**ANNEXURE I**

# M.Sc. COMPUTER SCIENCE with specialization in ARTIFICIAL INTELLIGENCE
## (2021 Admission)

| Semester- I | | | | |
|---|---|---|---|---|
| Course Code | Paper | Marks | | Credit |
| | | Sessional | Final | |
| 21-344-0101 | Mathematics for AI | 50 | 50 | 4 |
| 21-344-0102 | Computer System Design and Architecture | 50 | 50 | 4 |
| 21-344-0103 | Advanced Data Structures and Algorithms | 50 | 50 | 4 |
| 21-344-0104 | Data Science and Machine Learning | 50 | 50 | 4 |
| 21-344-0105 | Foundations of Artificial Intelligence | 50 | 50 | 4 |
| 21-344-0106 | Data Science and Machine Learning Lab | 50 | 50 | 2 |
| 21-344-0107 | Data Structure Lab | 50 | 50 | 2 |
| | Total Credits | | | 24 |

| Semester - II | | | | |
|---|---|---|---|---|
| Course Code | Paper | Marks | | Credit |
| | | Sessional | Final | |
| 21-344-0201 | Advanced Computer Networks | 50 | 50 | 4 |
| 21-344-0202 | Emerging Technologies in Data Processing and Management | 50 | 50 | 4 |
| 21-344-0203 | Pattern Recognition | 50 | 50 | 4 |
| 21-344-0204 | Information Security | 50 | 50 | 4 |
| | Elective I | 50 | 50 | 3 |
| 21-344-0206 | Data Management Lab | 50 | 50 | 2 |
| | Total Credits | | | 21 |

| Semester- III | | | | |
|---|---|---|---|---|
| Course Code | Paper | Marks | | Credit |
| | | Sessional | Final | |
| 21-344-0301 | Deep Learning | 50 | 50 | 4 |
| | Elective II | 50 | 50 | 3 |
| | Elective III | 50 | 50 | 3 |
| | Elective IV | 50 | 50 | 3 |
| | Elective V | 50 | 50 | 3 |
| 21-344-0306 | Seminar | 50 | | 1 |
| 21-344-0307 | Internship/Project Phase - 1 | 50 | | 3 |
| | Total Credits | | | 20 |

| Semester- IV | | | | |
|---|---|---|---|---|
| Course Code | Paper | Marks | | Credit |
| | | Sessional | Final | |
| 21-344-0401 | Internship/Project Work | 200 | 200 | 18 |
| | Total Credits | | | 18 |

List of Electives

| Semester II | | Semester III | |
|---|---|---|---|
| Course Code | Paper | Course Code | Paper |
| 21-344-0211 | Distributed Computing | 21-344-0311 | Swarm Intelligence |
| 21-344-0212 | Intelligent System# | 21-344-0312 | Fuzzy Logic |
| 21-344-0213 | Cloud Computing | 21-344-0313 | Computer Vision |
| 21-344-0214 | Software Defined Networks | 21-344-0314 | Computer Forensics |
| 21-344-0215 | Mobile Application Development using Android | 21-344-0315 | Knowledge Based Systems # |
| 21-344-0216 | Internet of Things | 21-344-0316 | Full Stack Web Development # |
| 21-344-0217 | Digital Image Processing # | 21-344-0317 | Natural Language Processing |
| | | 21-344-0318 | Block Chain Technology |
| | | 21-344-0319 | Explainable Artificial Intelligence # |
| | | 21-344-0320 | Introduction to Game Theory# |
| | | 21-344-0321 | Machine Learning for Big Data Analytics # |
| | | 21-344-0322 | Data Visualization # |
| # Syllabus to be approved | | | |

# 21-344-0101 - Mathematics for AI

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Explain sets and operations on sets. | (Cognitivelevel : Understand) |
| CO2 | Apply Propositional logic and First order logic to solve problems. | (Cognitive level : Apply) |
| CO3 | Solve the system of Linear equations using Gauss Elimination method. | (Cognitive level : Apply) |
| CO4 | Apply different methods to find the Inverse and Rank of a Matrix | (Cognitive level : Apply) |
| CO5 | Calculate Eigen values and Eigen vectors using Linear transformation and power methods. | (Cognitive level : Apply) |
| CO6 | Solve Derivatives and Partial Derivatives using rules of differentiation | (Cognitive level : Apply) |
| CO7 | Solve Recurrence relations by Substitution and Generating Functions | (Cognitive Level:Apply) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | |
| CO3 | 3 | | | | | | | | | | | |
| CO4 | 3 | | | | | | | | | | | |
| CO5 | 3 | | | | | | | | | | | |
| CO6 | 3 | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO7 | 3 | | | | | | | | | | | |

**UNIT I**

Sets, Operations on sets, Venn Diagrams, Multi Sets, Binary Relations, Equivalence Relations, Ordering Relations, Operations on Relations, Partial Orders. Statements and Notation, Connectives, Quantified Propositions, Logical Inferences, Methods of Proof of an Implication, First Order Logic and other Methods of Proof, Rules of Inference for Quantified Propositions, Proof by Mathematical Induction.

**UNIT II**

Linear Algebra – System of Linear equations, Solving System of Linear equations (methods), Linear Independence, Vectors, Scalars, Addition, Scalar multiplication, dot product, normal and orthonormal vectors, vector norm, vector space, linear combination, basis of vectors, vector projection, cosine similarity. Support Vector Machines, Implementation using python, classification using support vector machines.

**UNIT III**

Matrices, determinants, inverse of matrix, System of equations, Linear transformation - rank and nullity, Consistency, and inconsistency of linear system of equations, rank nullity theorem, Echelon form of a matrix and Row reduced echelon form of matrix. Corelation coefficient, Eigen values and Eigen vectors. Principle Component analysis (PCA) – Concepts and properties. Dimensionality reduction using PCA.

**UNIT IV**

Differentiation, Limits and continuity rules of differentiation, Derivatives, Scalar derivatives, Differentiation of univariate functions, Partial differentiation and gradients, Gradient of vector valued function. Gradient of matrices. Optimization using gradient functions, Constrained optimization, and Lagrange multipliers. Convex optimization. Back propagation in neural networks, implementation, application.

**UNIT V**

Generating Functions of Sequences, Calculating Coefficients of Generating Functions, Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, The Method of Characteristic Roots, Solutions of Inhomogeneous Recurrence Relations, Complexity calculations of prominent algorithms.

**TEXTBOOKS:**

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, “Mathematics for Machine Learning”, Cambridge University Press, 2020.

2. Kenneth H. Rosen, “Discrete Mathematics and Its Applications”, 7th Ed, McGrawHill, 2012.

3. Bernard Kolman, Robert Busby and Sharon Cutler Ross, “Discrete Mathematical Structures for Computer Science”, 6 th Ed, PHI, 2013.

4. Erwin Kreyszig, Advanced Engineering Mathematics, 10thEdition., John Wiley & Sons, (2014).

**********

# 21-344-0102 - Computer System Design and Architecture

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Discuss decimal, binary, octal, hexadecimal and BCD number systems, perform conversions among them and do the operations - complementation, addition, subtraction, multiplication and division on binary numbers. | (Cognitive level : Understand) |
| CO2 | Apply K-Map to simplify Boolean functions. | (Cognitive level : Apply) |
| CO3 | Design combinational circuits | (Cognitive level : Apply) |
| CO4 | Explain basic structure , memory structure and addressing modes of computers | (Cognitive level : Understand) |
| CO5 | Demonstrate the control signals required for the execution of a given instruction | (Cognitive level : Apply) |
| CO6 | Employ arithmetic algorithms in a digital computer | (Cognitive Level:Apply) |
| CO7 | Discuss different Architectures | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | | | | | | | | | | |
| CO2 | 3 | 2 | 2 | 2 | | | | | | | | |
| CO3 | 3 | 3 | 3 | 3 | | | | | | | | |
| CO4 | 2 | 2 | | | | | | | | | | |
| CO5 | 3 | 3 | 3 | 3 | | | | | | | | |
| CO6 | 2 | 2 | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO7 | 2 | 2 | | | | | | | | | | |

**UNIT I**

Digital Number System - Decimal , Octal, Binary , HexaDecimal Number systems, Conversions. Operations - Addition, Subtraction, Multiplication and Division of binary numbers. Representation of negative numbers- Complements, Subtraction with complements. Addition and subtraction of BCD, Octal and Hexadecimal numbers. Binary coded- Decimal codes, Error detection codes, Reflected code, Character coding schemes – ASCII, EBCDIC.

Boolean Logic, Boolean Algebra - Boolean Laws and Theorems, Boolean Functions - Simplification of Boolean Functions- Using Karnaugh- Map Method.

**UNIT II**

Logic gates , Combinational logic circuits- Binary adders and subtractors, Binary Parallel adder, Carry look ahead adder, BCD adder, Code converter, Magnitude comparator, Decoder, Demultiplexer, Encoder, Multiplexer, Parity generator/ Checker. MSequential Logic Design - Latches and Flipflops, Registers, Counters.

