COURSE STRUCTURE

Master of Technology (M.Tech.)

in

COMPUTER SCIENCE & ENGINEERING

Under

Choice Based Credit System (CBCS)

Academic Session: 2024-25

First Semester

S. No.	CODE	CAT	SUBJECT	TEACHING SCHEME			CREDITS	Contact Hrs/wk
				L	T	P		
1.	MCSC0013	PC	Mathematical Foundations of Data Analytics	3	0	0	3	3
2.	MCSC0014	PC	Computability, Complexity and Algorithms	3	0	0	3	3
3.	MCSC1007	PC	Artificial Intelligence and Expert Systems	4	0	0	4	4
4.	MCSE0007	PC	Machine Learning	4	0	0	4	4
5.	MCSE0010	OE	Research Methodology	3	0	0	3	3
PRACTICALS								
1.	MCSC0805	PC	Data Analytics Lab	0	0	2	1	2
2.	MCSC0806	PC	Algorithms Lab	0	0	2	1	2
3.	MCSJ0952	PW	Minor Project – I	0	0	-	2	-
4.	MTEH0301	OE	Soft Skills for Professionals - I	0	0	4	2	4
			TOTAL	**17**	**0**	**6**	**23**	**25**

Second Semester

S. No.	CODE	CAT	SUBJECT	TEACHING SCHEME			CREDITS	Contact Hrs/wk
				L	T	P		
1.	MCSC0011	PC	Big Data & Scalable Algorithms	4	0	0	4	4
2.	MCSC0009	PC	Image Processing and Analysis	4	0	0	4	4
3.		PE	Program Elective – I	4	0	0	4	4
4.		PE	Program Elective – II	4	0	0	4	4
5.	MCSE0011	OE	Research Ethics	2	0	0	2	2
PRACTICALS								
1..	MCSC0803	PC	Image Processing and Analysis Lab	0	0	2	1	2
2.	MCSJ0953	PW	Minor Project – II	0	0	-	2	-
3.	MTEH0302	OE	Soft Skills for Professionals - II	0	0	4	2	4
			TOTAL	**20**	**0**	**6**	**23**	**24**

Third Semester

S. No.	CODE	CAT	SUBJECT	TEACHING SCHEME			CREDITS	Contact Hrs/wk
				L	T	P		
2.		PW	Seminar / Term Paper	0	0	0	4	0
3.	MCSJ0950	PW	Dissertation – I	0	0	-	4	
			TOTAL	**0**	**0**	**0**	**8**	**0**

Fourth Semester

S. No.	CODE	CAT	SUBJECT	TEACHING SCHEME			CREDITS	Contact Hrs/wk
				L	T	P		
1.	MCSJ0951	PW	Dissertation – II	0	0	-	**16**	-

Program Electives

S. No.	CODE	SUBJECT	TEACHING SCHEME			CREDITS	Contact Hrs/wk
			L	T	P		
1.	MCSE0001	Computer Vision	4	0	0	4	4
2.	MCSE0002	Wireless Sensor Networks	4	0	0	4	4
3.	MCSE0003	Software and Service Oriented Architecture	4	0	0	4	4
4.	MCSE0004	Pattern Recognition	4	0	0	4	4
5.	MCSE0005	High-Performance Computing	4	0	0	4	4
6.	MCSE0006	Web Mining	4	0	0	4	4
7.	MCSE0008	Social Network Analytics	4	0	0	4	4
8.	MCSC0012	Advances in Cloud Computing	4	0	0	4	4
9.	MCSC0004	Advanced Concepts in Networking	4	0	0	4	4
10.	MCSE0009	Internet of Things	4	0	0	4	4
11.	MCSC0006	Mobile Ad-hoc Networks	4	0	0	4	4
12.	MCSC0015	Natural Language Processing & Information Retrieval	4	0	0	4	4
13.	MCSE0016	Deep Learning and Its Applications	4	0	0	4	4
14.	MCSE0017	Data Analytics for Business	4	0	0	4	4

