - working of one point, two point, multipoint and arithmetic crossovers - mutation - reinsertion - steps of simple genetic algorithm

39-45	Introduction to biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network
30 Hours	*LAB*

Essential Readings:

1. James J. Buckley, EsfandiarEslami, An introduction to fuzzy logic and fuzzy sets, Springer International edition, 2002
2. S.N. Sivanandam, S.N. Deepa, Introduction to genetic algorithms, Springer, 2008
3. S. Sivanandam, S. Sumathi, Introduction to Neural Networks using Matlab 6.0, The McGraw-Hill, 2005
4. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, 2nd ed., Wiley India

Further Readings:

1. Fuzzy Logic: Intelligence, Control, and Information, 1/E, Yen &Langari, 1999, Prentice Hall
2. Neural Networks and Learning Machines, 3/E, Haykin, 2009, Prentice Hall
3. Fuzzy Logic and Control: Software and Hardware Applications, Vol. 2, 1/E, Jamshidi, Vadiee& Ross, 1993, Prentice Hall
4. Genetic Algorithms in Search, Optimization, and Machine Learning, 1/E, Goldberg, 1989, Addison-Wesley

Timothy J. Ross, Fuzzy logic with engineering applications, 3rded, Wiley India

SPEECH PROCESSING AND RECOGNITION

Course Code	CAI91DE02104	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 Lab Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, self-study, presentations by students, assignments.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To introduce students to the basic concepts of speech production and perception mechanisms in human beings.
- To provide a broad overview of speech signal processing methods.
- To provide the knowledge of various speech tools for recording speech signals and also extracts different speech features from the recorded speech files.
- To develop speech and speaker recognition systems using various modelling techniques

Learning Outcomes

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

- Describe the mechanisms of human speech production and perception systems.
- Familiar with various information present in the speech signal.
- Extract various source and system features from the speech signal.
- Develop speech and speaker recognition systems using modelling techniques.

Prerequisites: None

Course Contents

UNIT II **[15% Weightage]**

Introduction: Speech production and perception mechanisms, Speech Signal Processing Methods.

UNIT II **[20% Weightage]**

Knowledge sources in speech: Time domain and frequency domain, Spectrograms, Knowledge sources at segmental, sub-segmental and supra-segmental (prosodic) levels, excitation source, vocal tract system.

UNIT III **[25% Weightage]**

Modeling techniques for developing speech systems: Vector quantization, Hidden Markov models, Gaussian mixture models, Support vector machines and Neural networks.

UNIT IV **[25% Weightage]**

Speech Recognition: Issues in speech recognition, Isolated word recognition, Connected word recognition, Continuous speech recognition, Large vocabulary continuous speech recognition.
Speaker Recognition: Issues in speaker recognition, Speaker verification vs identification, Text dependent vs text independent speaker recognition, Development of speaker recognition systems.

UNIT V **[15% Weightage]**

Introduction to some advanced topics: speech coding and text-to-speech synthesis.

Lab : 30 Hrs.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-11	**Introduction**: Speech production and perception mechanisms, Speech Signal Processing Methods.

12-19	**Knowledge sources in speech**: Time domain and frequency domain, Spectrograms, Knowledge sources at segmental, sub-segmental and supra-segmental (prosodic) levels, excitation source, vocal tract system.
20-30	**Modeling techniques for developing speech systems**: Vector quantization, Hidden Markov models, Gaussian mixture models, Support vector machines and Neural networks.
31-38	**Speech Recognition**: Issues in speech recognition, Isolated word recognition, Connected word recognition, Continuous speech recognition, Large vocabulary continuous speech recognition.
39-41	**Speaker Recognition**: Issues in speaker recognition, Speaker verification vs identification, Text dependent vs text independent speaker recognition, Development of speaker recognition systems.
41-45	**Introduction to some advanced topics:** speech coding and text-to-speech synthesis.
30 Hours	*Lab*

Essential Readings:

- D. O Shaughnessy, Speech Communication: Human and Machine, 2nd edition, IEEE Press, NY, USA, 1999.
- J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, Discrete-time Processing of Speech Signals, IEEE Press, NY, USA, 1999.
- T.F. Quateri, Discrete-Time Speech Signal Processing: Principles and Practice, Pearson Education, 2004.

Further Readings:

- L. R. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Pearson Education, Delhi, India, 2003.
- B. Gold and N. Morgan, Speech and Audio Signal Processing, Wiley Student Edition, Singapore, 2004.
- Ahmet M. Kondoz, Digital Speech: Coding for Low Bit Rate Communication, 2nded, Wiley publication, 2004.
- IEEE Trans. on Speech and Audio Processing.
- Speech Communication (Elsevier)
- Computer, Speech and Language (Elsevier)

Social Networks Analytics

Course Title:	**Social Networks Analytics**		
Course Code	CAI91DE02204	**Credits**	4
L + T + P	3 +0+1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 Lab Hours
Course Type	Discipline Based Core Elective	**Nature of the Course**	Theory/Skill Based
Methods of Content Interaction	Lecture, Tutorials, Class Tests, data analysis, seminar, presentations by students etc.		

Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)

Course Prerequisites: Understanding of Basic Graph Theory

Course Objectives

- To introduce students about the history of Social Networks and the types of social networks and their features
- To introduce them about various centrality measures and their importance in predicting user properties, behaviours and various events in social networks.
- To introduce students about some of the popular network models developed to understand/ mimic real social network formations and their characteristics.
- To introduce students with the concepts of formation of communities in social networks and introducing them with some of the popular community detection algorithms.
- To introduce students with the concept of strong and weak ties, homophily and their roles in topological evolution of social networks.
- To understand the concepts of cascading behaviours in social networks.
- To introduce students with common security and privacy concerns in social networks.

Course Learning outcomes

After the course the students:

- would understand the types of social networks and their architectures and their applications. They also will become familiar with popular public dataset for different types of social networks.
- would know about various centrality measures and their usage and roles in prediction variety of characteristics of nodes, edges and social networks.
- would become familiar with some of popular models proposed to understand evolution/formation of real social networks and their characteristics
- would understand the concepts of communities in social networks, their formation process and detecting the existing communities using some of the popular algorithms.
- would understand the concepts of strong and weak ties, homophily and selection and social influence and impact of these phenomena on dynamics of a social network.
- would become familiar with the basic concepts of cascading behaviour in social network
- would be able to understand the privacy and security issues with social networks

Course Contents:

UNIT 1 Introduction to Online Social Networks (20% Weightage)

History of Online Social Networks, definition, types of social networks and their features like architecture, various social network datasets

UNIT 2 Topology and Centrality Measures of Social Networks (20% Weightage)

Topology of a social network, Degree Centrality, Closeness Centrality, Betweenness

Centrality, Eigenvector centrality, clustering coefficient, applications of centrality metrics.

UNIT 3 Network Models and Communities (30% Weightage)

Random Networks: Erdos-Renyi and Barabasi-Albert Model and their properties, Scale-Free networks and their properties, Power Law Distribution, Small-world Networks

Community structures and community detection algorithms: Girvan–Newman algorithm

UNIT 4 Human Behaviour Dynamics (30% Weightage)

Strong and Weak Ties, Homophily, Selection and Social Influence, Cascading Behaviour in Networks, Understanding and predicting human behaviour for social communities. Privacy issues in online social networks,

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-2	History of Online Social Networks, definition
3-5	Types of social networks and their architecture
6-9	Degree Centrality, Closeness Centrality, Betweenness Centrality
10-13	Eigenvector centrality, clustering coefficient, applications of centrality metrics
14-18	Random Networks: Erdos-Renyi and Barabasi-Albert Model and their properties
19-22	Scale-Free networks and their properties
23-26	Power Law Distribution and its examples
27-29	Small-world Networks
29-34	Community structures and community detection algorithms: Girvan–Newman algorithm
35-37	Strong and Weak Ties
37-38	Homophily
39-40	Selection and Social Influence
40-41	Cascading Behavior in Networks
42-43	Understanding and predicting human behavior for social communities
43-45	Privacy issues in online social networks
30 Hours	LAB

Essential Readings:

1. Network Science 1st Edition by Albert-László Barabasi, Cambridge University Press, ISBN-13: 978-1107076266
2. Analyzing Social Networks Second Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson SAGE Publications Ltd ISBN-13: 978-1526404107.
3. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
4. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.

Suggested Readings:

1. Guandong Xu, Yanchun Zhang and L in Li, "Web Mining and Social Networking – Techniques and applications", First Edition Springer, 2011
2. John G. Breslin, Alexander Passant and Stefan Decker, "The Social Semantic Web", Springer, 2009
3. Dion Goh and Schubert Foo, "Social Information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.

NATURAL LANGUAGE PROCESSING

Course Code	CAI91DE02304	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 Lab Hours
Methods of Content Interaction	Lecture, Tutorials, Self-study, Practicals, presentations by students, assignments.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

At the end of this course:

- Students should have a sound knowledge of the methods used in different areas of natural language processing.
- Students should also be able to use this knowledge to implement simple natural language processing algorithms and applications.

Learning Outcomes

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

- Understand the application and analysis of NLP systems.
- Synthesis and evaluation: Compare and contrast approaches to natural language processing, Discuss the limitations and promise of NLP.

Prerequisites: Students should have knowledge of Algorithms, Theory of Computation etc.

UNIT I **[25% Weightage]**

Shallow Processing – Morphology fundamentals – Finite State Machine based Morphology – Part of Speech Tagging and Named Entity tagging – Machine learning algorithms for NLP

UNIT II **[12% Weightage]**

Parsing – Classical Approaches: Top-Down, Bottom-UP and Hybrid Methods – Chart Parsing, Early Parsing – Statistical Approach: Probabilistic Parsing, Tree Bank Corpora

UNIT III **[10% Weightage]**

Lexical Semantics and/or Discourse Processing – Lexicons, Word Sense Disambiguation – Coreferences

UNIT IV **[10% Weightage]**

Information Extraction and Text Classification – Approaches of IE and Applications. Anaphora Resolution in biomedical texts – text classification approach.