**UNIT III**

Basic Structure of computers , operational concepts - bus structures. Memory locations and addresses - memory operations,Instructions and instruction sequencing , addressing modes. I/O organization: accessing of I/O devices – interrupts, interrupt hardware -Direct memory access. The Memory System - Semiconductor RAM Memories Read-only Memories, Memory Hierarchy,Cache Memories - Mapping Functions

**UNIT IV**

Basic Processing Unit - Instruction Execution, execution of a complete instruction, Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.

**UNIT V**

Pipelining - Concepts, Instruction and arithmetic pipelines , hazard detection and resolution.
Hard_wired control-microprogram control,
Introduction to MicroArchitectures and System Design

**TEXT BOOK**

1. M. Morris Mano, "Digital Design", 6th Edition, Prentice Hall of India Pvt. Ltd.2018.
2. Computer organization And Embedded Systems, Hamacher, Vranesic, Zaky, Manjikian, 6Ed, McGraw-Hill , 2012

**REFERENCES**


1. Manish Saraswat, 'Computer Architecture And Organisation', 1st Ed. Vayu Education Of India, 2011.

2. Tanenbaum A.S, 'Structured Computer Organization'. 5/e, Prentice Hall of India, 2006.

3. Mano, M M, 'Computer System Architecture'. 3rd Ed. Prentice Hall of India, 2007.

4. Hayes, 'Computer Architecture and Organization', 2nd Ed. McGraw Hill, 1998.

5. Thomas L Floyd, Digital Fundamentals, 10th Ed, Pearson Education, 2009.

6. Rajaraman V. and T. Radhakrishnan, Computer Organization and Architecture, Prentice Hall, 2011

7. Noam Nisan,Shimon Schocken The Elements of Computing Systems: Building a Modern Computer from First Principles, MIT Press, 2008.


**********

# 21-344-0103 - Advanced Data Structures and Algorithms

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Perform complexity analysis of algorithms. | (Cognitive level: Understand) |
| CO2 | Implement advanced versions of Queue, tree and heap data structures. | (Cognitive level: Apply) |
| CO3 | Implement data structures for disjoint sets. | (Cognitive level: Apply) |
| CO4 | .Apply the advanced data structures in domain specific application areas. | (Cognitive level: Apply) |
| CO5 | Implement various algorithm design techniques for specific applications. | (Cognitive level: Apply) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 3 | | | | | | | | | | |
| CO2 | 2 | | | | | | | | | | | |
| CO3 | | 2 | | | | | | | | | | |
| CO4 | | | 2 | | | | | | | | | |
| CO4 | | | 2 | | | | | | | | | |

**UNIT I**

Algorithm Analysis - Mathematical Background – Time and Space Complexity of Algorithms – Computational and Asymptotic Complexity, Best average and Worst case Analysis, Asymptotic Notations – Big O, Big ɵ and Big ω, Running time calculations – General Rules, Solutions for the Maximum Subsequence Sum Problem, Logarithms in Running time.

**UNIT II**

Queues - Single and Double Ended Priority Queues, Trees - Threaded Binary Trees, Selection Trees, Forests and binary search trees, Counting Binary Trees, Red-Black Trees, Splay Trees, Suffix Trees, Digital Search Trees, Tries- Binary Tries, Multiway Tries, k-d Trees, Point Quadtrees

**UNIT III**

Heaps - Skew Heaps, Binomial Heaps, Fibonacci Heaps, Pairing Heaps, Symmetric Min-Max Heaps, Interval Heaps, Data Structures for Disjoint Sets, Disjoint-set operations, Linked-list representation of disjoint sets, Disjoint-set, forests, Analysis of union by rank with path compression, Medians and Order Statistics, Minimum and maximum, Selection in expected linear time, Selection in worst-case linear time.

**UNIT IV**

Maximum Flow-Flow Networks, Ford-Fulkerson method-analysis of Ford-Fulkerson, Edmonds-Karp algorithm, Maximum bipartite matching, Bi-connected Components, Finding strong components. Computational Geometry- Line segment properties, Finding the convex hull, Finding the closest pair of points, Skip lists.

**UNIT V**

Algorithm Design Techniques - Greedy Algorithm – Scheduling problem, Huffman codes, approximate bin packing, Divide and Conquer – Closest points problem, Selection problem, Dynamic Programming – All pairs shortest path.

**TEXT BOOK**


1. Ellis Horowitz, Sartaj Sahni, Susan Anderson Freed, Fundamentals of Data Structures in C, Second Edition, University Press, 2008.
2. Thomas Cormen, Charles E. Leiserson, Ronald Rivest, Introduction to algorithm,3rd edition, PHI Learning.
3. Mark Allem Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson.


**REFERENCE BOOKS**


1. Yedidyah Langsam, Moshe J. Augenstein, Aaron M. Tenenbaum, Data Structures using C and C++, Second Edition, PHI Learning Private Limited, 2010
2. Ellis Horowitz and Sartaj Sahni, Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms,Universities Press, 2nd Edition, Hyderabad .
3. Sara Baase & Allen Van Gelder , Computer Algorithms – Introduction to Design and Analysis, Pearson Education

4. Algorithm Design: Jon Kleinberg and Eva Tardos, Addison Wesley

**********

# 21-344-0104 - Data Science and Machine Learning

(July 2021)

## Course Outcomes:

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Solve problems related to descriptive statistics and Inferential Statistics. | (Cognitive level : Apply) |
| CO2 | Discuss the various data visualization techniques | (Cognitive level : Understand) |
| CO3 | Compare different learning methods | (Cognitive level : Analyze) |
| CO4 | Evaluate the performance of the different classifiers | (Cognitive level : Analyze) |
| CO5 | Compare clustering algorithms. | (Cognitive level : Analyze) |
| CO6 | Explain the concept of machine learning for big data analytics | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes- **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | | | | | | | | |
| CO2 | 3 | 3 | | 3 | 3 | | | | | | | |
| CO3 | 2 | 2 | | | | | | | | | | |
| CO4 | 3 | 3 | 2 | 2 | 2 | | | | | | | |
| CO5 | 3 | 2 | 2 | 2 | 2 | | | | | | | |
| CO6 | 2 | | | | | | | | | | | |

**UNIT I**

Data Definitions and Analysis Techniques - Elements, Variables, and Data categorization - Levels of Measurement - Data management and indexing - Introduction to statistical learning - Descriptive Statistics - Measures of central tendency, Measures of location of dispersions - Basic analysis techniques - Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test

**UNIT II**

Knowing data, Data Pre-processing: Data cleaning, Data reduction, Data transformation, Data discretization

Defining data visualization – Exploratory and Explanatory data visualization techniques- Visualization workflow - Data Representation - chart types: categorical, hierarchical, relational, temporal & spatial; 2-D: bar charts, Clustered bar charts, dot plots, connected dot plots, pictograms, proportional shape charts, bubble charts, radar charts, polar charts, Range chart, Box-and-whisker plots, univariate scatter plots, histograms word cloud, pie chart, waffle chart, stacked bar chart, back-to-back bar chart, treemap . 3-D: surfaces, contours, hidden surfaces, pm3d coloring, 3D mapping; multi-dimensional data visualization; manifold visualization; graph data visualization; Annotation.

Visual encoding of data – Data types, Categorical scales and graph design, visual display elements , design principles , Narrative structures , Dataviz Technology & Tools

**UNIT III**

Definition of learning systems, Goals and applications of machine learning, Types of learning, Components of a machine learning pipeline. Testing, Training and Validation, Errors and loss, Bias and Variance Trade off, Overfitting and underfitting, Regularization techniques, Feature Engineering: feature identification, curse of dimensionality, feature reduction through feature selection and feature extraction.

**UNIT IV**

Supervised Learning: Regression, Linear and polynomial regression for univariate and multivariate data, support vector regression,
Classification: Decision trees, Neural networks, Perceptron, Multi-Layer Perceptron, Back propagation algorithm, Support Vector Machines, Naïve Bayes Classifiers
Ensemble Learning: Bagging, boosting, stacking, Random forest algorithm.
Mining Techniques: Frequent Item set, Association rule mining

**UNIT V**

Data Clustering: Partitioning Methods, Hierarchical methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data - Constraint-Based Cluster Analysis
Machine Learning Models and Algorithms for Big Data – Big Data Characteristics- distributed file systems – MapReduce Programming Platforms – Distributed Machine Learning Algorithms.

**TEXT BOOKS**


1. Andy Kirk, Data Visualization A Handbook for Data Driven Design, Sage Publications, 2016
2. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly, 2013


**REFERENCE BOOKS**


1. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press, 2016.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.