Note: Students can also opt any NPTEL course of min 12 weeks as an elective as per his/her research area

Total Credit Division

S. No.	Category	Code	Credits
1.	Program Core	PC	**25**
2.	Program Elective	PE	**8**
3.	Open Elective	OE	**9**
4.	Projects	PW	**28**
		Overall Credits	**70**

SYLLABUS

Program Core (PC)

MCSC0013: MATHEMATICAL FOUNDATIONS OF DATA ANALYTICS

Objective: *The course objectives for each of the statistical methods are as follows:*

1. Selecting methods for collecting or analyzing data
2. Describing patterns, trends, associations, and relationships in data;
3. Using probability and simulation to describe probability distributions and define uncertainty in statistical inference;
4. Using statistical reasoning to draw appropriate conclusions and justify claims;
5. Use data to make evidence-based decisions that are technically sound.
6. Communicate the purposes of the analyses, the findings from the analysis, and the implications of those findings.

Credits: 03 **Semester – I** **L–T–P: 3–0–0**

Module No.	Content	Hours
I	**Introduction to Statistical Analysis**: Meaning and types of Statistics, Population vs. Sample, basic terminology, Measurement & Scaling. **Data Collection**: Explanatory and response variables. **Sampling strategies**: Simple, systematic, stratified, cluster, and multistage sampling. **Exploring Two-Variable Data**: Relationship between variables, Representing Two Categorical Variables. **Examining Relationship**: Covariance, Pearson correlation coefficient, Spearman's rank correlation coefficient. **Inferential Statistics**: Estimating unknown parameters, Confidence intervals, Hypothesis testing, Degree of freedom, Large Sample Tests for a Population Mean, t-test (one-sample, two sample: independent and dependent), Chi-square test (Independence and Goodness of fit). **Sampling Distributions**: Random Sampling, Sampling Distributions, Central Limit Theorem (CLT), Biased and unbiased point estimates.	20
II	**Random Variables**: Definition, Cumulative Distribution Function (CDF), continuous, discrete and mixed Random Variables, Probability Density Function (PDF), Probability Mass Function (PMF). **Properties of Random Variables**: Moments of Random variables: Mean and variance of random variable, Coefficients of variation, Skewness and kurtosis, Moments, Covariance and correlation coefficient. Properties of Distribution Functions, **Specific Random Variables**: Gaussian, Exponential, Rayleigh, Uniform, Binomial and Poisson Distributions. **Stochastic Processes**: Definition and Classification of Stochastic Processes, Poisson process, Birth and Death Process, Applications to Queues, Discrete Time Markov Chains, Limiting Distributions – Theory of M/M/1 and M/M/m queues – Little's Theorem	20

Reference Books:

- Andrew Bruce, Peter C. Bruce, and Peter Gedeck: "Practical Statistics for Data Scientists: 50+ Essential Concepts Using R", 2020
- Allen B. Downey , "Think Stats 2e", 2019
- Barron's AP Statistics by Dr. Martin Sternstein, Barrons Educational Series, 2020
- AHSS, Second Edition by David Diez, OpenIntro.org, 2019
- Statistics without Tears: An Introduction for Non-Mathematicians by Derek Rowntree, Penguin 2020
- Introductory Statistics by Shafer and Zhang, Open Education Resource (OER) LibreTexts Project 2021

Focus: This Course focuses on Employability under CO1 to CO5.