UNIT V **[15% Weightage]**

Applications – Machine Translation – Information Retrieval (cross-lingual) – Summarization – Question Answering

UNIT VI **[28% Weightage]**

Indian Language Computing – Named Entity Recognition – Part of Speech Tagging – Machine Translation - Cross lingual information access

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1	**Shallow Processing** – Morphology fundamentals
2-4	Finite State Machine based Morphology
5-10	Part of Speech Tagging and Named Entity tagging – Machine learning algorithms for NLP
11-14	**Parsing** – Classical Approaches: Top-Down, Bottom-UP and Hybrid Methods – Chart Parsing, Early Parsing – Statistical Approach: Probabilistic Parsing, Tree Bank Corpora
15-16	**Lexical Semantics and/or Discourse Processing** – Lexicons, Word Sense Disambiguation – Coreferences
17-20	Approaches of IE and Applications
21-26	**Information Extraction and Text Classification** – Anaphora Resolution in biomedical texts – text classification approach.
27-31	**Applications** – Machine Translation
32-37	Information Retrieval (cross-lingual) – Summarization – Question Answering
38-42	**Indian Language Computing** – Named Entity Recognition
43-45	Part of Speech Tagging – Machine Translation - Cross lingual information access
30 Hours	*Lab*
Essential Readings:	

1. Speech and Language Processing, by D. Jurafsky and R. Martin (2nd edition)
2. Natural Language Understanding : James Allan

Further Readings::
Foundations of Statistical NLP: Manning and Schutze
1. NLP a Panninian Perspective: Bharati, Chaitanya and Sangal
2. Statistical NLP :Charniak

QUANTUM COMPUTING

Course Code	CAI91DE02504	**Credits**	4
L + T + P	3 + 1+ 0	**Course Duration**	One Semester
Semester		**Contact Hours**	45 (L) + 30 (P) Hours
Course Type	Discipline based Elective		
Nature of the Course	Theory, Practical		
Special Nature/ Category of the Course (*if applicable*)	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Group discussion, seminar, presentations by students		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives:

- Understand the context of Quantum Computing
- To understand the mathematical fundamentals for quantum computing
- To study the quantum algorithms

Course Learning Outcomes:

- Understanding of quantum computing
- Mathematical concepts required for quantum computing

- Architecture of a Quantum Computing platform
- Quantum Algorithms and their applications

Prerequisites: Linear Algebra

Course Content

Unit I Introduction to Quantum Computing
Origin of Quantum Computing, Overview of major concepts in Quantum Computing, Qubits and multi-qubits states, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement

[20% Weightage]

Unit II Mathematics for Quantum Computing
Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.
[20% Weightage]

Unit III Quantum correlations:
Bell inequalities and entanglement, Schmidt decomposition, superdense coding, teleportation.
[20% Weightage]

Unit IV Quantum gates and algorithms:
Universal set of gates, quantum circuits, Solovay-Kitaev theorem, Deutsch-Jozsa algorithm, factoring **[20% Weightage]**

Unit V Programming a quantum computer:
The IBMQ, coding a quantum computer using a simulator to carry out basic quantum measurement and state analysis. **[20% Weightage]**

Course Interaction Plan

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-9	Introduction to Quantum Computing Origin of Quantum Computing, Overview of major concepts in Quantum Computing, Qubits and multi-qubits states, Bloch Sphere representation, Quantum Superposition, Quantum Entanglement
10-18	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors
19-27	Bell inequalities and entanglement, Schmidt decomposition, super dense coding, teleportation.
28- 37	Quantum gates and algorithms: Universal set of gates, quantum circuits, Solovay-Kitaev theorem, Deutsch-Jozsa algorithm, factoring
38-45	Programming a quantum computer:

	The IBMQ, coding a quantum computer using a simulator to carry out basic quantum measurement and state analysis.

Essential Reading

1. Quantum Computing for the Quantum Curious by Anastasia Perry, Jessica Turner, Joshua Isaacson, Ciaran Hughes, Ranbel F. Sun: Springer
2. Quantum Computing: A Gentle Introduction by Eleanor Rieffel and Wolfgang Polak: MIT Press

Intelligent Systems and Robotics

Course Code	CAI91DE02604	**Credits**	4
L + T + P	3 + 1+ 0	**Course Duration**	One Semester
Semester		**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline based Elective		
Nature of the Course	Theory		
Special Nature/ Category of the Course (*if applicable*)	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Group discussion, seminar, presentations by students		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives:

- Understand the context of intelligent systems and robotics
- Sensors, peripherals and software for robotic control
- Fundamentals of Cyber Physical systems and Industry 4.0
- AI based robotic application like image recognition, voice recognition etc

Course Learning Outcomes:

- Describe the general principles of intelligent systems and robotics, and the broad range of uses, including in various industries.
- The principles by which sensed data are converted into useful information
- The practical aspects of developing intelligent and robotic systems
- Fundamentals of Cyber physical systems and its integration with robotics
- Use case of robotics in solving speech, image and navigation based real life applications

Prerequisites: Basic Electronics, Artificial Intelligence

Course Content

Unit-I: INTRODUCTION to Robotics

Introduction to robotics, classification of robots, workspace analysis, Manipulator Kinematics: Convention for affixing frames to links – DH Representation, Derivation of Direct kinematic equations for various types of robots. Inverse Manipulator Kinematics: Solvability, algebraic vs. geometric, Pipers solution when three axes intersect, Examples of inverse manipulator kinematics, repeatability and accuracy, Robot Dynamics

[20% Weightage]

Unit-II: Robotic Control

Robot Kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation-Homogeneous coordinates, multiple Transformation-Simple problems, Introduction to Robot Sensing, Range sensors, Proximity sensors and touch sensors, Force and torque sensors, Introduction to Robot Vision, Low level and high-level vision, Introduction to Robot actuators, Introduction to Robot Control, Robot intelligence and task planning, Control Components, De-mining Robot: Embedded Robot Controller, I/O Interface, and PWM Amplifiers, Control software

[30% Weightage]

Unit III: Robotics and Cyber Physical Systems

Introduction to cyber physical systems, Structure and Functions of Cyber-Physical Systems, Components Model: Linked Logical and Physical Elements, Interactions Model: Linked State Transitions, Components of CPS, Application of CPS, Integration of CPS with robotics, robotic arm, Application of CPS, Introduction to smart manufacturing, Industry 4.0, Robotic applications in smart manufacturing **[20% Weightage]**

Unit IV: Artificial Intelligence in Robotic Application

Image Recognition, Using the artificial neural network and supervised learning for object recognition, teaching robotic arm for picking objects, adaptive and Q learning based approach for picking up objects, Google SAC-Z, Amazon Robotics challenge, speech to text conversion for robots, Mycroft, Navigation for robotics, SLAM, training using neural networks for navigation, human behavior in robotics, robot emotion engine, human emotion model

[30% Weightage]

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**

1-9	**INTRODUCTION to Robotics** Introduction to robotics, classification of robots, workspace analysis, Manipulator Kinematics: Convention for affixing frames to links – DH Representation, Derivation of Direct kinematic equations for various types of robots. Inverse Manipulator Kinematics: Solvability, algebraic vs. geometric, Pipers solution when three axes intersect, Examples of inverse manipulator kinematics, repeatability and accuracy, Robot Dynamics
10-22	**Robotic Control** Robot Kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple Transformation-Simple problems, Introduction to Robot Sensing, Range sensors, Proximity sensors and touch sensors, Force and torque sensors, Introduction to Robot Vision, Low level and high-level vision, Introduction to Robot actuators, Introduction to Robot Control, Robot intelligence and task planning, Control Components, De-mining Robot: Embedded Robot Controller, I/O Interface, and PWM Amplifiers, Control software
23-31	**Robotics and Cyber Physical Systems** Introduction to cyber physical systems, Structure and Functions of Cyber-Physical Systems, Components Model: Linked Logical and Physical Elements, Interactions Model: Linked State Transitions, Components of CPS, Application of CPS, Integration of CPS with robotics, robotic arm, Application of CPS, Introduction to smart manufacturing, Industry 4.0, Robotic applications in smart manufacturing
32-35	**Artificial Intelligence in Robotic Application** Image Recognition, Using the artificial neural network and supervised learning for object recognition, teaching robotic arm for picking objects, adaptive and Q learning based approach for picking up objects, Google SAC-Z, Amazon Robotics challenge, speech to text conversion for robots, Mycroft, Navigation for robotics, SLAM, training using neural networks for navigation, human behavior in robotics, robot emotion engine, human emotion model
15 Hours	***Tutorials***

Essential Reading:

1. Introduction to Autonomous Mobile Robots by Illah Reza Nourbakhsh and Roland Siegwart: MIT Press

2. Principles of Cyber-Physical Systems by Rajeev Alur: MIT Press

Cloud Computing

Course Code	CAI91DE02704	**Credits**	4
L + T + P	3+1+0	**Course Duration**	One Semester
Semester		**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline-Based Core Elective		
Nature of the Course	Theory/Skill Based		
Special Nature/ Category of the Course (*if applicable*)	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Group discussion, seminar, presentations by students		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives:

- the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges;
- the basic ideas and principles in data center design; cloud management techniques and cloud software deployment considerations;
- different CPU, memory and I/O virtualization techniques that serve in offering software, computation and storage services on the cloud; Software Defined Networks (SDN) and Software Defined Storage(SDS);
- cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage;
- Cloud application development

Course Learning Outcomes:

- Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing.
- Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost, and then study how to leverage and manage single and multiple datacenters to build and deploy cloud applications that are resilient, elastic and cost-efficient.
- Discuss system, network and storage virtualization and outline their role in enabling the cloud computing system model.
- Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS.
- Analyze various cloud programming models and apply them to solve problems on the cloud

Prerequisites: Basics of computer, Networking

Course Content

Module I Fundamentals of cloud computing
System Models for Edge and Cloud Computing – Software Environments for Cloud computing–Edge computing characteristic and architecture-edge computing challenges-Cloud Computing Service Models – Public – Private – Hybrid Clouds – Infrastructure-as-a Service (IaaS) – Platform-as-aService (PaaS) - Software-as-a-Service (SaaS)-Different Service Providers

[20% Weightage]

Module II Cloud Infrastructure
Cloud Computing and Service Models-Architectural Design of Compute and Storage Clouds-Inter-cloud Resource Management- Resource Provisioning and Platform Deployment, Virtual Machine Creation and Management.

[20% Weightage]

Module III Cloud Resource virtualization
Basics of Virtualization, Types of Virtualization, Implementation Levels of Virtualization-VMM Design Requirements and Providers, Virtualization Support at the OS Level, Middleware Support for Virtualization- Virtualization Structures, Tools and Mechanisms-Binary Translation with Full Virtualization, Para-Virtualization with Compiler Support-Virtual Clusters and Resource management- Virtualization for Data-Center Automation-Cloud OS for Virtualized Data Centers, Trust Management in Virtualized Data Centers

[20% Weightage]

Module IV Cloud Storage and Security
Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems.
Security Overview – Cloud Security Challenges – Security -as-a Service – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security**.**

[20% Weightage]

Module V Cloud Application Development
Amazon Web Services: EC2 – instances, connecting clients, security rules, launching, usage of S3, Google: Google App Engine, Google Web Toolkit, Microsoft: Azure Services Platform

[20% Weightage]

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-9	**Fundamentals of cloud computing**

	Network centric computing, Network centric content, peer-to –peer systems, cloud computing delivery models and services, Ethical issues, Vulnerabilities, Major challenges for cloud computing. Parallel and Distributed Systems: introduction, architecture, distributed systems, communication protocols, logical clocks, message delivery rules, concurrency, and model concurrency with Petri Nets.
10-18	**Cloud Infrastructure** Cloud Computing and Service Models-Architectural Design of Compute and Storage Clouds-Inter-cloud Resource Management- Resource Provisioning and Platform Deployment, Virtual Machine Creation and Management
19-27	**Cloud Resource virtualization** Basics of Virtualization, Types of Virtualization, Implementation Levels of Virtualization- VMM Design Requirements and Providers, Virtualization Support at the OS Level, Middleware Support for Virtualization- Virtualization Structures, Tools and Mechanisms- Binary Translation with Full Virtualization, Para-Virtualization with Compiler Support- Virtual Clusters and Resource management- Virtualization for Data-Center Automation- Cloud OS for Virtualized Data Centers, Trust Management in Virtualized Data Centers
28-36	**Cloud Storage and Security** Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Security Overview – Cloud Security Challenges – Security -as-a Service – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security**.**
37-45	**Cloud Application Development** Amazon Web Services: EC2 – instances, connecting clients, security rules, launching, usage of S3, Google: Google App Engine, Google Web Toolkit, Microsoft: Azure Services Platform
30 Hours	***Lab***

Essential Reading:

1. Cloud Computing: From Beginning to End by Ray Rafaels: Createspace Independent Publishing Platform

2. Cloud Computing: A Hands-On Approach by Arshdeep Bahga: Vijay Madisetti

3. Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS) by Michale J.Kavis: Wiley

TEXT BOOKS:

1. Kai Hwang , Geoffrey C Fox, Jack J Dongarra : "Distributed and Cloud Computing – From Parallel Processing to the Internet of Things" , Morgan Kaufmann Publishers – 2012**.**

2. Mastering Cloud Computing – Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi – Tata McGraw Hill Education**.**

3. Cloud Computing: Concepts, Technology & Architecture (The Pearson Service Technology Series from Thomas Erl)

1. Cloud Computing with Security and Scalability.: Concepts and Practices 3rd ed. 2023 Edition by Naresh Kumar Sehgal (Author), Pramod Chandra P. Bhatt (Author)
2. CLOUD COMPUTING: Cloud Concepts;Methodology,Network Architecture Paperback – July 30, 2021 by Hemanand D (Author), Chembian W T (Author), Vallem Ranadheer Reddy (Author)

REFERENCES:

1. Alex Amies, Harm Sluiman, Qiang Guo Tong and Guo Ning Liu: Developing and Hosting Applications on the cloud, IBM Press, 2012**.**

VIRTUAL REALITY

Course Details			
Course Title: Virtual Reality			
Course Code:	CAI91DE02804	**Credits**	4
L + T + P	3 + 1+ 0	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline-Based Core Elective	**Nature of the Course**	Theory
Methods of Content Interaction	Lectures, Tutorials, simulations, seminars, assignments, and presentations by students		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Prerequisites: Understanding of fundamentals of Computer Graphics, Human-Computer Interaction and Computer Vision.