**********

# 21-344-0105 - Foundations of Artificial Intelligence

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Explain the basic concepts of Artificial Intelligence | (Cognitive level : Understand) |
| CO2 | Apply Constraint satisfaction problem to solve various standard problems in AI | (Cognitive level : Apply) |
| CO3 | Compare the performance of heuristic techniques for a given problem | (Cognitive level : Analyze) |
| CO4 | Apply minimax and alpha beta pruning strategy in game playing | (Cognitive level : Apply) |
| CO5 | Explain the concept of agents, behaviour and environment of Intelligent agents. | (Cognitive level : Understand) |
| CO6 | Describe various Soft Computing Techniques | (Cognitive Level:Understand) |
| CO7 | Describe the generic concepts of Natural Language processing and Robotics | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | | | | | | | | | | |
| CO2 | 3 | 2 | 2 | 2 | | | | | | | | |
| CO3 | 3 | 3 | 3 | 3 | | | | | | | | |
| CO4 | 2 | 2 | | | | | | | | | | |
| CO5 | 3 | 3 | 3 | 3 | | | | | | | | |
| CO6 | 2 | 2 | | | | | | | | | | |
| CO7 | 2 | 2 | | | | | | | | | | |

**UNIT I**

Introduction to artificial intelligence - Artificial Intelligence- Definitions, Programming Methodologies, Techniques, Intelligent Systems, Propositional calculus, Predicate Calculus, Rule-Based Knowledge Representation. Unification, Resolution, Constraint Satisfaction Problem

**UNIT II**

Intelligent Agents – Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The structure of Agents. The Present and Future of AI- Agent Components, Agent Architectures

**UNIT III**

Heuristic search and state space search - Techniques for Heuristic Search, State Space Search-Strategies for State Space Search -Applications of Search Techniques in Game Playing- Minimax strategy and Alpha Beta Pruning, and Planning

**UNIT IV**

Artificial Neural Networks, Fuzzy Sets & Fuzzy Logic, Rough Set Theory, Swarm Intelligence – Evolutionary Algorithms – Genetic Algorithms.

**UNIT V**

Perception –Image Formation, Early Image-Processing Operations, Object Recognition by Appearance, Object Recognition from Structural Information. Introduction to Recommender Systems -Case study: Real time application.Natural Language Processing- Language Models, Text Classification, Information Retrieval, Information Extraction. Robotics- Robot Hardware, Robotic Perception, Robotic Software Architecture.

**TEXT BOOKS**

1. Stuart Russell, Peter Norvig: “Artificial Intelligence: A Modern Approach “, 3rd Ed, Pearson, 2016.

2. Elaine Rich, Kevin Knight, B.Nair: “ARTIFICIAL INTELLIGENCE “, 3rd Ed, Mc Graw Hill, 2017.

**REFERENCES**

1. Charu C. Aggarwal. “Recommender Systems. The Textbook”, Springer, 2016.

2. N.P.Padhy:Artificial Intelligence and Intelligent Systems, Oxford University Press, 2009.

**********

# 21-344-0106 - Data Science and Machine Learning Lab

(July 2021)

## Course Outcomes:

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

| | | |
|---|---|---|
| CO1 | Apply data preprocessing techniques on the Data set. | (Cognitive level : Apply) |
| CO2 | Apply various data visualization techniques on real dataset. | (Cognitive level : Apply) |
| CO3 | Employ statistical Analysis Techniques on given dataset | (Cognitive level : Analyze) |
| CO4 | Evaluate the performance of different classifiers | (Cognitive level : Evaluate) |
| CO5 | Analyze the performance of clustering algorithms on real datasets from society | (Cognitive level : Analyze) |
| CO6 | ApplyMapReduce framework for processing large data sets by considering prototype of big data application scenarios | (Cognitive level : Apply) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LO1 | 3 | 3 | | | 3 | | | | | | | |
| LO2 | 3 | 2 | 3 | | 3 | | | | | | | |
| LO3 | 3 | 3 | | | | 2 | | | | | | |
| LO4 | 3 | 3 | 3 | 2 | 2 | 3 | | | | | | |
| LO5 | 3 | 3 | 3 | 2 | 2 | 3 | | | | | | |
| LO6 | 3 | 3 | 2 | 2 | 3 | | | | | | | |

- Understand the data set
- Apply data preprocessing techniques on large data sets
- Statistical analysis of data
- Understand different Visualization techniques
- Find Correlation of different attributes of a given dataset.
- Classification
  - Build a classification model.
  - Evaluate the model' s performance.

    - Compare different classifiers
- Clustering
    - Demonstration of clustering techniques on a given dataset
- Implementation of map reduce algorithm.

**********

# 21-344-0107 - Data Structure Lab

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Develop programs to implement advanced versions of queues, Trees and Heaps | (Cognitive level: Create) |
| CO2 | Develop programs using data structures for applications in various domain specific areas. | (Cognitive level: Create) |
| CO3 | Develop programs using Greedy approaches. | (Cognitive level: Create) |
| CO4 | Develop programs using Divide and Conquer and approaches. | (Cognitive level: Create) |
| CO5 | Develop programs using Dynamic programming approaches. | (Cognitive level: Create) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 3 | | | | | | | | | |
| CO2 | | | 2 | | | | | | | | | |
| CO3 | | | 2 | | | | | | | | | |
| CO4 | | | 2 | | | | | | | | | |
| CO5 | | | 2 | | | | | | | | | |

- Queues - Single and Double Ended Priority Queues,
- Trees - Threaded Binary Trees, Selection Trees, Forests and binary search trees, Counting Binary Trees, Red-Black Trees, Splay Trees, Suffix Trees, Digital Search Trees
- Tries- Binary Tries, Multiway Tries, k-d Trees,
- Heaps - Skew Heaps, Binomial Heaps, Fibonacci Heaps, Pairing Heaps, Symmetric Min-Max Heaps, Interval Heaps,
- Data Structures for Disjoint Sets,
- Ford-Fulkerson and Edmonds-Karp algorithm,
- Finding the convex hull and closest pair of points.
- Greedy Algorithms
- Divide and Conquer Algorithms
- Dynamic Programming

**********

# 21-344-0201 Advanced Computer Networks

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Describe how computer networks are organized with the concept of layered approach | (Cognitive level : Understand) |
| CO2 | Analyze topological and routing strategies for an IP based networking infrastructure | (Cognitive level : (Analyze) |
| CO3 | Explain protocols of computer networks, and how they can be used to assist in network design and implementation | (Cognitive level : Understand) |
| CO4 | Explain congestion and flow control strategies | (Cognitive level : Understand) |
| CO5 | Develop network communication services for client/server and other application layouts (Create) | (Cognitive Level:Create) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | | | | | | | | | |
| CO2 | 2 | 2 | | | | | | | | | | |
| CO3 | 3 | 3 | | | | | | | | | | |
| CO4 | 2 | 2 | | | | | | | | | | |
| CO5 | 2 | 2 | | | 3 | | | | | | | |

**UNIT I**

Introduction, history and development of computer networks, network topologies. Layering and protocols. Physical Layer: Different types of transmission media, errors in transmission: attenuation, noise. Repeaters. Encoding (NRZ, NRZI, Manchester, 4B/5B, etc.), MAC Layer: Aloha, CSMA, CSMA/CD, CSMA/CA protocols. Examples: Ethernet, including Gigabit Ethernet and WiFi (802.11), Token Ring, Bluetooth, WiMax

**UNIT II**

The Services Provided by the Link Layer, Error-Detection and -Correction Techniques-Parity Checks, Checksumming Methods, Cyclic Redundancy Check (CRC), Switched Local Area Networks-Link-Layer Addressing and ARP, Ethernet, Link-Layer Switches, Virtual Local Area Networks (VLANs), Wireless Links and Network Characteristics-CDMA, 802.11 Architecture, 802.11 MAC Protocol, IEEE 802.11 Frame, Mobility in the Same IP Subnet

**UNIT III**

IPv4 and IPv6 Addressing, IP Address – Subnetting / Super netting, Packet Forwarding with Classfull, Routing Algorithms-The Link-State (LS) Routing Algorithm, Distance-Vector (DV) Routing Algorithm, OSPF, Routing Among the ISPs: BGP-The Role of BGP, Advertising BGP Route Information, Determining the Best Routes, IP-Anycast, SDN Control Plane-SDNController and SDN ControlApplications, OpenFlow Protocol, Data and Control Plane Interaction, ICMP: The Internet Control Message Protocol, Simple Network Management Protocol (SNMP)

**UNIT IV**

Transport-Layer Services, Multiplexing and Demultiplexing, Connectionless Transport-UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer, Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go-Back-N (GBN), Selective Repeat, Connection-Oriented Transport, TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control, causes and the Costs of Congestion, Congestion Control, TCP Congestion Control, Classic TCP congestion Control, Network-Assisted Explicit Congestion Notification and Delay-based Congestion Control, Fairness

**UNIT V**

Principles of Network Applications-Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the Internet, Application-Layer Protocol, Web and HTTP, Electronic Mail in the Internet-SMTP, DNS—The Internet's Directory Service, Peer-to-Peer Applications, Video Streaming and Content Distribution Networks, Socket Programming: Creating Network Applications

## Reference Books

[1] Kurose and Ross, Computer Networks A systems approach , Pearson Education.

[2] William Stallings, Data and Computer Communications, Pearson Education.

[3] AS Tanenbaum, DJ Wetherall, Computer Networks, 5th Ed., Prentice-Hall, 2010.

[4] W. R. Stevens.*TCP/IP Illustrated, Volume 1: The protocols,*Addison Wesley, 1994.

[5] G. R. Wright.*TCP/IP Illustrated, Volume 2: The Implementation,*Addison Wesley, 1995.

[6] W. R. Stevens.*TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols,*Addison Wesley, 1996.

[7] B.A. Forouzan, Data communication & networking, 5th Edition, Tata Mc-Graw Hills.