Course Outcome: By the end of the class, students will learn to:

- CO1: A range of statistical methods;
- CO2: Apply the methods to actual quantitative data and interpreting the results of the analysis
- CO3: Choose appropriate technique to solve real application problem.
- CO4: Sampling the data and distribution based on estimation methodology.
- CO5: Analyze the methods in relationship and Specific Random Variables.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/PSOs
CO1	PO2/PSO4
CO2	PO1/PSO1
CO3	PO3/PSO4
CO4	PO2,PO3/PSO1
CO5	PO3/PSO4

MCSC0014: COMPUTABILITY, COMPLEXITY AND ALGORITHMS

Objective: *To skill the students in understanding and applying the key techniques for designing of efficient algorithms at the advanced level. Students will be able to appreciate and analyse the concept of Computational complexity for time efficiency.*

Credits: 03 **Semester – I** **L–T–P: 3–0–0**

Module No.	Content	Teaching Hours
I	**Algorithms:** Analyzing algorithms, Complexity of Algorithms. **Growth of functions:** Asymptotic Notations, Recurrence Relations and their Solution Methods. **Sorting and Order Statistics:** Counting, Radix, Bucket sort. **Divide and Conquer**: Quick Sort, Merge Sort, Heap Sort. **Advanced Data Structures:** B – trees, Binomial Heaps, Fibonacci Heaps **Greedy Method:** Knapsack Problem, Job Sequencing with Deadlines, Activity Selection Problem, Huffman Codes.	20
II	**Graph Algorithms:** Minimum Spanning Trees; Depth First Search, Breadth First Search; Maximum Flow. **Single Source Shortest Path Problem:** Dijkstra & Bellman Ford Algorithms. **Dynamic Programming**: Chained Matrix Multiplications, Longest Common Subsequence (LCS), 0/1 Knapsack, All pair shortest paths – Warshal's and Floyd's algorithms **Backtracking:** 8 – Queens Problem, Graph Coloring, Sum of subsets. **Branch & Bound:** TSP Problem. **String Matching:** Naïve, Rabin Karp, Knuth-Morris-Pratt, Automata Matcher. **Approximation Algorithms:** Vertex & Set Cover Problem **NP-Completeness:** Basic Concepts, Nondeterministic Algorithms, NP-Completeness, Examples of NP Complete Problems.	20

Text Book:

- *Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms (4 ed.), The MIT/PHI Press, 2020. ISBN 9780262367505*.

Reference Books:

- G. Brassard and P.Bratley,(2001)"*Algorithmic, PHI T.H.*
- A. Aho, J. Hopcroft and J.Ullman, (1983)"*The design and Analysis of Computer Algorithms*", Addison Wesley.
- E. Horowitz and S. Sahani, (2001)" *Fundamentals of Computer Algorithms",* Galgotia, New Delhi.
- S.E. Goodman and S.T. Hedetniemi, (1977)" *Introduction to the Design and Analysis of Algorithms",* McGraw Hill.

Outcome: After completion of the course, students will be able to:

- CO1: Understanding of complexity representation in terms of Big Oh, Theta and Omega notations.
- CO2: Derive and solve recurrences describing the performance of divide-and-conquer algorithms
- CO3: Compare and analyze different data structures
- CO4: Understand the major graph algorithms and their analyses.
- CO5: Understand different design paradigms such as Greedy approach, Dynamic Programming, Backtracking, and Branch & Bound, and their applications. Synthesize algorithms using these paradigms and analyze them.
- CO6: Understand String Matching algorithms and their applications and analysis.
- CO7: Understand the concept of P and NP problems.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/PSOs
CO1	PO2/PSO4
CO2	PO1/PSO1
CO3	PO3/PSO4
CO4	PO2,PO3/PSO1
CO5	PO3/PSO1, PSO2
CO6	PO2/PSO2,PSO3
CO7	PO2/PSO4

MCSE0007: MACHINE LEARNING

Objective:

- *To introduce students to the basic concepts and techniques of Machine Learning.*
- *To develop skills of using recent machine learning software for solving practical problems.*
- *To gain experience of doing independent study and research.*