Course Objectives:

- Learn the fundamental Computer Vision, Computer Graphics and Human-Computer interaction
- Techniques related to VR/AR
- Review the Geometric Modeling Techniques
- Review the Virtual Environment
- Discuss and Examine VR/AR Technologies
- Use of various types of Hardware and Software in Virtual Reality systems
- Simulate and Apply Virtual/Augmented Reality to varieties of Applications

Course Learning Outcomes:

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

- Understand fundamental Computer Vision, Computer Graphics and Human-
- Computer Interaction Techniques related to VR/AR
- Understand Geometric Modeling Techniques
- Understand the Virtual Environment
- Analyze and evaluate VR/AR Technologies
- Apply various types of Hardware and Software in Virtual Reality systems
- Design and formulate Virtual/Augmented Reality Applications

Course Contents:

UNIT 1 Introduction to Virtual Reality (20% Weightage)

Virtual Reality and Virtual Environment, Historical development of VR, Real-time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, VR Applications.

UNIT 2 Computer Graphics and Geometric Modelling (20% Weightage)

The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, Color theory, Conversion From 2D to 3D, 3D space curves, 3D boundary representation, Simple 3D modelling, 3D clipping, Illumination models, Reflection models, Shading algorithms, Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection models

UNIT 3 Virtual Environment (20% Weightage)

Input/Output Devices: Input devices (Tracker, Sensor, Digital Gloves, Movement Capture, Video-based Input, 3D Menus & 3D Scanner, etc.), Output devices (Visual/Auditory/Haptic Devices)

Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems,

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system.

Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels,

Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft

UNIT 4 Augmented Reality (AR) (20% Weightage)

Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating AR systems

UNIT 5 IoT Augmented Reality (AR) (20% Weightage)

Human factors: Introduction, the eye, the ear, the somatic senses, *Hardware:* Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML

Tutorial: 15 Hrs.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-3	Virtual Reality and Virtual Environment, Historical development of VR, Real-time computer graphics, Flight Simulation,
4-5	Flight Simulation, Virtual environment requirement, benefits of virtual reality, VR Applications.
6-9	The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection
10-13	Color theory, Conversion From 2D to 3D, 3D space curves, 3D boundary representation, Simple 3D modelling, 3D clipping
14-16	Illumination models, Reflection models, Shading algorithms

17-20	Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection models
21-22	*Input/Output Devices:* Input devices (Tracker, Sensor, Digital Gloves, Movement Capture, Video-based Input, 3D Menus & 3D Scanner, etc.), Output devices (Visual/Auditory/Haptic Devices)
23-25	*Generic VR system:* Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems
26-29	*Animating the Virtual Environment:* Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system
29-32	*Physical Simulation:* Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft
33-36	Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods
37-40	Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating AR systems
41-41	Human factors: Introduction, the eye, the ear, the somatic senses
42-42	*Hardware:* Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems
43-45	Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML
15 Hours	*Tutorials*

Essential Readings:

- Coiffet, P., Burdea, G. C., (2003), "Virtual Reality Technology," Wiley-IEEE Press, ISBN: 9780471360896
- Learning Virtual Reality by Tony Parisi, O' Reilly
- Schmalstieg, D., Höllerer, T., (2016), "Augmented Reality: Principles & Practice," Pearson, ISBN: 9789332578494
- LaViola Jr., J. J., Kruijff, E., McMahan, R. P., Bowman, D. A., Poupyrev, I., (2017), "3D User Interfaces: Theory and Practice," Pearson, ISBN: 9780134034324
- Fowler, A., (2019), "Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#," Apress, ISBN: 9781484246672
- Craig, A. B., (2013), "Understanding Augmented Reality, Concepts and Applications," Morgan Kaufmann, ISBN: 9780240824086

Suggested Readings:

- Hassanien, A. E., Gupta, D., Khanna, A., Slowik, A., (2022), "Virtual and Augmented Reality for Automobile Industry: Innovation Vision and Applications," Springer, ISBN: 9783030941017
- Norman, K., Kirakowski, J., (2018), " Wiley Handbook of Human Computer Interaction," Wiley-Blackwell, ISBN: 9781118976135.
- Craig, A. B., Sherman, W. R., Will, J. D., (2009), "Developing Virtual Reality Applications, Foundations of Effective Design," Morgan Kaufmann, ISBN: 9780123749437
- John Vince, J., (2002), "Virtual Reality Systems, " Pearson, ISBN: 9788131708446
- Anand, R., "Augmented and Virtual Reality," Khanna Publishing House
- Kim, G. J., (2005), "Designing Virtual Systems: The Structured Approach", ISBN: 9781852339586.
- Bimber, O., Raskar, R., (2005), "Spatial Augmented Reality: Merging Real and Virtual Worlds," CRC Press, ISBN: 9781568812304
- O'Connell, K., (2019), "Designing for Mixed Reality: Blending Data, AR, and the Physical World," O'Reilly, ISBN: 9789352138371
- Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-onApproach)", 1st Edition, VPT, 2014.
- Sanni Siltanen, S., (2012), "Theory and applications of marker-based augmented reality," Julkaisija –Utgivare Publisher, ISBN: 9789513874490

INTERNET OF THINGS

Course Details			
Course Title: Internet of Things			
Course Code:	CAI91DE02904	**Credits**	4
L + T + P	3 + 1+ 0	**Course Duration**	One Semester

Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline-Based Core Elective	**Nature of the Course**	Theory
Methods of Content Interaction	Lectures, Tutorials, simulations, seminars, assignments, and presentations by students		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Prerequisites: Understanding of fundamentals of computer science especially the computer network concepts.

Course Objectives:

- To understand the application areas of IoT.
- To realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
- To able to understand the building blocks of Internet of Things and its characteristics.
- To understand IoT architecture and standardization.
- To learn the IoT protocol stack and other important related protocols.
- To understand various applications of IoT and the challenges involved in their development.

Course Learning Outcomes:

At the end of the course, students:

- Understand the vision of IoT from a global context.
- Explain the Edge computing Architecture
- Explain the Fog Computing Architecture
- Determine the Market perspective of IoT.
- Use of Devices, Gateways and Data Management in IoT.
- Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.
- Building state-of-the-art architecture in IoT.

Course Contents:

UNIT 1 Fundamentals of IoT (20% Weightage)

IoT definition and characteristics of IoT, IoT applications, Evolution of IoT, Enabling Technologies, Overview of IoT architecture and protocols: IoT components and IoT Communication Technologies, Simplified IoT, Domain Specific IoTs, IoT standards, IoT Challenges including Privacy and Security Issues.

UNIT 2 IoT Design & Architecture **(35% Weightage)**

Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects. Introduction to IoT Reference Architecture, Functional View, Information View, Deployment and Operational View, and Other Relevant architectural views.

IoT Architectures: IoT Network Architecture and Design, one M2M, IoT World Forum (IoTWF) and Alternative IoT models, Design principles and needed capabilities, IoT Design Methodologies, Real-World Design Constraints, Technical Design constraints, Data representation and visualization, Interaction and remote control.

UNIT 3 IoT Communication Protocols-I **(25% Weightage)**

PHY/MAC Layer: IEEE 802.11, IEEE 802.15, Wireless HART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, Network Layer: IP as the IoT Network Layer, The Need for Optimization, Optimizing IP for IoT, 6LoWPAN, 6TiSCH, RPL.

UNIT 4 IoT Communication Protocols-II **(20% Weightage)**

Transport & Session Layer Protocols: Transport Layer, Introduction to MPTCP, DCCP, SCTP, DTLS – Session Layer-CoAP, AMQP

Service Layer Protocols & Security: Service Layer -oneM2M, M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN

Tutorial : 15 Hrs.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-5	IoT definition and characteristics of IoT, IoT applications, Evolution of IoT, Enabling Technologies, Overview of IoT architecture and protocols: IoT components and IoT Communication Technologies
6-9	Simplified IoT, Domain Specific IoTs, IoT standards, Privacy and Security Issues.
10-13	*Functional blocks of an IoT ecosystem* – Sensors, Actuators, Smart Objects and Connecting Smart Objects.

14-20	Introduction to IoT Reference Architecture, Functional View, Information View, Deployment and Operational View, and Other Relevant architectural views.
21-24	*IoT Architectures:* one M2M, IoT World Forum (IoTWF) and Alternative IoT models, Design principles and needed capabilities,
25-26	IoT Design Methodologies, Real-World Design Constraints, Technical Design constraints
27-28	Data representation and visualization, Interaction and remote control.
29-33	*PHY/MAC Layer:* (IEEE 802.11, IEEE 802.15), Wireless HART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy
34-37	Network Layer: 6LoWPAN, 6TiSCH, RPL.
38-42	*Transport & Session Layer Protocols:* Transport Layer Introduction to MPTCP, DCCP, SCTP, DTLS – Session Layer-CoAP, AMQP
42-45	*Service Layer Protocols & Security:* Service Layer -oneM2M, M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN
15 Hours	*Tutorials*

Essential Readings:

- Hanes David, Salgueiro Gonzalo, Grossetete Patrick, "IoT fundamentals: Networking technologies, protocols and use cases for the Internet of Things", Cisco, Pearson India, 2015.
- Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012
- Jan Holler, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.
- Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things, Springer, 2011.
- Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach, Universities Press, 2015
- Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", First Edition, Cisco Press, USA.
- Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer

Suggested Readings:

- Peter Waher, “Learning Internet of Things”, PACKT publishing, Birmingham – Mumbai
- Chou, T. (2016). Precision: Principles, Practices and Solutions for the Internet of Things. Lulu Press, Inc.
- Stallings, W. (2009). Wireless communications & networks. Pearson Education India.
- Stallings, W. (2004). Computer networking with Internet protocols and technology. Upper Saddle River, NJ, USA: Pearson/Prentice Hall.
- Stallings, W. (2003). Network security essentials: Applications and standards, 4/e. Pearson Education India.
- Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118- 47347-4, Willy Publications
- Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-onApproach)”, 1st Edition, VPT, 2014.
- Jean-Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP, The Next Internet”, Morgan Kaufmann, 2010

EDGE & FOG COMPUTING

Course Details			
Course Title: EDGE & FOG COMPUTING			
Course Code:	CAI91DE03004	**Credits**	4
L + T + P	3 + 1+ 0	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core/Core Elective	**Nature of the Course**	Theory
Methods of Content Interaction	Lecture, Tutorials, simulation, seminar, assignment, presentations by students		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Edge and Fog Computing

Course Prerequisites: Understanding of fundamentals of computer science, computer networking and operating systems. Knowledge of electronic components is helpful.