*********

# 21-344-0202 - Emerging Technologies in Data Processing and Management

(July 2021)

## Course Outcomes

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Employ ER diagram as a data modeling technique to represent entity framework. | (Cognitive level : Apply) |
| CO2 | Compare the architectures of distributed and parallel systems. | (Cognitive level : Analyze) |
| CO3 | Explain the concept of data ware housing | (Cognitive level : Understand) |
| CO4 | Experiment with SQL queries and construct normalized databases | (Cognitive level : Apply) |
| CO5 | Demonstrate the semi-structured data handling using XML and JSON | (Cognitive level : Understand) |
| CO6 | Explain the types of NoSQL databases and Map reduce framework | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | | | | | | | | | |
| CO2 | 2 | 2 | | | | | | | | | | |
| CO3 | 2 | 2 | | | | | | | | | | |
| CO4 | 3 | 3 | 1 | | | | | | | | | |
| CO5 | 3 | 3 | 1 | | | | | | | | | |
| CO6 | 3 | 3 | | | | | | | | | | |

**UNIT 1:**

**Database Systems Fundamentals**: A Historical Perspective, Files System versus DBMS, Advantages of DBMS, Describing and storing data in a DBMS , Transaction management, Structure of a DBMS, People who work with Databases, Overview of Database Design. Entities, Attributes and Entity Sets, Relationships and Relationship sets, Additional Features of E-R Model: Key Constraints. Conceptual Design with the E-R Model. **Data Storage & Indexing** : File Organizations ,Organization of Records in Files, Indexing Structures, Primary & Secondary Indexes, Tree-structured Index, Hash-based Indexes, Multidimensional Indexes, Bitmap Indexes

**UNIT II:**

**Database System Architectures:** Centralized and Client-Server Architectures, Server System Architectures, Parallel Systems, Distributed Systems, Parallel Databases, I/O Parallelism, Inter and Intra Query Parallelism, Intra and inter operation parallelism, Design of parallel systems, Distributed database concepts, Distributed Data storage, Distributed Transactions, Commit Protocols, Concurrency control, Distributed Query Processing. Data Warehousing: Introduction, Evolution of Data Warehouse, Characteristics, Benefits, Limitation of Data Warehousing, Architecture and Components of Data Warehouse, Conceptual Models, Data Mart, OLAP.

**UNIT III:**

**RDBMS and SQL:** Relational Query Languages, The SQL Query Language, Querying Multiple Relations, Creating Relations in SQL, Destroying and Altering Relations, Adding and Deleting Tuples, Integrity Constraints (ICs), Primary and Candidate Keys in SQL, Foreign Keys, Referential Integrity in SQL, Enforcing Referential Integrity, Categories of SQL Commands, Data Definition, Data Manipulation Statements: SELECT - The Basic Form Subqueries, Functions, GROUP BY Feature, Updating the Database, Data Definition Facilities, Views,

**Normalization:** Functional Dependency, Anomalies in a Database, The normalization process: Conversion to first normal form, Conversion to second normal form, Conversion to third normal form, The boyce-code normal form(BCNF), Fourth Normal form and fifth normal form, normalization and database design, Denormalization

**UNIT IV:**

**Semi-Structured Data:** XML database management system.XML databases, XML schema, Storing XML in Databases, XML and SQL. XML Query processing: XML query languages, XQuery, XPath. Approaches for XML query processing, Query processing on relational structure and storage schema. JSON: Overview, Data Types, Objects, Schema, JSON with Java/PHP/Ruby/Python.

**UNIT V:**

**No SQL Databases**: Column-oriented Databases, Graph Databases, Key-value pair Databases, Document Databases. CAP Theorem, Sharding. **Big Data Management**: Hadoop: HDFS, Dealing with Massive Datasets-Map Reduce and Hadoop. Introduction to HBase: Overview, HBase Data Model, HBase Physical Model, HBase Architecture. HIVE: Hive Data Model, Architecture, Hive queries, Hive DDL, DML

## Reference Books


1. A Silberschatz, H Korth, S Sudarshan, "Database System and Concepts", fifth Edition McGraw-Hill , Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning.
2. Guy Harrison, "Next Generation Data Bases – NoSQL, NewSQL and Big Data", 1stEd ,Apress, 2015.
3. Authored by DT Editorial Services , "Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization WileyIndia, 2016
4. Ramakrishna R. & Gehrke J, Database Management Systems, 3e, Mc-Graw Hill, 2003.
5. Silberschatz A, Korth H F, & Sudarshan S, Database System Concepts, 5e, TMH, 2005.
6. Elmarsi R, & Navathe S B, Fundamental of Database System, 5e, Pearson Education, 2008.
7. Robinson, I, Webber, J, & Eifrem E, Graph Databases, 2e, O'Reilly, 2015.


**********

# 21-344-0203 - Pattern Recognition

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Describe basics of Probability, Random Processes and Linear Algebra, Machine perception and pattern recognition system | (Cognitive level: Understand) |
| CO2 | Perform Bayes Decision Theory and apply Parameter Estimation Methods | (Cognitive level: Understand) |
| CO3 | Apply unsupervised learning and clustering | (Cognitive level: Apply) |
| CO4 | Apply sequential pattern recognition and dimensionality reduction | (Cognitive level: Apply) |
| CO5 | Apply Linear discriminant functions and Non-metric methods for pattern classification | (Cognitive level: Apply) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | | 2 | | | | | | | | | | |
| CO3 | | | 2 | | | | | | | | | |
| CO4 | | | 2 | | | | | | | | | |
| CO5 | | | 2 | | | | | | | | | |

**UNIT I**

Basics of Probability, Random Processes and Linear Algebra: Probability: independence of events, conditional and joint probability, Bayes' theorem; Random Processes: Stationary and nonstationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra; Linear Algebra: Inner product, outer product, inverses, eigenvalues, eigen vectors, singular values, singular vectors.

**UNIT II**

Machine perception, Pattern recognition systems, Design cycle, Learning and adaptation, Bayes Decision Theory: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, discrete features, Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case.

**UNIT III**

Unsupervised learning and clustering: Criterion functions for clustering; Algorithms for clustering: K-Means, Hierarchical and other methods; Cluster validation; Gaussian mixture models; Expectation-Maximization method for parameter estimation; Maximum entropy estimation.

**UNIT IV**

Sequential Pattern Recognition: Hidden Markov Models (HMMs); Discrete HMMs; Continuous HMM, Nonparametric techniques for density estimation: Parzen-window method; K-Nearest Neighbour method. Dimensionality reduction: Fisher discriminant analysis; Principal component analysis; Factor Analysis.

**UNIT V**

Linear discriminant functions: Gradient descent procedures; Perceptron; Support vector machines, Non-metric methods for pattern classification: Non-numeric data or nominal data; Decision trees: CART, algorithm independent machine Learning, bias and variance regression and classification classifiers.

**TEXT BOOK**


1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006


**REFERENCE BOOKS**


1. Earl Gose , Steve Jost, “Pattern Recognition and Image Analysis”, PEARSON,2015.
2. Robert J.Schalkoff, Pattern Recognition Statistical, Structural and Neural Approaches,
   John Wiley & Sons Inc., New York, 1992
3. V. S. Devi, M. N. Murty, “Pattern Recognition: An Introduction”, Universities Press, Hyderabad, 2011.
4. Robert J. Schalkoff, “Pattern Recognition : Statistical Structural and Neural Approaches”,
   John Wiley & Sons Inc., New York, 1992.
5. Tou and Gonzales, “Pattern Recognition Principles”, Wesley Publications Company, London 1974.


**********

# 21-344-0204 - INFORMATION SECURITY

**(July 2021)**

## Course Outcomes

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Explain the basic concepts of information security – Threats, Vulnerabilities and Controls. | (Cognitive level : Understand) |
| CO2 | Solve the problems using conventional symmetric key algorithms. | (Cognitive level : Apply) |
| CO3 | Apply Asymmetric key cryptography algorithm RSA to protect the information. | (Cognitive level : Apply) |
| CO4 | Examine various malwares and program flaws | (Cognitive level : Analyze) |
| CO5 | Compare Security enabled in conventional and trusted operating systems. | (Cognitive level : Analyze) |
| CO6 | Describe various security measures in database management systems. | (Cognitive level : Understand) |
| CO7 | Discuss network threats and security techniques. | (Cognitive level : Understand) |
| CO8 | Examine the working of firewalls in an institution network. | (Cognitive level : Analyze) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | |
| CO3 | 3 | | | | | | | | | | | |
| CO4 | 3 | 3 | | 3 | | | | | | | | |
| CO5 | 3 | 3 | | 3 | | | | | | | | |
| CO6 | 3 | | | | | | | | | | | |
| CO7 | 3 | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO8 | 3 | 3 | | | 3 | | | | | | | |

**UNIT I**

Introduction and Basic concepts: threats, vulnerabilities, controls; risk; Breaches;confidentiality, integrity, availability; Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning).

Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners.

Modular Arithmetic Basic cryptography - Basic cryptographic terms, Historical background, Symmetric crypto Systems - Conventional systems, Asymmetric crypto primitives –RSA.