Course Objectives

- To introduce students the concept of Edge and Fog computing and its features
- To introduce them about various edge and fog computing architectures.
- To introduce students to methods to improve performance IoT using of edge computing.
- To introduce students with the concepts of formal modeling for Fog computing, optimization opportunities and optimization techniques.
- To introduce students to Fog computing middleware.
- To introduce students to data management techniques in Fog.
- To skill students with simulation tool for Fog computing so that they can further perform independent studies in the domain.

Course Learning outcomes

After the course the students will be able to:

- explain the Edge computing Architecture
- explain the Fog computing Architecture
- identify the benefits of edge computing.
- create use cases in IoT with edge computing
- simulate the Fog using iFogSim for given scenario

UNIT 1 Introduction to Fog and Edge Computing (25% eightage)

Edge and Fog Computing models, Completing the Cloud, Advantages and limitations of Edge and Fog Computing, Similarities and Differences between Edge & Fog Computing, applications of these models: SCALE, How Edge and Fog computing achieves these advantages: SCANC, Hierarchy of Edge and Fog Computing, Addressing the Challenges in Federating Edge Resources: The Networking Challenge, The Management Challenge, Miscellaneous Challenges.

UNIT 2 Optimization Problems in Fog and Edge Computing (20% Weightage)

The Case for Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Metrics, Optimization Opportunities along the Fog Architecture, Optimization Opportunities along the Service Life Cycle, Optimization Techniques.

UNIT 3 Middleware for Fog and Edge Computing: Design Issues (20% Weightage)

Need for Fog and Edge Computing Middleware, Design Goals, State-of-the-Art Middleware Infrastructures, System Model.

UNIT 4 Data Management in Fog Computing (15% Weightage)

Fog Data Management, Applications and Issues: Big Data Analytics, Health Monitoring, Surveillance, IoT.

UNIT 5 Modeling and Simulation Using iFogSim Toolkit (15% Weightage)

iFogSim Simulator and Its Components, Installation of iFogSim, Building Simulation with iFogSim, Example Scenarios, Simulation of a Placement Policy, A Case Study in Smart Healthcare.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-2	Fog and Edge Computing (FEC) Completing the Cloud
3-5	Advantages of FEC: SCALE, How FEC Achieves these Advantages: SCANC
6	Hierarchy of Fog and Edge Computing
7-10	Addressing the Challenges in Federating Edge Resources: The Networking Challenge, The Management Challenge, Miscellaneous Challenges.
11-14	The Case for Optimization in Fog Computing, Formal Modeling Framework for Fog Computing
14-17	Metrics, Optimization Opportunities along the Fog Architecture
18-22	Optimization Opportunities along the Service Life Cycle, Optimization Techniques
27-29	Need for Fog and Edge Computing Middleware, Design Goals
29-34	State-of-the-Art Middleware Infrastructures, System Model
35-36	Fog Data Management
37-38	Applications and Issues: Big Data Analytics
39-40	Applications and Issues: Health Monitoring, Surveillance
40-41	Applications and Issues: IoT
42-43	iFogSim Simulator and Its Components, Installation

43-45	Building Simulation with iFogSim, Example Scenarios, Simulation of a Placement Policy, A Case Study in Smart Healthcare
15 Hours	Tutorials

Essential Readings:

1. Rajkumar Buyya, Satish Narayana Srirama, Fog and Edge Computing: Principles and Paradigms, Wiley, 2019 ISBN: 978-1-119-52498-4

Suggested Readings:

1. Ajit Singh, Edge Computing: Simply In Depth, 2019 ISBN: 979-8725825428

2. Cao, Jie, Zhang, Quan, Shi, Weisong, Edge Computing: A Primer, Pearson Education, Springer, 2018 ISBN: 978-3030020828

3. Awaisi, K. S., Abbas, A., Khan, S. U., Mahmud, R., & Buyya, R. (2021). Simulating Fog Computing Applications using iFogSim Toolkit. Mobile Edge Computing, 565-590.

4. Mahmud, R., Kotagiri, R., & Buyya, R. (2018). Fog computing: A taxonomy, survey and future directions. *Internet of Everything: Algorithms, Methodologies, Technologies and Perspectives*, 103-130.

5. http://www.buyya.com/papers/iFogSim-Tut.pdf

6. https://github.com/Cloudslab/iFogSim
7. https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-325.pdf

BLOCKCHAIN TECHNOLOGY

Course Details			
Course Title: BLOCKCHAIN TECHNOLOGY			
Course Code:	CAI91DE03104	**Credits**	4
L + T + P	3 +1+0	**Course Duration**	One Semester
Semester	I	**Contact Hours**	45 (L) + 15 (T) Hours

Course Type	Discipline-Based Core Elective	**Nature of the Course**	Theory
Methods of Content Interaction	Lectures, Programming, Assignments, Class Tests, Mini Project and viva		
Assessment and Evaluation	30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) 70% - End Term External Examination (University Examination)		

Course Prerequisites: Knowledge of at least one of the programming languages

Course Objectives

- The objective of this course is to provide conceptual understanding of block chain technology.
- Industry use of Blockchain technology.
- The course covers the technological underpinning of block Chain operations in both theoretical and practical implementation of solutions using Ethereum.

Course learning outcomes

After the course the students:

- Understand block chain technology.
- Understand Cryptocurrency
- Understand Smart contract
- Develop block chain based solutions and write smart contract using Ethereum Framework.

Course Contents:

UNIT I Introduction to Blockchain and Crypto Primitives (25% Weightage)

Introduction and Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Blockchain, Transactions, Distributed Consensus, Public Blockchain vs Private Blockchain, Properties of Private Blockchain, Understanding Cryptocurrency to Blockchain, Permissioned Model of Blockchain, Overview of Security aspects of Blockchain,

Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, cryptocurrency.

UNIT-II Understanding Blockchain with Cryptocurrency: (25% Weightage)

Bitcoin and Blockchain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

UNIT III Understanding Blockchain for Enterprises: (25% Weightage)

Permissioned Blockchain: Permissioned model and use cases, Design issues for Permissioned blockchains, Execute contracts, State machine replication, Overview of Consensus models for permissioned blockchain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems. Enterprise application of Blockchain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Blockchain.

UNIT V Blockchain application development (25% Weightage)

Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-2	Introduction and Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts
3-5	Block in a Blockchain, Transactions, Distributed Consensus, Public Blockchain vs Private Blockchain, Properties of Private Blockchain,
6-9	Understanding Cryptocurrency to Blockchain, Permissioned Model of Blockchain, Overview of Security aspects of Blockchain,
10-14	**Basic Crypto Primitives:** Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, cryptocurrency
15-16	Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network

16-17	Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.
18-22	Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW,
23-25	Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool
26-30	Permissioned Blockchain: Permissioned model and use cases, Design issues for Permissioned blockchains, Execute contracts, State machine replication
31-35	Overview of Consensus models for permissioned blockchain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.
35-39	**Enterprise application of Blockchain:** Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Blockchain. .
40-42	Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation,
43-45	Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.
15 Hours	Tutorial

Essential Readings:

1. Blockchain: Blueprint for a New Economy by Melanie Swan, O'Reilly, 2015
2. Blockchain: The Blockchain for Beginners-Guide to Blockchain Technology and Leveraging Blockchain Programming by Josh Thompsons
3. Blockchain Basics by Daniel Drescher, Apress; 1stedition, 2017

Suggestive Readings:

1. Mastering Blockchain by Lorne Lantz and Daniel Cawrey, O'Reilly, 2020
2. Mastering Ethereum: Building Smart Contracts and DApps by Andreas M. Antonopoulos, Dr. Gavin Wood, Gavin Wood, O'Reilly, 2018

Computer Vision

Course Code	CAI91DE03204	**Credits**	4
L + T + P	3+1+0	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		
Special Nature/ Category of the Course (*if applicable*)	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Group discussion, seminar, presentations by students		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives:

- Understand the concept of computer vision and image characteristics
- Fundamentals of image processing, image enhancement and transformations
- Gain hands-on experience of computer vision softwares
- Image Analysis

Course Learning Outcomes:

- Understanding of images and its characteristics
- Image enhancement and filtering using softwares.
- Ability to apply various image transformation and segmentation methods.
- Participant will be able to work with various image classification methods

Prerequisites: Python programming

Course Contents:

Module I: Introduction to Computer Vision [25% Weightage]

Introduction to computer vision, Image Processing VS Computer Vision, Introduction to images
Digital Image, pixels, matrix representation of image, image display, Display Utility Functions
Colored Image, Image Channels, Splitting and Merging Channels, Manipulating Color pixels, Creation of image, Cropping an image Section, Resizing an image, image mask, Contrast Enhancement, Brightness Enhancement, Bitwise operations, Image Annotation, Draw a line over an image, Draw a Circle over an image, Draw a Rectangle over an image, Draw text over an image

Module IV: Image Enhancement and Filtering [25 % Weightage]
Color: Physics of color; human color perception, Representing color; A model for image color; surface color from image color.

Color Spaces, RGB Color Space, HSV Color Space, Finding Dominant Color in an image , Color Transforms, Histogram Equalization, Advanced Histogram Equalization(CLAHE) , Image Filtering, Meaning of Convolution and Correlation, Image Smoothing, Box Blur Gaussian Blur, Median Blur

Unit -III Linear filters and Edge detection [20 % Weightage]

Linear filters: Linear filters and convolution; shift invariant linear systemsdiscrete convolution, continuous convolution, edge effects in discrete convolution; Spatial frequency and fourier transforms; Sampling and aliasing; filters as templates; Normalized correlations and finding patterns

Edge detection: Noise; estimating derivatives; detecting edges.

Unit IV: Binary Image Processing [15 % Weightage]
Thresholding, Thresholding, Erosion / Dilation, Overview on Erosion and Dilation, Opening and Closing, Connected Component Analysis, Contour Analysis

Unit V:Segmentation by clustering: [15 % Weightage]
Human vision, applications, segmentation by graph theoretic clustering. Segmentation by fitting a model, Hough transform; fitting lines, fitting curves.

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-2	Introduction to computer vision, Image Processing VS Computer Vision, Introduction to images

3-5	Digital Image, pixels, matrix representation of image, image display, Display Utility Functions
6-8	Colored Image, Image Channels, Splitting and Merging Channels, Manipulating Color pixels,
10-14	Creation of image, Cropping an image Section, Resizing an image, image mask, Contrast Enhancement, Brightness Enhancement, Bitwise operations, Image Annotation, Draw a line over an image, Draw a Circle over an image, Draw a Rectangle over an image, Draw text over an image
15-17	Color: Physics of color; human color perception, Representing color; A model for image color; surface color from image color.
18-19	, Color Transforms, Histogram Equalization, Advanced Histogram Equalization(CLAHE)
20-24	, Image Filtering, Meaning of Convolution and Correlation, Image Smoothing, Box Blur Gaussian Blur, Median Blur
25-29	**Linear filters:** Linear filters and convolution; shift invariant linear systemsdiscrete convolution, continuous convolution, edge effects in discrete convolution;
30-32	Spatial frequency and fourier transforms; Sampling and aliasing; filters as templates; Normalized correlations and finding patterns
33-34	Noise; estimating derivatives; detecting edges.
35-37	Thresholding, Thresholding, Erosion / Dilation, Overview on Erosion and Dilation, Opening and Closing, Connected Component Analysis, Contour Analysis
38-41	Human vision, applications, segmentation by graph theoretic clustering.
42-45	Segmentation by fitting a model, Hough transform; fitting lines, fitting curves.
15 Hours	***Tutorials***

Essential Readings:

1. David A Forsynth and Jean Ponce, Computer Vision- A modern approach, Pearson education series, 2003.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, Digital image processing and computer vision, Cengage learning, 2008.
3. Schalkoff R. J., Digital Image Processing and Computer Vision, John Wiley, 2004.