**UNIT II**

Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., , Malware Analysis.

Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, AntiPhishing.

**UNIT III**

Security in conventional operating systems - Memory, time, file, object protection requirements and techniques Identification and authentication. Trusted operating systems.

**UNIT IV**

Database management systems security - Database integrity , Database secrecy , Inference control , Multilevel databases.

**UNIT V**

Network security - Network threats: eavesdropping, spoofing, modification, denial of service attacks, Introduction to network security techniques: firewalls, intrusion detection systems. Cyber crimes and control measures.

**TEXT BOOK**

1. Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing", 5 th Ed, Prentice hall, 2015.

**REFERENCES**

1. Michael E. Whitman, 'Information Security: incident response and disaster recovery', Cengage Learning, 2009

2. WM. Arthur Conklin, Gregory B. White, Chuck Cotheren, Dwayne Williams, Roger Lavis,"Principles of Computer Security", 4 th Ed,Mc Graw Hill 2016.

**********

# 21-344-0206 - Data Management Lab

(July 2021)

## Course Outcomes:

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

| | | |
|---|---|---|
| CO1 | Employ SQL DDL/DML commands to create and query a database. | (Cognitive level : Apply) |
| CO2 | Apply XPath and XQuery queries | (Cognitive level : Apply) |
| CO3 | Apply Read, Write and Parsing operations on JSON data using Python and java | (Cognitive level : Apply) |
| CO4 | Employ HIVE commands to query a database. | (Cognitive level :Apply) |
| CO5 | ApplyMapReduce framework for processing large data sets | (Cognitive level :Apply) |

Mapping of course outcomes with programme outcomes **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LO1 | 3 | 2 | 3 | | | | | | | | | |
| LO2 | 3 | 2 | 3 | | | | | | | | | |
| LO3 | 3 | 2 | 3 | | | | | | | | | |
| LO4 | 3 | 2 | 3 | | | | | | | | | |
| LO5 | 3 | 3 | 3 | 2 | 2 | 2 | | | | | | |

- Familiarization of MySQL RDBMS, SQL- query-structure
- Storing XML in Databases
- Familiarization of basics of XML Query processing( XQuery, XPath)
- Basics of JSON with Java and Python.
- Understanding Hive queries, Hive DDL, DML.
- Implementation of map reduce algorithm.

**********

# 21-344-0301 - Deep Learning

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Discuss the basic concepts of neural networks like perceptron model, MLP, loss functions, backpropagation, and parameter optimization. | (Cognitive level : Understand) |
| CO2 | Design DNN and CNN models using python to familiarise the efficiency of these models in solving real life problems. | (Cognitive level : Create) |
| CO3 | Design RNN, LSTM, and GRU models to handle time series data and demonstrate the efficiency of these models in application areas like NLP. | (Cognitive level : Create) |
| CO4 | Compare the architecture differences and capabilities of different pre-trained models. | (Cognitive level : Analyze) |
| CO 5 | Apply transfer learning to extract relevant features from image datasets. | (Cognitive level : Apply) |
| CO6 | Describe advanced Deep Learning architectures such as Autoencoders and GAN. | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | | | | | | | | | | |
| CO2 | 2 | 2 | | | 3 | | | | | | | |
| CO3 | 3 | 2 | | | 3 | | | | | | | |
| CO4 | 3 | 3 | 2 | | | | | | | | | |
| CO5 | 3 | 3 | 2 | 3 | 3 | | | | | | | |
| CO6 | 2 | 3 | | | | | | | | | | |

**UNIT 1**:

Introduction to Machine Learning and Neural Networks - Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Threshold logic, Linear Perceptron, Multilayer Perceptron, Perceptron Learning Algorithm, Linear separability; loss functions – various types, regularization and hyper parameter tuning, Feed Forward Neural Networks, Forward propagation, activation functions and its derivatives, backpropagation and optimization functions, batch normalization.

**UNIT II:**

Deep Neural Networks (DNN) and Convolutional Neural Networks (CNN) – Deep Neural Network algorithm, Initialization of network parameters, Optimization – Gradient descent, parameter updates and optimization, vanishing gradient problem, regularization techniques to handle overfitting.

Convolutional Neural Networks – Convolutional operation, padding, strided convolution, pooling, training single layered and multi layered CNNs, CNNs in image processing applications.

**UNIT III:**

Recurrent Neural Networks (RNN) for sequence modelling – Introduction to RNN, RNN architecture, Backpropagation in basic RNN, Applications of RNN; Long Short Term Memory (LSTM) – Architecture, LSTM implementation, Case study related to NLP and time series data analysis; Gated Recurrent Unit (GRU) – difference between LSTM & GRU, architecture, implementation and applications.

**UNIT IV:**

Pretrained models and Transfer Learning – Residual Network, Skip Connection, Alex Net, VGG16, VGG19, Inception V3, Dense Net, Architecture differences, Case study; Advantages of transfer learning, feature extraction using transfer learning, pretrained models-based image classification.

**UNIT V:**

Advanced Deep Learning Architectures – Generative models, Restrictive Boltzmann Machines (RBMs), Autoencoders, different autoencoder architectures, Generative Adversarial Networks (GAN), image generation using GANs.

**TEXTBOOK**

1, Deep Learning with R, Abhijit Ghatak, Springer Nature Singapore Pte Ltd, 2019.

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

**REFERENCES**


1. Yuxi ( Hayden), Liu and Savansh Mehta, “Hands -on Deep Learning Architectures with Python”, Packt,
2. Josh Patterson & Adam Gibson, “Deep Learning: A Practitioners Approach”, published by O’Reilly Media.
3. Nikhil Ketkar, “Deep Learning with Python”, published by Apress Media


**********

**Elective Papers for Semester II**

# 21-344-0211 - DISTRIBUTED COMPUTING

(July 2021)

## Course Outcomes

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Describe about the basics of distributed computing | (Cognitive level : Understand) |
| CO2 | Explain the concept of distributed file system | (Cognitive level : Understand) |
| CO3 | Discuss about the objects and components of distributed systems | (Cognitive level : Understand) |
| CO4 | Describe web services and OS support in distributed systems. | (Cognitive level : Understand)) |
| CO5 | Examine how security is provided in distributed systems. | (Cognitive level: Analyze) |
| CO6 | Explain the design aspects of various advanced distributed computing models like Cluster of cooperative computers, Grid computing, Peer-to-Peer networks, and Internet of Things. | (Cognitive level : Understand) |
| CO7 | Compare Cluster and Grid computing models | (Cognitive level : Analyze) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | 2 | | | | | | | | | | | |
| CO3 | 2 | | | | | | | | | | | |
| CO4 | 2 | | | 2 | | | | | | | | |
| CO5 | 2 | | 2 | 3 | | | | | | | | |
| CO6 | 2 | | | 2 | | | | | | | | |
| CO7 | | | | | | | | | | | | |

**UNIT I:**

**Distributed Computing System**: Introduction to distributed computing systems, Examples, Trends, Design challenges, System Models, Networking and Internetworking, Inter process communication, Remote Invocation.

**UNIT II:**

**OS Support**: Introduction, OS Layer, Protection, Processes and Threads, Communication, Invocation, Architecture. **Distributed File System:** File service architecture, Sun Network File System

**UNIT III:**

**Distributed objects and Components:** Object to Components, **Peer – to – Peer systems**: Introduction ,Peer-to-peer middleware, Routing overlays

**UNIT IV:**

**Web Services:** Service descriptions and IDL for web services, A directory service for use with web services, XML security, Coordination of web services, Applications of web services, **Security**: Introduction, Overview of security techniques, Cryptographic algorithms, Digital signatures, Cryptography pragmatics.

**UNIT V:**

**Cluster Computing**: Cluster computers and MPP architectures, Cluster job and resource management. **Grid Computing:** Grid architecture and service modeling, Grid resource management and brokering. **Internet of Things:** IoT for Ubiquitous computing, RFID, Sensors and ZigBee technologies, Applications of IoT (smart buildings, cyber-physical systems).

**TEXT BOOKS:**

1. George Coulouris, Jean Dollimore , Tim Kindberg , Gordon Blair, " Distributed Systems :Concepts and Design", 5th Ed, Addison Wesely, 2012 .
2. Ajay D. Kshemkalyani, and Mukesh Singhal "Distributed Computing: Principles, Algorithms, and Systems", Cambridge University Press, 2008 (Reprint 2013).
3. Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, "Distributed and Cloud Computing: From Parallel processing to the Internet of Things", Morgan Kaufmann, 2012 Elsevier Inc

**REFERENCES:**

1. A. S. Tanenbaum , “Distributed Operating Systems “ , Pearson, 2009.
2. “Fundamentals of Distributed Operating Systems” , S.K. Kataria& Sons, 2013.

**********

# 21-344-0213 - CLOUD COMPUTING

(July 2021)

## Course Outcomes

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Describe about the basics of edge and cloud computing | (Cognitive level : Understand) |
| CO2 | Explain the concept of various edge and cloud computing models and services | (Cognitive level : Understand) |
| CO3 | Discuss about the objects and components of cloud computing systems | (Cognitive level : Understand) |
| CO4 | Describe about the various public cloud platforms and software environments | (Cognitive level : Understand)) |
| CO5 | Examine how security is provided in cloud computing systems. | (Cognitive level Analyze) |
| CO6 | Explain the use of various cloud services available online | (Cognitive level : Understand) |

Mapping of course outcomes with program outcomes **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | 2 | | | | | | | | | | | |
| CO3 | 2 | | | | | | | | | | | |
| CO4 | 2 | | | 2 | | | | | | | | |
| CO5 | 2 | | 2 | 3 | | | | | | | | |
| CO6 | 2 | | | 2 | | | | | | | | |

**UNIT I:**

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

**UNIT II:**

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

**UNIT III:**

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

**UNIT IV:**

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

**UNIT V:**

Eucalyptus- Nimbus – Open Stack – Extended Cloud Computing Services —- Public Cloud Platforms: GAE – AWS – Azure,Emerging Cloud

**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


**REFERENCES:**


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

2. George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud (Theory in Practice)”, O’Reilly Publications, 2009.
3. Haley Beard, “Cloud Computing Best Practices for Managing and Measuring Processes for On-demand Computing – applications and Data Centers in the Cloud with SLAs”,
   Emereo Pty Limited, July 2008
4. James E. Smith and Ravi Nair: Virtual Machines: Versatile Platforms for Systems and Processes, Morgan Kaufmann, ELSEVIER Publication, 2006.
5. John W Rittinghouse and James F Ransome , “Cloud Computing: Implementation -Management – and Security”, CRC Press, 2010.
6. Michael Miller, “Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online”, Pearson Education, 2009.
7. Richard N. Katz, “The Tower and The Cloud”, Higher Education in the Age of Cloud Computing, 2008.
8. Toby Velte, Anthony Velte and Robert Elsenpeter: “Cloud Computing – A Practical Approach”, TMH, 2009.

**********

# 21-344-0214 - Software Defined Networks

(July 2021)

## Course Outcomes

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Describe the benefits of SDN by the separation of data and control planes | (Cognitive level : Understand) |
| CO2 | Discuss SDN controllers and application models | (Cognitive level : Understand) |
| CO3 | Compare traditional networks and software defined networks | (Cognitive level : Analyze) |
| CO4 | Employ software programs to perform varying and complex networking tasks | (Cognitive level : Apply) |
| CO5 | Solve real world problems using SDN | (Cognitive level : Apply) |
| CO6 | Describe various technologies in Data center | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | |
| CO3 | 3 | 3 | | 3 | | | | | | | | |
| CO4 | 3 | | | 3 | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | | | 3 | | | | | | | | |
| CO6 | 3 | | | | | | | | | | | |

**UNIT I**

Introduction – History of Software Defined Networking (SDN), Modern Data Center, Traditional Switch Architecture, Evolution of SDN ,How SDN Works – Centralized and Distributed Control and Date Planes

**UNIT II**

Open flow & SDN controllers -Open Flow Specification, Drawbacks of Open SDN, SDN via APIs, SDN via Hypervisor-Based Overlays – SDN via Opening up the Device – SDN controllers and application models

**UNIT III**

Data centers- Data Center Demands, Tunneling Technologies for the Data Center, Path Technologies in the Data Center, Ethernet Fabrics in the Data Center, SDN Use Cases in the Data Center, Comparison of Open SDN, Overlays, and APIs

**UNIT IV**

Network function virtualization (NFV)-Definition, standards , OPNFV,SDN v/s NFV ,In-Line Network Functions. SDN security:-FRESCO, FortNOX

**UNIT V**

SDN applications- Application Types , Controller Considerations ,Network Device Considerations, Creating Network Virtualization Tunnels, Offloading Flows in the Data Center, Access Control for the Campus, Traffic Engineering for Service Providers. Programming SDN networksNorthbound Application Programming Interface, Current Languages and Tools

**TEXTBOOKS/ REFERENCES**


1. Software Defined Networks: Paul Goransson, Chuck Black, Timothy Culver 2nd Edition, 2014.

2. Thomas D. Nadeau, Ken Gray, ―SDN: Software Defined Networks, O'Reilly Media, 2013.

3. Network Innovation through OpenFlow and SDN: Principles and Design, Edited by Fei Hu, CRC Press, 2014.

**********

# 21-344-0215 - Mobile Application Development using Android

(July 2021)

## Course Outcomes

After completion of the course the students will be able to

| | | |
|---|---|---|
| CO1 | Explain the basics of Android Operating System | (Cognitive level:Understand) |
| CO2 | Show the installation and configuration of Android application development tools. | (Cognitive level: Apply) |
| CO3 | Design good user interfaces for the mobile application | (Cognitive level: Create) |
| CO4 | Discuss the different mobile data management in Android | (Cognitive level: Understand) |
| CO5 | Apply Java programming concepts to Android application development. | (Cognitive level: Apply) |
| CO6 | Develop simple mobile applications, Location map-based services | (Cognitive level: Create) |

Mapping of course outcomes with programme outcomes - Low=1, medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | | 1 |
| CO2 | | | | | 2 | | | | | | | |
| CO3 | | | 3 | | | | | | | | | |
| CO4 | | | | 1 | | | | | | | | |
| CO5 | 3 | | | | | | | | | | | |
| CO6 | | | 3 | | | | | | | | 2 | |

**UNIT I:**

**Introduction to Android**

Introduction to Android Architecture: Introduction, History, Features and Android Architecture. Application Environment and Tools, Android Studio, Android SDK, AVD. Application Components- Activity, Content providers, Broadcast receivers, Services. Intents- Explicit and Implicit Intents, Intent Filter, Manifest File. Debugging android application.

**UNIT II:**

**User Interface Design**

User Interface Design: Views &View Groups, Views: Button, Text Field, Radio Button, Toggle Button, Checkbox, Spinner, Image View, Image switcher, Event Handling, Listeners, Layouts: Linear, Relative, ListView, Grid View, Table View, Web View, Adapters. Creating the user interface programmatically, managing changes to screen orientation, displaying notifications- Setting up notifications, Notification manager.

**UNIT III:**

**Mobile Data Management**

Shared Preferences – Saving and Loading User Preferences, Persisting Data to Files, Creating and using Databases, SQLite Databases. Content Providers - Using a Content Provider, Built-in Content Provider - Browser, Call log, Contacts, Media Store and Settings.

**UNIT IV**

**Native Capabilities, Location-based services**

Camera, Audio, Sensors and Bluetooth, Maps & Location: Maps: Map-Based Activities, how to load maps, to finding map API key, GPS, Working with Location Manager, working with Google Maps extensions, Location Updates, location-based services (LBS), Location Providers, selecting a Location Provider, Finding Your Location.

**UNIT V:**

**Threading, Services, Web services**

Tasks & Processes: Tasks, Switching between Task, Process, Process lifecycle. Threads: Thread Life cycle, Worker Threads, Thread Handlers, Threads & Loopers. Services: Services and Notifications – bound/unbound services, Starting and stopping services, Android Interface Definition Language, Handler and Messenger, Passing objects over IPC, Scheduling of services. Web Services – Android Server Communication: communication protocols, server-side applications, client-side applications for web services.

## Textbook:

- Android App Development for Dummies, 3ed, Michael Burton, Wiley

## References:


- Head First Android Development 2e: A Brain-Friendly Guide, Dawn Griffiths & David Griffiths,2017 – O'Reilly
- Android Programming for Beginners - Second Edition, John Horton,2018
- Java Programming for Android Developers for Dummies, Second Edition, Barry Burd

**********

# 21-344-0216 - Internet Of Things

(July 2021)

## Course Outcomes

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Describe general concepts of Internet of Things. | (Cognitive level : Understand) |
| CO2 | Compare M2M and IoT Architectures. | (Cognitive level : Analyze) |
| CO3 | Describe about various devices, sensors required for IoT applications | (Cognitive level : Understand) |
| CO4 | Design IoT Applications using Arduino IDE. | (Cognitive level : Create) |
| CO5 | Examine interoperability problems in IoT. | (Cognitive level : Analyse) |
| CO6 | Discuss IoT applications. | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | 3 | 3 | | 3 | | | | | | | | |
| CO3 | 2 | | | | | | | | | | | |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | |
| CO5 | 3 | 3 | | 3 | | | | | | | | |
| CO6 | 3 | | | | | | | | | | | |

-

**UNIT I**

Introduction -Physical Design of IoT, Logical Design of IoT, IoT Levels, Deployment templates, IoT enabling technologies.

IoT Applications, Sensing,Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

**UNIT II**

Networking IoT and Communication protocols – Link Layer, Network Layer, Transport layer, Application Layer.Sensor Networks and Machine to Machine communication – Differences and Similarities between M2M and IoT, Software defined networking , Network function virtualization.

**UNIT III**

M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol –Modbus– Zigbee Architecture – Network layer –LowPAN - CoAP – Security

**UNIT IV**

Building IoT - RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry PiBoard - Linux on Raspberry Pi- Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino. Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Implementation of IoT.

**UNIT V**

IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture,Healthcare, Home Automation

**TEXT BOOK/REFERENCES**


1. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley &Sons, 2013.
2. Cuno Pfister, “Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud”, Maker Media, 2011.
3. Pethuru Raj and Anupama C. Raman , “The Internet of Things: Enabling Technologies, Platforms, and Use Cases", (CRC Press).
4. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", by (Universities Press)2015.
5. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.