Additional Readings:

1. Learning OpenCV Book by Adrian Kaehler and Gary BradskiHadoop: O'Reilly
2. Mastering OpenCV 4 with Python by Alberto Fernández Villán:packt publication
3. A Practical Introduction to Computer Vision with OpenCV by Kenneth Dawson-Howe

Data Visualization

Course Details			
Course Title: Data Visualization			
Course Code:	CAI91DE03304	**Credits**	4
L + T + P	3 +1+0	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline-Based Core Course	**Nature of the Course**	Core
Methods of Content Interaction	Lectures, Programming, Assignments, Class Tests, Mini Project and viva		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70%- End Term External Examination (University Examination)		

Course Prerequisites:

Course Objectives

- To understand the basics of data visualization.
- To Learn various techniques about visualizing the data.
- To implement data visualization tools.
- To learn about methods of visualizing distributions, associations among two or more quantitative variables and different types of data.

Course learning outcomes

After the course the students:

- Understand basic types of data and need of visualization.
- Understand and analyse the visualization for data and distributions.
- Identify and develop the different types of tools for visualizing the data.
- Understand how to visualize the complex datasets.
- Understand the different Image file formats.

Course Contents:

UNIT 1

[20%] Introduction to Data, The Basic Data Types – Nominal, Ordinal, interval, Ratio scaled.
Non dependency Oriented Data: Quantitative Multidimensional Data, Categorical and Mixed Attribute Data, Binary and Set Data, Text Data.
Dependency-Oriented Data: Time-Series Data, Discrete Sequences and Strings, Spatial Data, Network and Graph Data.
Why visualize Data? The visualization pipeline.

UNIT-II **[20%]**

Visualizing Data: Mapping Data onto Aesthetics, Coordinate Systems and Axes, Colour scales, Directory of Visualizations, Visualizing Amounts.

UNIT-III

[20%]

Visualizing Distributions and visualizing many Distributions at once, Visualizing Associations among Two or More Quantitative Variables, Visualizing Time series and other functions of an independent variable.

UNIT-IV

[20%]

Visualize Trends, Geospatial data and uncertainty, Visualization of Networks and Trees, visualizing multidimensional data, Data Reduction – Reduce Items and Attributes.

UNIT-V

[20%]

The principles of proportional link, Handling overlapping points, Balance the data and context, Understanding the most commonly used Image file formats, choosing the right visualization software.

Content Interaction Plan:

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-4	Introduction to Data, The Basic Data Types – Nominal, Ordinal, interval, Ratio scaled. Non dependency Oriented Data: Quantitative Multidimensional Data, Categorical and Mixed Attribute Data, Binary and Set Data, Text Data.
5-6	Dependency-Oriented Data: Time-Series Data, Discrete Sequences and Strings, Spatial Data, Network and Graph Data.
7-9	Why visualize Data? The visualization pipeline.
10-14	Visualizing Data: Mapping Data onto Aesthetics,
15-16	Coordinate Systems and Axes, Colour scales,
17-19	Directory of Visualizations, Visualizing Amounts,
20-22	Visualizing Distributions and visualizing many Distributions at once,
23-29	Visualizing Associations among Two or More Quantitative Variables, Visualizing Time series and other functions of an independent variable.

30-33	Visualize Trends, Geospatial data and uncertainty,
34-37	Visualization of Networks and Trees, visualizing multidimensional data, Data Reduction – Reduce Items and Attributes.
38-40	The principles of proportional link, Handling overlapping points, Balance the data and context,
41-45	Understanding the most commonly used Image file formats, choosing the right visualization software
15 Hours	Tutorial

Essential Readings:

1. Claus O. Wilke, Fundamentals of Data Visualization, O'Reilly publication, first Release Edition.
2. Tamara Munzner. Visualization Analysis and Design. A K Peters Visualization Series, CRC Press, 2014

Suggestive Readings:

1. Kieran Healy, Data Visualization: A Practical Introduction 1stEdition, Princeton university press.
2. Jiawei Han and Micheline Kamber, Data Mining- Concepts and Techniques-Morgan Kaufmann Publishers, Elsevier, 2nd Edition, 2006.

Human Computer Interaction

Course Title:	**Human Computer Interaction**		
Course Code	CAI91DE03404	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline-Based Core/Core Elective	**Nature of the Course**	Theory/Skill Based
Methods of Content Interaction	Lectures, Tutorials, simulations, seminars, and presentations by students		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Prerequisites: Understanding of fundamentals of computer science.

Course Objectives

- To introduce students to the foundations of Human Computer Interaction.
- To make students familiar with the design technologies for individuals and persons with disabilities.
- To make students aware of mobile HCI.
- To teach students the guidelines for user interface.

Course Learning outcomes

After the course, the students will be able to:

- design effective dialogue for HCI.
- design effective HCI for individuals and persons with disabilities.
- assess the importance of user feedback.
- explain the HCI implications for designing multimedia/e-commerce/ e-learning Web sites.
- develop meaningful user interfaces.

UNIT 1 Foundations of HCI **(20% Weightage)**

The Human: I/O channels – Memory – Reasoning and problem-solving; The Computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms. - Case Studies.

UNIT 2 Design & Software Process **(20% Weightage)**

Interactive Design: Basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process: Software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules: principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

UNIT 3 Models and Theories **(20% Weightage)**

HCI Models: Cognitive models: Socio-Organizational issues and stakeholder requirements – Communication and collaboration models-Hypertext, Multimedia and WWW.

UNIT 4 Mobile HCI **(20% Weightage)**

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. - Case Studies.

UNIT 5 Web Interface Design **(20% Weightage)**

Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays

and Virtual Pages, Process Flow - Case Studies.

Lecture cum Discussion **(Each session of 1 Hour)**	**Unit/Topic/Sub-Topic**
1-2	The Human: I/O channels – Memory – Reasoning and problem-solving
3-4	The Computer: Devices – Memory – processing and networks
5-6	Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms
7-8	HCI Case Studies
9-14	Interactive Design: Basics – process – scenarios – navigation – screen design – Iteration and prototyping
14-17	HCI in software process: Software life cycle – usability engineering – Prototyping in practice – design rationale
18-22	Design rules: principles, standards, guidelines, rules. Evaluation Techniques – Universal Design
27-29	HCI Models: Cognitive models: Socio-Organizational issues and stakeholder requirements
29-34	Communication and collaboration models-Hypertext, Multimedia and WWW.
35-36	Mobile Ecosystem: Platforms, Application frameworks
37-38	Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture
39-40	Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. - Case Studies
40-41	Designing Web Interfaces – Drag & Drop, Direct Selection
42-43	Contextual Tools, Overlays, Inlays and Virtual Pages
43-45	Process Flow - Case Studies
15 Hours	Tutorials

Essential Readings:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ―Human Computer Interaction‖, 3rd Edition, Pearson Education, 2004, ISBN: 9780130461094

Reference Books:

1. Brian Fling, "Mobile Design and Development", First Edition, O'Reilly Media Inc., 2009 ISBN: 8184048173
2. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O'Reilly, 2009 ISBN: 935542289X

TIME SERIES ANALYSIS & FORECASTING

Course Code	CAI91DE03504	**Credits**	4
L + T + P	3 +0 +1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 Lab Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory and Lab		
Methods of Content Interaction	Lecture, Tutorials, self-study, presentations by students, assignments.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To learn about important time series models and their applications in various fields.
- To formulate real life problems using time series models.
- To use statistical software to estimate the models from real data, and draw conclusions and develop solutions from the estimated models.
- To use visual and numerical diagnostics to assess the soundness of their models.
- To combine and adapt different statistical models to analyze larger and more complex data.

Learning Outcomes

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

- Understand what is time series, stationary proces and ARMA models.
- Understand spectral analysis, Stationary Process and ARMA Models.
- Apply important concepts and principles of Nonstationary and Seasonal Time Series Models.
- Understand different time series forecasting techniques.

Course Contents

UNIT I **(15% weightage)**

Introduction - Examples of time series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components.

Stationary Process and ARMA Models - Basic properties and linear processes, Introduction to ARMA models, properties of sample mean and autocorrelation function, Forecasting stationary time series, ARMA(p, q) processes, ACF and PACF, Forecasting of ARMA processes.

UNIT II **(15% weightage)**

(10% weightage)

Spectral Analysis - Spectral densities, Time-invariant linear filters, The spectral density of an ARMA process, Modeling and Forecasting with ARMA Processes.
Modeling and Forecasting with ARMA Processes - Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection**.**
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UNIT III **(25% weightage)**
Nonstationary and Seasonal Time Series Models - ARIMA models, Identification techniques, Unit roots in time series, Forecasting ARIMA models, Seasonal ARIMA models, Regression with ARMA errors.

UNIT IV **(25% weightage)**
Multivariate Time Series - Second-order properties of multivariate time series, Estimation of the mean and covariance, Multivariate ARMA processes, best linear predictors of second-order random vectors, Modeling and forecasting.
State-Space Models - State-space representations, The basic structure model, State-space representation of ARIMA models, The Kalman Recursions, Estimation for state-space models.

UNIT V **(20% weightage)**
Forecasting Techniques - The ARAR algorithm, The Holt-Winter algorithm, The Holt-Winter seasonal algorithm. *Estimation of time series models.*

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**

1-8	*Introduction* - Examples of time series, Stationary models and autocorrelation function, Estimation and elimination of trend and seasonal components.
9-12	*Stationary Process and ARMA Models* - Basic properties and linear processes, Introduction to ARMA models, properties of sample mean and autocorrelation function, Forecasting stationary time series, ARMA(p, q) processes, ACF and PACF, Forecasting of ARMA processes.
13-15	*Spectral Analysis* - Spectral densities, Time-invariant linear filters, The spectral density of an ARMA process, Modeling and Forecasting with ARMA Processes. *Modeling and Forecasting with ARMA Processes* - Preliminary estimation, Maximum likelihood estimation, Diagnostics, Forecasting, Order selection.
16-18	*Nonstationary and Seasonal Time Series Models* - ARIMA models, Identification techniques, Unit roots in time series, Forecasting ARIMA models, Seasonal ARIMA models, Regression with ARMA errors.
19-27	*Multivariate Time Series* - Second-order properties of multivariate time series, Estimation of the mean and covariance, Multivariate ARMA processes, Best linear predictors of second-order random vectors , Modeling and forecasting.
28-38	*State-Space Models* - State-space representations, The basic structure model, State-space representation of ARIMA models, The Kalman Recursions , Estimation for state-space models.
39-45	*Forecasting Techniques* - The ARAR algorithm, The Holt-Winter algorithm, The Holt-Winter seasonal algorithm. *Estimation of time series models.*
30 Hours	*Lab*

Essential Readings:

- Brockwell, Peter J. and Davis, Richard A. (2002). Introduction to Time Series and Forecasting, 2nd edition. Springer-Verlag, New York.

Further Readings:

- Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994). Time Series Analysis: Forecasting and Control, 3rd Edition, Prentice Hall, New Jersey.
- Chatfield, C. (1996). The Analysis of Time Series, 5th edition, Chapman and Hall, New York.
- Shumway, R.H., Stoffer, D.S. (2006). Time Series Analysis and Its Applications (with R examples). Springer-Verlag, New York.
- James D. Hamilton (1994). Time Series Analysis, 1st Edition, Princeton University Press.

CYBER SECURITY

Course Title:	Cyber Security		
Course Code	CAI91DE03604	**Credits**	4
L + T + P	3 + 1 + 0	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 15 (T) Hours
Course Type	Discipline-Based Core Elective	**Nature of the Course**	Theory/Skill Based
Methods of Content Interaction	Lectures, Tutorials, simulations, seminars, and presentations by students		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Prerequisites: Understanding of fundamentals of computer networks and Operating Systems fundamentals with an understanding of the Linux operating system.