**********

Elective papers for Semester III

# 21-344-0311 - Swarm Intelligence

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Explain basic concepts of self-organization, meta heuristic, and explain popular swarm intelligent algorithms. | Cognitive Level: Understand |
| CO2 | Describe state space search algorithms in AI. | Cognitive Level: Understand |
| CO3 | Apply Ant colony optimization for solving Travelling Salesperson problem and to solve problems related to feature selection. | Cognitive Level: Apply |
| CO4 | Analyse the performance of ACO and PSO in selecting important features from datasets. | Cognitive Level: Analyze |
| CO5 | Apply ABC algorithm in solving knapsack problem | Cognitive Level: Apply |
| CO6 | Describe Krill Herd Optimization algorithm and its application in solving real life problems. | Cognitive Level: Understand |

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | 2 | | | | | | | | | | | |
| CO3 | 3 | | 3 | 2 | 3 | | | | | | | |
| CO4 | 3 | | 3 | 2 | 3 | | | | | | | |
| CO5 | 2 | | | | 2 | | | | | | | |
| CO6 | 2 | | | | | | | | | | | |

**UNIT I:**

Introduction to Swarm Intelligence – Essence of an Algorithm, Algorithms and Self – Organization, Links between Algorithms and Self-Organization, Characteristics of Metaheuristics; Swarm Intelligence based algorithms – Ant Algorithms; Bee Algorithms; Particle Swarm Optimization and Krill Herd Algorithms; Strategies for state space search in AI- Depth First and Breadth First Search Heuristic Search- Best First Search and Hill Climbing.

**UNIT II:**

Ant Colony Optimization (ACO) - Theoretical Considerations, Combinatorial optimization and meta heuristic, Stigmergy, Convergence Proofs, ACO Algorithm, ACO and Model Based Search, Variations Of ACO: Elitist Ant System (EAS), Minmax Ant System (MMAS) and Rank Based Ant Colony System (RANKAS), ACO Algorithm for Travelling Salesperson problem, ACO algorithm for feature selection.

**UNIT III:**

Particle Swarm Optimization: Principles of Bird Flocking and Fish Schooling, Evolution of PSO, Operating Principles, PSO Algorithm, Neighbourhood Topologies, Convergence Criteria, Variations of PSO.

**UNIT IV:**

Artificial Bee Colony (ABC) Optimization - Behaviour of real bees, ABC Algorithm, Variations of ABC: Abcgbest and Abcgbestdist, Case Study: Application of ABC algorithm in solving Travelling Salesman Problem, Knapsack Problem and for feature selection.

**UNIT V:**

Krill Herd Optimization - Herding Behaviour of Krill Swarms, Lagrangian Model of Krill Herding, Methodology, Application of Krill Herd Algorithm in Feature Selection.

**TEXTBOOKS:**


1. Xin-She Yang, Zhihua Cui, Renbin Xiao, Amir Hossein Gandomi, Mehmet Karamanoglu, “Swarm Intelligence and Bio-Inspired Computation, Theory and Applications”, Elsevier 2013.
2. Marco Dorigo and Thomas Stutzle, “Ant Colony Optimization”, MIT Press, Cambridge, England, 2004.
3. Ben Coppin, “Artificial Intelligence Illuminated”, Jones and Bartlett Publishers, 2004.
4. Kennedy J and Russel C Eberhart, “Swarm Intelligence”, Morgan Kaufmann Publishers, USA, 2001.

**********

# 21-344-0312 - Fuzzy Logic

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Describe Fuzzy systems, Classical sets, fuzzy sets. | (Cognitive level: Understand) |
| CO2 | Describe Classical relations and fuzzy relations. | (Cognitive level: Understand) |
| CO3 | Perform fuzzification, defuzzification and describe logic systems and fuzzy systems. | (Cognitive level: Apply) |
| CO4 | Develop membership function and apply the extension principle. | (Cognitive level: Apply) |
| C05 | Perform fuzzy classification and clustering and describe fuzzy arithmetic. | (Cognitive level: Apply) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | | 2 | | | | | | | | | | |
| CO3 | | | 2 | | | | | | | | | |
| CO4 | | | 2 | | | | | | | | | |
| CO5 | | | 2 | | | | | | | | | |

**UNIT I**

Introduction: Fuzzy systems – Historical perspective, Utility and limitations, uncertainity and information, fuzzy sets and membership, Chance vs Fuzziness. Classical sets and Fuzzy sets: Classical set - Operations, properties, mapping to functions. Fuzzy sets - operations, properties, Alternative fuzzy set operations.

**UNIT II**

Classical Relations and Fuzzy relations: Cartesian product, crisp relations - cardinality, operations, properties, composition, Fuzzy relations - cardinality, operations, properties, Fuzzy Cartesian products and composition, Tolerance and equivalence relation, Crisp equivalence and tolerance relations, Fuzzy tolerance and equivalence relations, value

assignments - Cosine amplitude, Max-min method, other similarity methods, other forms of composition operation.

**UNIT III**

Properties of membership functions, Fuzzification and Defuzzification: Features of the membership functions, various forms, Fuzzification, defuzzification to crisp sets, λ-cuts for fuzzy relations, Defuzzification to scalars. Logic and Fuzzy systems: Classical logic - proof, Fuzzy logic - approximate reasoning, other forms of the implication operation. Natural language, Linguistic hedges, Fuzzy rule based systems, Fuzzy Inference System, Graphical techniques for inference.

**UNIT IV**

Development of membership functions: Membership value assignments - intuition, inference, rank ordering. Extension Principle: Crisp functions, Mapping and relations, Functions of Fuzzy sets-Extension principle, Fuzzy transform, practical considerations.

**UNIT V**

Fuzzy Arithmetic: Interval analysis, Approximate methods of extension-DSW and restricted DSW algorithms Fuzzy classification: Classification by equivalence relation- Crisp Relations and Fuzzy Relations, Cluster analysis, cluster validity, C-means clustering - Hard C- Means and Fuzzy C-Means, Fuzzy C-Means algorithm.

**TEXT BOOK**


1. Ross, Fuzzy Logic with Engineering Applications, 3rd Edn, Wiley India,2010.
2. Hajek P, Mathematics of Fuzzy Logic, Kluwer ,1998


**REFERENCE BOOKS**


1. Rajasekharan and Vijyayalakshmi pai, Neural Networks, Fuzzy Logic and Genetic Algorithm, PHI, 2003.
2. Sivanandan and Deep, Principles of Soft Computing, John Wiley and Sons, 2007


**********

# 21-344-0313 - Computer Vision

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Describe digital image formation and representation and perform low level image processing | (Cognitive level: Understand) |
| CO2 | Perform Feature detection | (Cognitive level: Apply) |
| CO3 | Perform segmentation and Feature-based alignment. | (Cognitive level: Apply) |
| CO4 | Develop structure from motion and perform dense motion estimation. | (Cognitive level: Apply) |
| CO5 | Perform depth estimation, Object Detection, Face recognition, Instance recognition and understand multi-camera views. | (Cognitive level: Apply) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | | | 2 | | | | | | | | | |
| CO3 | | | 2 | | | | | | | | | |
| CO4 | | | 2 | | | | | | | | | |
| CO5 | | | 2 | | | | | | | | | |

**UNIT I**

Digital Image Formation and Representation: Fundamentals of Image Formation, Geometric Primitives and Transformations: Orthogonal, Euclidean, Affine, Projective; Photometric Image Formation, Digital Camera, Low-level Image processing: Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

**UNIT II**

Feature Detection: Edges - Canny, Laplacian of Gaussian(LoG), Difference of Gaussian(DoG); Lines - Hough Transform, Corners - Harris and Hessian Affine, Orientation

Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

**UNIT III**

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, Markov Random Field Segmentation, Texture Segmentation; Feature-based Alignment: 2D and 3D Feature-based alignment, Pose estimation, Geometric intrinsic calibration.

**UNIT IV**

Structure from motion: Triangulation, Two-frame structure from motion, Factorization, Bundle adjustment, constrained structure and motion; Dense motion estimation – Translational alignment, Parametric motion, Spline-based motion, Optical flow, Layered motion.

**UNIT V**

Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, 3-D reconstruction framework; Auto-calibration.Stereo; Recognition - Object Detection, Face recognition, Instance recognition.

**TEXT BOOK**


1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.