Course Objectives:

- Learn the foundations of Cyber security and threat landscape
- To equip students with the technical knowledge and skills needed to protect and defend against cyber threats.
- To develop skills in students that can help them plan, implement, and monitor cyber security mechanisms to ensure the protection of information technology assets.
- To expose students to governance, regulatory, legal, economic, environmental, social and ethical contexts of cyber security.

Course Learning outcomes

After the course, the students will be able to:

- Understand the cyber security fundamentals and threat landscape
- Develop a deeper understanding and familiarity with various types of cyber attacks, cyber crimes, vulnerabilities and remedies thereto.
- Understand the security policies and cyber laws
- Analyse and evaluate existing legal frameworks and laws on cyber security
- Analyse and evaluate the importance of personal data its privacy and security
- Analyse and evaluate the security aspects of social media platforms
- Based on the Risk assessment, plan suitable security controls, audit and compliance.

UNIT 1 Introduction to Cyber Security **(20% Weightage)**

Cyber security, increasing threat landscape, cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker, Non-state actors, Definition and Classifications of Cybercrimes, Cyber terrorism, Cyberoffenses, How

Criminals Plan Them: How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets, Critical IT and National Critical Infrastructure, Cyberwarfare.

UNIT 2 Cybercrimes, Tools and Techniques (30% Weightage)

Cyber crimes targeting Computer systems and Mobiles: Proxy Servers and Anonymizers, Data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, viruses, Trojans, ransomware, data breach, Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cyber-squatting, Pharming, Cyber espionage, Cryptojacking, Darknet-illegal trades, drug trafficking, human trafficking., *Social Media Scams & Frauds*: Impersonation, identity theft, job scams, misinformation, fake news cyber crime against persons - cyber grooming, child pornography, cyber stalking, Social Engineering attacks, Cyber Police stations, Crime reporting procedure.

UNIT 3 Cyber Law (15% Weightage)

Cyber crime and legal landscape around the world, IT Act-2000 and its amendments. Limitations of IT Act, 2000. Cyber crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies. Intellectual Property Issues, Overview of Intellectual Property Related Legislation in India, Patent, Copyright.

UNIT 4 Data Privacy and Data Security (20% Weightage)

Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR), 2016, Personal Information Protection and Electronic Documents Act (PIPEDA), Social media: data privacy and security issues.

UNIT 5 Cyber Security Management, Compliance and Governance (15% Weightage)

Cyber security Plan: cyber security policy, cyber crises management plan, Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy.

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**

1-4	Cyber security, increasing threat landscape, cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker, Non-state actors
5-7	Definition and Classifications of Cybercrimes, Cyber terrorism, Cyberoffenses, How Criminals Plan Them: How Criminals Plan the Attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets,
8-8	Critical IT and National Critical Infrastructure, Cyberwarfare.
9-12	*Cyber crimes targeting Computer systems and Mobiles*: Proxy Servers and Anonymizers, Data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, viruses, Trojans, ransomware, data breach,
13-15	Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cyber-squatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking.,
16-18	*Social Media Scams & Frauds*: Impersonation, identity theft, job scams, misinformation, fake news cyber crime against persons - cyber grooming, child pornography, cyber stalking, Social Engineering attacks, Cyber Police stations, Crime reporting procedure.
19-21	Cyber crime and legal landscape around the world, IT Act-2000 and its amendments. Limitations of IT Act, 2000.
22-24	Cyber crime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media
25-26	Cyber Laws of other countries, Case Studies. Intellectual Property Issues, Overview of Intellectual Property Related Legislation in India, Patent, Copyright.
27-29	Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles,
30-34	Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR), 2016, Personal Information Protection and Electronic Documents Act (PIPEDA)
35-35	Social media: data privacy and security issues.
36-38	*Cyber security Plan:* cyber security policy, cyber crises management plan
39-40	Business continuity, Risk assessment, Types of security controls and their goals
40-43	Cyber security audit and compliance

44-45	National cyber security policy and strategy
15 Hours	Tutorials

Essential Readings:

1. James Graham, Ryan Olson, Rick Howard, "Cyber Security Essentials", CRC Press, 15-Dec 2010.
2. SunitBelapure and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives", Wiley India Pvt Ltd, ISBN: 978-81-265-21791
3. Dr. Surya PrakashTripathi, RitendraGoyal, Praveen Kumar Shukla, KLSI. "Introduction to information security and cyber laws". Dreamtech Press. ISBN: 9789351194736, 2015

Suggested Readings:

1. Thomas J. Mowbray, "Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions", Copyright © 2014 by John Wiley & Sons, Inc, ISBN: 978-1-118 -84965-1.
2. Anti- Hacker Tool Kit (Indian Edition) by Mike Shema, McGraw-Hill Publication

SOFT COMPUTING

Course Details			
Course Title: SOFT COMPUTING			
Course Code	CAI91DE02004	**Credits**	4
L + T + P	3 +0+1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 (Lab) Hours
Course Type	Discipline based Elective		
Nature of Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, self-study, seminar, presentations by students, assignments.		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

- To familiarize with soft computing concepts.
- To introduce the fuzzy logic concepts, fuzzy principles and relations.
- To provide the basics of ANN and Learning Algorithms.
- Discuss Genetic Algorithms and its applications to soft computing

Course Learning Outcomes

After going through this course a student should be able to:

- Understand basics of fuzzy system, genetic algorithms & their relations.
- Learn artificial neural network models and their functions.
- Apply genetic algorithms & artificial neural networks as computation tools to solve a variety of problems in various areas of interest ranging from optimization problems to text analytics.

Pre-requisites: Artificial intelligence

Course Contents:

UNIT I **[15% weightage]**

Introduction to soft computing - relevance, advantage and importance of soft computing - components of soft computing - applications of soft computing - ability of soft computing to handle uncertainty, vagueness, ambiguity - introduction to computational intelligence - relationship between computational intelligence and soft computing

UNIT II **[20% weightage]**

Introduction to fuzzy sets - t-norms - t-conorms - alpha-cuts - distance between fuzzy sets, fuzzy numbers - extension principle - interval arithmetic and alpha-cuts - properties of fuzzy arithmetic - fuzzy max and min - inequalities

UNIT III **[20% weightage]**

Introduction to fuzzy logic - applications of fuzzy logic - types of membership functions, fuzzy inference system - fuzzifier - defuzzifier - inference engine - rule base, fuzzy rules - mamdani type fuzzy rules - Takagi-Sugeno type fuzzy rules, introduction to type-2 fuzzy logic and its advantages over type-1 fuzzy logic

UNIT IV **[25% weightage]**

Introduction to genetic algorithm - applications of genetic algorithm - concepts of genes, chromosomes, population and its initialization - fitness function - types of selection mechanism, working of roulette wheel selection - types of crossover operations - working of one point, two point, multipoint and arithmetic crossovers - mutation - reinsertion - steps of simple genetic algorithm

UNIT V **[20% weightage]**

Introduction to biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network

Content Interaction Plan:

Lecture cum Discussion (Each	**Unit/Topic/Sub-Topic**

session of 1 Hour)	
1-10	Introduction to soft computing - relevance, advantage and importance of soft computing - components of soft computing - applications of soft computing - ability of soft computing to handle uncertainty, vagueness, ambiguity - introduction to computational intelligence - relationship between computational intelligence and soft computing
11-21	Introduction to fuzzy sets - t-norms - t-conorms - alpha-cuts - distance between fuzzy sets, fuzzy numbers - extension principle - interval arithmetic and alpha-cuts - properties of fuzzy arithmetic - fuzzy max and min - inequalities
22-30	Introduction to fuzzy logic - applications of fuzzy logic - types of membership functions, fuzzy inference system - fuzzifier - defuzzifier - inference engine - rule base, fuzzy rules - mamdani type fuzzy rules - Takagi-Sugeno type fuzzy rules, introduction to type-2 fuzzy logic and its advantages over type-1 fuzzy logic
31-38	Introduction to genetic algorithm - applications of genetic algorithm - concepts of genes, chromosomes, population and its initialization - fitness function - types of selection mechanism, working of roulette wheel selection - types of crossover operations - working of one point, two point, multipoint and arithmetic crossovers - mutation - reinsertion - steps of simple genetic algorithm
39-45	Introduction to biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network
30 Hours	*LAB*

Essential Readings:

5. James J. Buckley, EsfandiarEslami, An introduction to fuzzy logic and fuzzy sets, Springer International edition, 2002
6. S.N. Sivanandam, S.N. Deepa, Introduction to genetic algorithms, Springer, 2008
7. S. Sivanandam, S. Sumathi, Introduction to Neural Networks using Matlab 6.0, The McGraw-Hill, 2005
8. S.N. Sivanandam, S.N. Deepa, Principles of Soft Computing, 2nd ed., Wiley India

Further Readings:

5. Fuzzy Logic: Intelligence, Control, and Information, 1/E, Yen &Langari, 1999, Prentice Hall
6. Neural Networks and Learning Machines, 3/E, Haykin, 2009, Prentice Hall
7. Fuzzy Logic and Control: Software and Hardware Applications, Vol. 2, 1/E, Jamshidi, Vadiee& Ross, 1993, Prentice Hall
8. Genetic Algorithms in Search, Optimization, and Machine Learning, 1/E, Goldberg, 1989, Addison-Wesley

Timothy J. Ross, Fuzzy logic with engineering applications, 3rded, Wiley India

SPEECH PROCESSING AND RECOGNITION

Course Code	CAI91DE02104	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 Lab Hours
Course Type	Discipline Based Core Elective		
Nature of the Course	Theory		
Methods of Content Interaction	Lecture, Tutorials, self-study, presentations by students, assignments.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To introduce students to the basic concepts of speech production and perception mechanisms in human beings.
- To provide a broad overview of speech signal processing methods.
- To provide the knowledge of various speech tools for recording speech signals and also extracts different speech features from the recorded speech files.
- To develop speech and speaker recognition systems using various modelling techniques

Learning Outcomes

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

- Describe the mechanisms of human speech production and perception systems.
- Familiar with various information present in the speech signal.
- Extract various source and system features from the speech signal.
- Develop speech and speaker recognition systems using modelling techniques.

Prerequisites: None

Course Contents

UNIT II **[15% Weightage]**

Introduction: Speech production and perception mechanisms, Speech Signal Processing Methods.

UNIT II **[20% Weightage]**

Knowledge sources in speech: Time domain and frequency domain, Spectrograms, Knowledge sources at segmental, sub-segmental and supra-segmental (prosodic) levels, excitation source, vocal tract system.

UNIT III **[25% Weightage]**

Modeling techniques for developing speech systems: Vector quantization, Hidden Markov models, Gaussian mixture models, Support vector machines and Neural networks.

UNIT IV **[25% Weightage]**

Speech Recognition: Issues in speech recognition, Isolated word recognition, Connected word recognition, Continuous speech recognition, Large vocabulary continuous speech recognition.
Speaker Recognition: Issues in speaker recognition, Speaker verification vs identification, Text dependent vs text independent speaker recognition, Development of speaker recognition systems.

UNIT V **[15% Weightage]**

Introduction to some advanced topics: speech coding and text-to-speech synthesis.
Lab : 30 Hrs.

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-11	**Introduction**: Speech production and perception mechanisms, Speech Signal Processing Methods.
12-19	**Knowledge sources in speech**: Time domain and frequency domain, Spectrograms, Knowledge sources at segmental, sub-segmental and supra-segmental (prosodic) levels, excitation source, vocal tract system.
20-30	**Modeling techniques for developing speech systems**: Vector quantization, Hidden Markov models, Gaussian mixture models, Support vector machines and Neural networks.
31-38	**Speech Recognition**: Issues in speech recognition, Isolated word recognition, Connected word recognition, Continuous speech recognition, Large vocabulary continuous speech recognition.
39-41	**Speaker Recognition**: Issues in speaker recognition, Speaker verification vs identification, Text dependent vs text independent speaker recognition, Development of speaker recognition systems.
41-45	**Introduction to some advanced topics:** speech coding and text-to-speech synthesis.
30 Hours	*Lab*

Essential Readings:

- D. O Shaughnessy, Speech Communication: Human and Machine, 2nd edition, IEEE Press, NY, USA, 1999.
- J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, Discrete-time Processing of Speech Signals, IEEE Press, NY, USA, 1999.
- T.F. Quateri, Discrete-Time Speech Signal Processing: Principles and Practice, Pearson Education, 2004.

Further Readings:

- L. R. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Pearson Education, Delhi, India, 2003.

- B. Gold and N. Morgan, Speech and Audio Signal Processing, Wiley Student Edition, Singapore, 2004.
- Ahmet M. Kondoz, Digital Speech: Coding for Low Bit Rate Communication, 2nded, Wiley publication, 2004.
- IEEE Trans. on Speech and Audio Processing.
- Speech Communication (Elsevier)
- Computer, Speech and Language (Elsevier)

Social Networks Analytics

Course Title:	**Social Networks Analytics**		
Course Code	CAI91DE02204	**Credits**	4
L + T + P	3 +0+1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 Lab Hours
Course Type	Discipline Based Core Elective	**Nature of the Course**	Theory/Skill Based
Methods of Content Interaction	Lecture, Tutorials, Class Tests, data analysis, seminar, presentations by students etc.		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Prerequisites: Understanding of Basic Graph Theory

Course Objectives

- To introduce students about the history of Social Networks and the types of social networks and their features
- To introduce them about various centrality measures and their importance in predicting user properties, behaviours and various events in social networks.
- To introduce students about some of the popular network models developed to understand/ mimic real social network formations and their characteristics.
- To introduce students with the concepts of formation of communities in social networks and introducing them with some of the popular community detection algorithms.
- To introduce students with the concept of strong and weak ties, homophily and their roles in topological evolution of social networks.
- To understand the concepts of cascading behaviours in social networks.
- To introduce students with common security and privacy concerns in social networks.

Course Learning outcomes

After the course the students:

- would understand the types of social networks and their architectures and their applications. They also will become familiar with popular public dataset for different types of social networks.
- would know about various centrality measures and their usage and roles in prediction variety of characteristics of nodes, edges and social networks.
- would become familiar with some of popular models proposed to understand evolution/formation of real social networks and their characteristics
- would understand the concepts of communities in social networks, their formation process and detecting the existing communities using some of the popular algorithms.
- would understand the concepts of strong and weak ties, homophily and selection and social influence and impact of these phenomena on dynamics of a social network.
- would become familiar with the basic concepts of cascading behaviour in social network
- would be able to understand the privacy and security issues with social networks

Course Contents:

UNIT 1 Introduction to Online Social Networks (20% Weightage)

History of Online Social Networks, definition, types of social networks and their features like architecture, various social network datasets

UNIT 2 Topology and Centrality Measures of Social Networks (20% Weightage)

Topology of a social network, Degree Centrality, Closeness Centrality, Betweenness Centrality, Eigenvector centrality, clustering coefficient, applications of centrality metrics.

UNIT 3 Network Models and Communities (30% Weightage)

Random Networks: Erdos-Renyi and Barabasi-Albert Model and their properties, Scale-Free networks and their properties, Power Law Distribution, Small-world Networks

Community structures and community detection algorithms: Girvan–Newman algorithm

UNIT 4 Human Behaviour Dynamics (30% Weightage)

Strong and Weak Ties, Homophily, Selection and Social Influence, Cascading Behaviour in Networks, Understanding and predicting human behaviour for social communities. Privacy issues in online social networks,

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1-2	History of Online Social Networks, definition
3-5	Types of social networks and their architecture
6-9	Degree Centrality, Closeness Centrality, Betweenness Centrality

10-13	Eigenvector centrality, clustering coefficient, applications of centrality metrics
14-18	Random Networks: Erdos-Renyi and Barabasi-Albert Model and their properties
19-22	Scale-Free networks and their properties
23-26	Power Law Distribution and its examples
27-29	Small-world Networks
29-34	Community structures and community detection algorithms: Girvan–Newman algorithm
35-37	Strong and Weak Ties
37-38	Homophily
39-40	Selection and Social Influence
40-41	Cascading Behavior in Networks
42-43	Understanding and predicting human behavior for social communities
43-45	Privacy issues in online social networks
30 Hours	LAB

Essential Readings:

5. Network Science 1st Edition by Albert-László Barabasi, Cambridge University Press, ISBN-13: 978-1107076266
6. Analyzing Social Networks Second Edition by Stephen P Borgatti, Martin G. Everett, Jeffrey C. Johnson SAGE Publications Ltd ISBN-13: 978-1526404107.
7. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007.
8. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.

Suggested Readings:

4. Guandong Xu, Yanchun Zhang and L in Li, "Web Mining and Social Networking – Techniques and applications", First Edition Springer, 2011
5. John G. Breslin, Alexander Passant and Stefan Decker, "The Social Semantic Web", Springer, 2009
6. Dion Goh and Schubert Foo, "Social Information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.

NATURAL LANGUAGE PROCESSING

Course Code	CAI91DE02304	**Credits**	4
L + T + P	3 + 0 + 1	**Course Duration**	One Semester
Semester	III	**Contact Hours**	45 (L) + 30 Lab Hours
Methods of Content Interaction	Lecture, Tutorials, Self-study, Practicals, presentations by students, assignments.		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

At the end of this course:

- Students should have a sound knowledge of the methods used in different areas of natural language processing.
- Students should also be able to use this knowledge to implement simple natural language processing algorithms and applications.

Learning Outcomes

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

- Understand the application and analysis of NLP systems.
- Synthesis and evaluation: Compare and contrast approaches to natural language processing, Discuss the limitations and promise of NLP.

Prerequisites: Students should have knowledge of Algorithms, Theory of Computation etc.

UNIT I **[25% Weightage]**

Shallow Processing – Morphology fundamentals – Finite State Machine based Morphology – Part of Speech Tagging and Named Entity tagging – Machine learning algorithms for NLP

UNIT II **[12% Weightage]**

Parsing – Classical Approaches: Top-Down, Bottom-UP and Hybrid Methods – Chart Parsing, Early Parsing – Statistical Approach: Probabilistic Parsing, Tree Bank Corpora

UNIT III **[10% Weightage]**

Lexical Semantics and/or Discourse Processing – Lexicons, Word Sense Disambiguation – Coreferences

UNIT IV **[10% Weightage]**

Information Extraction and Text Classification – Approaches of IE and Applications. Anaphora Resolution in biomedical texts – text classification approach.

UNIT V **[15% Weightage]**

Applications – Machine Translation – Information Retrieval (cross-lingual) – Summarization – Question Answering

UNIT VI **[28% Weightage]**

Indian Language Computing – Named Entity Recognition – Part of Speech Tagging – Machine Translation - Cross lingual information access

Content Interaction Plan:

Lecture cum Discussion (Each session of 1 Hour)	**Unit/Topic/Sub-Topic**
1	**Shallow Processing** – Morphology fundamentals
2-4	Finite State Machine based Morphology
5-10	Part of Speech Tagging and Named Entity tagging – Machine learning algorithms for NLP
11-14	**Parsing** – Classical Approaches: Top-Down, Bottom-UP and Hybrid Methods – Chart Parsing, Early Parsing – Statistical Approach: Probabilistic Parsing, Tree Bank Corpora
15-16	**Lexical Semantics and/or Discourse Processing** – Lexicons, Word Sense Disambiguation – Coreferences
17-20	Approaches of IE and Applications
21-26	**Information Extraction and Text Classification** – Anaphora Resolution in biomedical texts – text classification approach.
27-31	**Applications** – Machine Translation
32-37	Information Retrieval (cross-lingual) – Summarization – Question Answering
38-42	**Indian Language Computing** – Named Entity Recognition
43-45	Part of Speech Tagging – Machine Translation - Cross lingual information access
30 Hours	*Lab*

Essential Readings:

3. Speech and Language Processing, by D. Jurafsky and R. Martin (2nd edition)
4. Natural Language Understanding : James Allan

Further Readings::

Foundations of Statistical NLP: Manning and Schutze

3. NLP a Panninian Perspective: Bharati, Chaitanya and Sangal
4. Statistical NLP :Charniak

Mandatory Elective Non-Credit Course (MENC)

Innovation & Entrepreneurship

Course Details			
Course Title: Innovation & Entrepreneurship			
Course Code:	CAI82ME03800	**Credits**	
L + T + P		**Course Duration**	One Semester
Semester	II	**Contact Hours**	
Course Type	MENC	**Nature of the Course**	Non Credit
Methods of Content Interaction	Lectures, Assignments, Class Tests, Mini Project and viva		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Prerequisites:

Course Objectives

- To Identify, define, and characterize problems
- To Spot opportunities for innovation
- To Understand the framework of product development
- Design, evaluate, and implement marketing strategies
- Develop an in depth understanding of the target demographic

Course learning outcomes

After the course the students will be able to:

- Segment and analyze opportunities
- Evaluate and select models for new ventures
- Design the customer journey
- Aassess and Analyze entrepreneurship as a career choice

Course Contents:

UNIT 1 Introduction
[50%]

National Innovation and Startup Policy (NISP): Guiding Framework for HEIs, National Education Policy (NEP): Research, Innovation and Entrepreneurship for HEIs

Attaining Market-Product Fit: Prototype Designing Process and Tools for Development of Minimum Viable Product (MVP)

Understanding Technology Readiness Level (TRL), Manufacturing Readiness Level (MRL) and Investment Readiness Level (IRL) Stages & Implications in Innovation Development

UNIT-II Business Plan
[50%]

Business Plan Development: Components and Stages in Business Plan Development,
Validation of Business Opportunity: Application of Market Research Tools at the Early Stage of Startup, Attaining Business Fit: Startup Planning and Management

Legal Structures and Ethical Steps in Establishing Startups

Essential Readings:

1. Innovation and Entrepreneurship - Peter Drucke
2. Innovation and Entrepreneurship - by John Bessant (Author), Joe Tidd (Author)
3. Managing Technology Entrepreneurship and Innovation - Paul Trott, Dap Hartmann, Patrick van der Duin
4. Innovation and Entrepreneurship in an Educational Ecosystem Cases from Taiwan
5. Innovation and Entrepreneurship Space - Dr. Kiran Kumari Patil
6. Documents available on Ministry of Education Innovation Cell website

Suggestive Readings:

1. Innovation and Entrepreneurship - Mike Kennard
2. Innovation and Entrepreneurship in Education - Ana Faria, Pantelis M. Papadopoulos, Roland Burger

R Programming

Course Code:	CAI82ME03900	**Credits**	Non-Credit
L + T + P		**Course Duration**	One Semester
Semester	II	**Contact Hours**	
Course Type	Mandatory Elective Non-Credit Course		
Nature of the Course	Theory/Practical		
Special Nature/ Category of the Course (*if applicable***)**	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Self-study, Lab Assignments		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

To enable students understand

- Basics of R programming.
- Learn Fundamentals of R.
- Covers how to use different functions in R, how to read data into R, accessing R
- packages, writing R functions, debugging, and organizing data using R functions

- Cover the Basics of statistical data analysis with examples
- The whole syllabus will give an idea to collect, compile and visualize data using statistical functions

Course Learning outcomes

After completing the course the students

- Understand the basics of Fundamentals of R.
- Understands the loading, retrieval techniques of data
- Will be able to prepare professional presentation with variety of themes using beamer.
- Understand how data is analysed and visualized using statistic functions

Course Contents:

Unit – 1: Introduction to R Programming (25% Weightage)

Introduction to R, Advantages of R over Other Programming, R Studio: R command Prompt, R script file, Handling Packages in, Installing a R Package, Evolution of R?, Data types, Scalar, Vectors, Matrix, List, Data frames, Factors, Handling date in R, Conversion of data types, Variable assignment, Data types of Variable, Finding Variable ls(), Deleting Variables, Operators in R, Arithmetic Operators, Relational Operators, Logical Operator, Assignment Operators, Miscellaneous Operators , if statement, if – else statement, if – else if statement, switch statement – R Loops: repeat loop, while loop, for loop - Loop control statement: break statement, next statement

Unit – 2: Functions in R (25% Weightage)

Function definition, Built in functions: mean(), paste(), sum(), min(), max(), seq(), user-defined function, calling a function, calling a function without an argument, calling a function with argument values - R-Strings – Manipulating Text in Data: substr(), strsplit(), paste(), grep(), toupper(), tolower() - R Vectors – Sequence vector, rep function, vector access, vector names, vector math, vector recycling, vector element sorting - R List - Creating a List, List Tags and Values, Add/Delete Element to or from a List, Size of List, Merging Lists, Converting List to Vector - R Matrices – Accessing Elements of a Matrix, Matrix Computations: Addition, subtraction, Multiplication and Division- R Arrays: Naming Columns and Rows, Accessing Array Elements, Manipulating Array Elements, Calculation Across Array Elements - R Factors –creating factors.