**REFERENCE BOOKS**


1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006


**********

# 21-344-0314 - Computer Forensics

(July 2021)

## Course Outcomes

After completion of this course, students will be able to

| | | |
|---|---|---|
| CO1 | Describe different types of threats related to digital information and the relevance of Digital evidence for crime investigation. | (Cognitive level : Understand) |
| CO2 | Explain systematic approach to computer investigations. | (Cognitive level : Understand) |
| CO3 | Apply forensic procedure to collect and recover digital evidence using tools. | (Cognitive level : Apply) |
| CO4 | Judge the validity of digital evidence before presenting using cryptographic hashes. | (Cognitive level : Analyze) |
| CO5 | Apply various tools and commands for capturing digital evidence. | (Cognitive level : Apply) |
| CO6 | Create forensic duplicates for investigation using tools and commands. | (Cognitive level : Create) |
| CO7 | Describe steps to follow for network , email and mobile forensics. | (Cognitive level : Understand) |

Mapping of course outcomes with programme outcomes - **Low=1, medium=2, High=3**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | | | | | | | | | | |
| CO2 | 2 | 2 | | | | | | | | | | |
| CO3 | 3 | 3 | | | 2 | | | | | | | |
| CO4 | 3 | 3 | | | 3 | | | | | | | |
| CO5 | 3 | 3 | | | 3 | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | 3 | 3 | | | 3 | | | | | | | |
| CO7 | 2 | 2 | | | | | | | | | | |

**UNIT I**

Introduction to traditional Computer Crime, Problems associated with computer crime, Identity Theft, Identity fraud. Computer Forensics Fundamentals- Type of Computer Forensics Technology. Type of Vendor and Computer Forensics Services.
Scientific method in forensic analysis

**UNIT II**

Digital Evidence in Criminal Investigations, the digital crime scene, Investigating Cybercrime, Duties Support Functions and Competencies.
Computer investigation and Data Acquisition, Computer Forensics Evidence and CaptureData Recovery-Evidence collection and Data Seizure-Duplication and preservation of Digital Evidence-Computer image verification and Authentication.

**UNIT III**

Introduction to Incident - Incident Response Methodology - Steps, Activities in Initial Response Phase after detection of an incident, Creating response toolkit,

**UNIT IV**

Initial Response & Volatile Data Collection from Windows system - Initial Response & Volatile Data Collection from Unix system - Forensic Duplication, Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic Duplicate, Forensic Duplicate of a Hard Drive.

**UNIT V**

Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing - Internet Fraud. Hackers Tools. Cellphone and mobile device forensics. Forensics hardwares and softwares, Information Security Investigations, Corporate Cyber Forensics,Investigating large scale Data breach cases, Analyzing Malicious software.

**TEXT BOOK**

1. John R. Vacca, Computer Forensics: Computer Crime Scene Investigation Laxmi Publications, 2015 reprint. .

**REFERENCES**


1. Dr.Darren R Hayes, A Practical guide to Computer Forensics investigation, Pearson 2015.

2. Aaron Philipp, David Cowen, Chris Davis , Computer Forensics Secrets & Solutions , McGraw-Hill Osborne Media, 2006.

3. Kenneth C.Brancik “Insider Computer Fraud” Auerbach Publications Taylor & Francis Group–2008.

4. Bill Nelson,Amelia Philips and Christopher Steuart, “Guide to computer forensics and investigations”, Cengage Learning; 4th edition, 2009.

5. Dejey , Murugan ,” Cyber Forensics”, OXFORD,2018.


**********

# 21-344-0317 - NATURAL LANGUAGE PROCESSING

(July 2021)

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Describe language models in NLP | Cognitive Level: Understand |
| CO2 | Explain preprocessing steps in NLP and describe grammars and how a language is built based on grammar | Cognitive Level: Understand |
| CO3 | Employ various vectorization techniques and apply them in various datasets | Cognitive Level: Apply |
| CO4 | Explain Neural Language Models and apply supervised ML techniques to various datasets | Cognitive Level: Apply |
| CO5 | Describe various DL techniques that are used with NLP | Cognitive Level: Understand |

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | | | | | | | | | |
| CO2 | 1 | | | | | | | | | | | |
| CO3 | 2 | | 3 | 2 | | | | | | | | |
| CO4 | 2 | | 3 | 2 | | | | | | | | |
| CO5 | 1 | | | | 1 | | | | | | | |

**UNIT I**

Regular Expressions, Text Normalization, Edit Distance, Regular Expressions, Words, Corpora, Text Normalization, Minimum Edit Distance, N-gram Language Models, N-Grams, Evaluating Language Models

**UNIT II**

Preprocessing: Handling corpus-raw text - Stemming and Lemmatization for raw text, Stop word removal, Feature Engineering: Understanding feature engineering, Basic feature of NLP - Parsers and parsing, Types of grammar, POS tagging and POS taggers, n-grams, Bag of words, TF-IDF, Encoders, and decoders, Probabilistic models

**UNIT III**

Advanced Feature Engineering: Word embedding, Understanding the basics of word2vec, Understanding the components of the word2vec model, Main processing algorithms - CBOW, Skip-gram, Applications of word2vec, and simple examples

**UNIT IV**

Neural Networks and Neural Language Models: Training Neural Nets, Neural Language Models

Understanding ML algorithms for NLP: Supervised ML algorithms: Decision tree, Random forest, Naive Bayes, Support vector machines

**UNIT V**

Deep Learning Architectures for Sequence Processing: Recurrent Neural Networks, Managing Context in RNNs: LSTMs and GRUs, Self-Attention Networks: Transformers

Case studies: Word sense disambiguation system, Automatic Question Answering system

**TEXTBOOK**


1. Jurafsky, Dan. *Speech & language processing*. Pearson Education India, 2020.
2. Thanaki, Jalaj. *Python natural language processing*. Packt Publishing Ltd, 2017.


**REFERENCE BOOKS**


1. Goldberg, Yoav. "Neural network methods for natural language processing." Synthesis lectures on human language technologies 10.1 (2017): 1-309.

2. Manning, Christopher, and Hinrich Schutze. Foundations of statistical natural language processing. MIT Press, 1999.

3. Kulkarni, Akshay, and Adarsha Shivananda. *Natural language processing recipes: Unlocking text data with machine learning and deep learning using python*. Apress, 2019.


**********

# 21-344-0318 - BLOCKCHAIN TECHNOLOGY

## Course Outcomes

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

| | | |
|---|---|---|
| CO1 | Explain the concept of decentralization, its impact and relationship with blockchain technology | (Cognitive level : Understand) |
| CO2 | Explain the inner workings of blockchain and relevant mechanisms behind Bitcoin and alternative cryptocurrencies | (Cognitive level : (Understand) |
| CO3 | Create and execute smart contracts | (Cognitive level : Create) |
| CO4 | Apply hyperledger Fabric and Ethereum platform to implement the Block chain Applications | (Cognitive level : Apply) |
| CO5 | Examine innovative application models, leveraging the blockchain technology | (Cognitive Level:Analyze) |

Mapping of course outcomes with program outcomes - Low=1, medium=2, High=3

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | |
| CO3 | | 3 | | | 2 | | | | | | | |
| CO4 | | 3 | | | 2 | | | | | | | |
| CO5 | 3 | | 2 | | | | | | | | | |

**UNIT 1:**

Distributed Ledger Technology, Decentralization, Bitcoin Network and Architecture, Block in a Blockchain, Advantages over Traditional Databases, Mining Mechanism, Types of

Blockchain: Public, Private, Consortium, Cryptography: Public and private keys, Discrete logarithm problem, Elliptic Curve Cryptography, ECC using Openssl, Hash Functions, Merkle Tree, Merkle Patricia Trie, Digital Signature, Wallets and Keys, User Addresses and Privacy

**UNIT 2:**

History, Distributed ledger, Creation of Coins, Double spending, Bitcoin protocols, Transaction in Bitcoin Network, Bitcoin payments, Bitcoin investment and buying and selling bitcoins, Bitcoin installation, Setting up a bitcoin node, Setting up the source code, Setting up bitcoin.conf, Starting up a node in testnet, Starting up a node in regtest, Starting up a node in live mainnet, Experimenting with bitcoin-cli, AltCoins, Ethereum, EVM, Accounts, Transactions, Gas, Fees, Smart Contracts, Eth 2.0

**UNIT 3:**

Definitions, Types of Mining Algorithms, Proof of Work, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Elapsed Time, Proof of Burn. Sharding Chains, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool

**UNIT 4:**

Setting up Ethereum Node using Geth Client, Smart Contracts and DApps, Truffle, Ganache CLI, Metamask, Remix, Solidity, Writing and Deploying Smart Contracts in Solidity, Connection to Web3.js Library, Vulnerabilities in Smart Contracts, Attacks, Prevention of Attacks, Decentralized Autonomous Organization (DAO), Building an Initial Coin Offering (ICO), Blockchain application development: 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

**UNIT 5:**

Understanding Blockchain for Enterprises: 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, Enterprise application of Blockchain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, Supply Chain

Financing, Identity on Blockchain, Voting System, and Healthcare, anomaly detections, serverless blockchain, blockchain on cloud

**Text Books**

[1] Mastering Bitcoin: Unlocking digital crypto currencies", ORELLY,2015.

[2] Joseph J. Bambara and Paul R. Allen, Blockchain – A practical guide to developing business, law, and technology solutions, McGraw Hill, 2018.

**Reference Books**

[1] Melanie Swan, Blockchain – Blueprint for a new economy, OReilly publishers, 2018.

[2] Mastering Blockchain, by Lorne Lantz, Daniel Cawrey, Publisher(s): O'Reilly Media, Inc.ISBN: 9781492054702

[3] Mastering Blockchain, Imran Bashir, Packt Publishing Ltd, ISBN-10 1787129292, 2017.

[4data science
] Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.

**********