Unit – 3: Data Analysis using R (25% Weightage)

Data Frames –Create Data Frame, Data Frame Access, Understanding Data in Data Frames: dim(), nrow(), ncol(), str(), Summary(), names(), head(), tail(), edit() functions - Extract Data from Data Frame, Expand Data Frame: Add Column, Add Row - Joining columns and rows in a Data frame rbind() and cbind() – Merging Data frames merge() – Melting and Casting data melt(), cast().

Unit: 4 (25% Weightage)

Loading and handling Data in R: Getting and Setting the Working Directory – getwd(), setwd(), dir() - R-CSV Files - Input as a CSV file, Reading a CSV File, Analyzing the CSV File: summary(), min(), max(), range(), mean(), median(), apply() - Writing into a CSV File – R - Excel File – Reading the Excel file, Cbind, Rbind, Sorting, Aggregating, dplyr, Data Visualisation in R.

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Essential Readings:

1. Crawley, M. J. (2013). The R Book. 2nd ed. Wiley.
2. Horton, N.J., & Kleinman, K. (2015). Using R and RStudio for Data Management, Statistical Analysis, and Graphics (2nd ed.). Chapman and Hall/CRC. https://doi.org/10.1201/b18151
3. James, G. et al. (2014). An introduction to statistical learning with applications in R. Springer, New York

Suggested Readings:

1. Chang, W. (2018). R Graphics Cookbook, 2nd Ed. O'Reilly Media, Inc..

INTELLECTUAL PROPERTY RIGHTS

Course Details			
Course Title: INTELLECTUAL PROPERTY RIGHTS			
Course Code:	CAI92ME04000	**Credits**	Non-Credit
L + T + P		**Course Duration**	One Semester
Semester	III	**Contact Hours**	
Course Type	Mandatory Elective Non-Credit Course (MENC)	**Nature of the Course**	Skill Based
Methods of Content Interaction	Lectures, Tutorials, Self-study,		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Prerequisites: Knowledge of at least one of the programming languages

Course Objectives

- The main objective of the IPR is to make the students aware of their rights for the protection of their inventions done in their project work.
- To get registration in our country and foreign countries for their invention, designs and thesis or theory written by the students during their project work and for this, they must have knowledge of patents, copyright, trademarks, designs and the Information Technology Act.
- The further teacher will have to demonstrate with products and ask the student to identify the different types of IPRs.

Course learning outcomes

- The students once they complete their academic projects, they get the awareness of acquiring the patent
- They also learn to have a copyright for their innovative works.
- They also get the knowledge of plagiarism in their innovations which can be questioned legally

Course Contents:

Unit I: (25% Weightage)

Origin and Development of IPR – Historical and theoretical basis for the protection of IPR, Concept of Property Theories on the concept of property – Nature – Public Vs. Private – Tangible Vs. Intangible – Industrial Vs. Intellectual, Introduction to TRIPS and WTO.

Unit II (35% Weightage)

Kinds of Intellectual property rights: Copyright, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.

Patent Rights And Copy Rights: Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.

Copy Right: Origin, Definition &Types of Copyright, Registration procedure, Assignment & Licence, Terms of Copy Right, Piracy, Infringement, Remedies, Copyrights with special reference to software.

Trade Marks: Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties.

Unit III (20% Weightage)

International IP Regime: World Intellectual Property Organisation (WIPO) – Functions of WIPO – Membership – GATT Agreement – Major Conventions on IP – Berne Convention – Paris Convention – TRIPS agreement.

Indian IP Regime: Overview of IP laws in India – Major IP Laws in India – International treaties signed by India. IPR and the Constitution of India

Unit IV **(20% Weightage)**

Basic Tenets Of Information Technology Act-2000: IT Act 2008 and its amendments: Introduction, E-Commerce and legal provisions, E-Governance and legal provisions
Digital signature and Electronic Signature, Cybercrimes,

Essential Readings:

- Dreyfuss, R. C., & Pila, J. (Eds.). (2018). The Oxford Handbook of intellectual property law. Oxford University Press.
- World Intellectual Property Organization. (2004). WIPO intellectual property handbook: Policy, law and use (Vol. 489). WIPO.

Suggested Reading:

1. Fisher, Matthew (ed.), *Fundamentals of Patent Law: Interpretation and Scope of Protection*, (2010), New Delhi, Mohan law House.
2. Miller, Joseph Scott (ed.), *Patents*, (2010), UK, Edward Elgar.
3. Kankanala, Kalyan C., *Indian Patent Law and Practice*, (2010), India, Oxford University Press
4. Dr Bhandari, M.K. Law relating to IPR, Central Law Publication, (4th Edition 2015)
5. Brazell, L. (Ed.). (2013). Intellectual Property Law Handbook. Law Society.

SOFT SKILLS

Course Code:	CAI92ME04100	**Credits**	Non-credit
L + T + P		**Course Duration**	One Semester
Semester	III	**Contact Hours**	
Course Type	Mandatory Elective Non-Credit Course		
Nature of the Course	Theory/Practical		
Special Nature/ Category of the Course (*if applicable*)	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Self-study,		
Assessment and Evaluation	• 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) • 70% - End Term External Examination (University Examination)		

Course Objectives

- To help the students develop communication skills and self-confidence.
- To introduce various interview techniques to the students
- To inculcate leadership qualities in the young minds
- To enable the students understand the importance of employing perfect body language in communication
- To make the students learn about etiquette and its importance
- To provide an in-depth view to the students about building self-esteem and confidence

Learning outcomes

After completing the course the students

- Will be able to communicate with proper body language
- Will be able to do time management during presentations
- Will be able to compete in the global scenario.

Course Contents

Unit - 1 **(25% Weightage)**

Public Speaking: The power of Public Speaking, Developing confidence, planning, Preparation, Successful and effective delivery of speech

Group Discussion: What is group discussion? Why are group discussions held? Preparation for a group discussion, Skills for effective participation, Traits tested in a group discussion, initiating a group discussion, Non-verbal communication in group discussion, Types of group discussions.

Unit - 2 **(25% Weightage)**

Interviews: Interviewing in the 21st century, developing an Interview Strategy, Taking Care of the Details, Practicing for the Interview, During the Interview, Stress Interviews, Traditional Interviews

Writing Skills: Basics of writing, writing paragraphs, Writing research articles, Report writing, writing a CV

Unit - 3 **(20% Weightage)**

Personality development: Introduction to personality, Dimensions of personality, Determinants of personality, Winning personality, Human behaviour, Importance of possessing the right attitude, Factors affecting attitudes, Positive and negative attitudes, Internal and external motives, Importance of self-motivation, Discipline in problem solving, Grooming, Body language, Eye contact, Social etiquette, Manners in conversations.

Unit - 4

Presentation skills **(30% Weightage)**

Introduction to Presentation: Role of presentation, Purpose of presentation, Types of presentation, Time management during presentation, Drawing audience attention & their active participation, Brainstorming sessions & feedback.

Body Language: Importance of body language, Forms of body language, Parts of body language, Body language in building interpersonal & industrial relationships, Advantages of perfect body language

Etiquette: Modern etiquette, Benefits of etiquette, Classification of etiquette (personal, business, dining, interview, telephonic)

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Suggested Readings:

1. Personality Development – Elizabeth Hurlock, Tata McGraw Hill, New York 1976
2. The Etiquette Book :A Complete Gide to Modern Manners- Jodi R.R. Smith, Sterling Publications, New York 2011
3. Winning at Interviews (Second edition) – Edgar Thorpe and Showick Thorpe, Pearson, New Delhi 2009
4. Soft Skills – Dr. K.Alex, S.Chand & Company, New Delhi,2010
5. Professional Presentations – Malcolm Goodale, Cambridge University Press, New Delhi, 2010

SCIENTIFIC WRITING TOOLS

Course Code:	CAI91ME04200	**Credits**	Non-credit
L + T + P		**Course Duration**	One Semester
Semester	III	**Contact Hours**	
Course Type	Mandatory Elective Non-Credit Course		
Nature of the Course	Theory/Practical		
Special Nature/ Category of the Course (*if applicable*)	Skill Based		
Methods of Content Interaction	Lecture, Tutorials, Self-study,		
Assessment and Evaluation	● 30% - Continuous Internal Assessment (Formative in nature but also contributing to the final grades) ● 70% - End Term External Examination (University Examination)		

Course Objectives

To enable students understand

- Basics of document preparation using latex.
- To know how to do text formatting in a latex document.
- To insert mathematical symbols and equations in a document
- To insert figures, graphs, charts, images, tables in a document

Learning outcomes

After completing the course the students

- Will be able to understand fundamentals of latex and beamer and commonly required packages.
- Will be able prepare variety document like report, papers, thesis, and so on
- Will be able to prepare professional presentation with variety of themes using beamer.

Course Contents

Unit - 1 **(15% Weightage)**

Scientific writing tools, Latex as Scientific writing tool, installation of the software LaTeX, Understanding Latex compilation, Latex features, general syntax of a document in latex, latex editors.

Unit - 2 **(30% Weightage)**

Formatting the text, defining color for text, fonts, sections and paragraphs, inserting mathematical symbols, writing equations, creating Matrices and Array, Tables in Latex, inserting images, creating lists,.

Unit - 3 **(25% Weightage)**

Latex Page Layout, Sections and subsections, Equation references, References and citation in latex, bibliography database

Unit - 4 **(30% Weightage)**

Writing Resume, question paper, articles/research papers, thesis report, creating presentation using beamer.

Essential Readings:

1. LaTeX Beginner's Guide, Stefan Kottwitz, ISBN 13-9781847199867, Packt Publishing Limited.
2. Latex: A Document Preparation System, 2/E, Lamport, Pearson Education India, ISBN 8177584146, 9788177584141

Further Readings::

6. More Math Into LaTeX, George Grätzer, Springer, 15-Feb-2016, ISBN 9783319237961.
7. Guide to LaTeX, Tools and Techniques for Computer Typesetting, Helmut Kopka, Patrick W. Daly, Pearson Education, 2003, ISBN 0321617746, 9780321617743
8. https://www.latex-project.org/
9. https://ctan.org/