Credits: 04 **Semester – I** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction:** Definition, Applications, Types of learning system **Inductive Classification**: Concept learning, Concept learning as search through a hypothesis space, General-to-specific ordering of hypotheses, finding maximally specific hypotheses, Find-S algorithm, Version spaces and the candidate elimination algorithm, inductive bias. **Evaluation of Learning Algorithms:** Measuring the accuracy of learned hypotheses, cross-validation, learning curves, **Supervised learning:** Linear Regression, Gradient Descent (GD), Classification-Logistic regression, k-nearest neighbor classifier **Decision Tree Learning:** Picking the best splitting attribute: entropy and information gain,ID3 Algorithm, Searching for simple trees and computational complexity, Overfitting, Decision tree classifier,	20
II	**Supervised Learning:** Feature Selection, Feature Extraction, Collaborative Filtering, Support vector machine classifier, Naïve Bayes classifier **Unsupervised Learning:** k-means clustering, Hierarchical clustering **Ensemble Methods:** Bagging, Boosting, Improving classification with Ada-Boost algorithm. **Deep Learning/ Artificial Neural Network:** Introduction, Model Representation, Gradient Descent, Stochastic Gradient Descent, Multilayer Perceptron, Multiclass Representation, Backpropagation Algorithm.	20

Text Book:

- Tom M. Mitchell , "Machine Learning. Tata McGraw-Hill Education, 2013.
- Alpaydin, E. ' "Introduction to Machine Learning. MIT press, 2009.

Reference Books:

- Harrington, P. ' "Machine learning in action. Shelter Island, NY: Manning Publications Co, 2012.
- Bishop, C. M. ' "Pattern recognition and machine learning (information science and statistics) springer-verlag new york. Inc. Secaucus, NJ, USA, 2006.

Course Outcome: After completion of Lab, student will be able to:

- CO1: Apply the basic concepts of machine learning.
- CO2: Formulate models based on regression.
- CO3: Design models based on supervise and re-enforcement learning for classification.
- CO4: Apply the ensemble methods for improving classification.
- CO5: Identify the ways of feature extraction, reduction and selection.
- CO6: Analyze the use of machine learning algorithms.
- CO7: Analyze and formulate a model based on CNN.
- CO8: Design application based on machine learning.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2 / PSO3
CO2	PO2 / PSO3
CO3	PO1, PO3/PSO3
CO4	PO1, PO2/ PSO1, PSO3
CO5	PO2/ PSO3
CO6	PO2/ PSO1, PSO3
CO7	PO2, PO3/ PSO1, PSO3
CO8	PO3/PSO4

MCSC0805: DATA ANALYTICS LAB

Objective: *This course introduces students to R, a widely used statistical programming language. Students will learn to manipulate data objects, produce graphics, analyze data using common statistical methods, and generate reproducible statistical reports.*

Credits: 01 **Semester – I** **L–T–P: 0–0–2**

Content	Lab Hours
1. Introduction and Basics o Arithmetic in R o Vectors in R 2. Basics -II o Matrix in R o List in R 3. Data frames, functions, loops, if/else o Creation of Data Frame o Use of while and if/else on a variable of data frame o Importing Data in R 4. Operations on Data Frame o Handing Numerical and categorical variables o Adding a column o Deleting a column o Adding a row o Deleting a row o Manipulation on data in particular row and column 5. Missing Value Treatment o Data imputation 6. Probability Distribution in R o Binomial Distribution o Normal Distribution 7. Data Visualization using GGPlot2 o Bar Plot o Histogram o Boxplot o Villon plot 8. Data Visualization using GGPlot2 o Scatter plot o Line plot o facets 9. Statistical tests in R - I o T-Test (One Sample) o Paired and Independent T-test 10. Statistical tests in R - II o Chi-Square Test ▪ Goodness of fit ▪ Independence test 11. Correlation & Regression o Calculate correlation o Regression line fitting o Making prediction	24 Hours

Text Book:

- Paul Teetor. *R Cookbook: Proven recipes for data analysis, statistics, and graphics*. O'Reilly Media, Inc., 2011.

Reference Books:

- Norman Matloff. *The art of R programming: A tour of statistical software design*. No Starch Press, 2011.
- Winston Chang. *R graphics cookbook*. O'Reilly Media, Inc., 2012.
- Hadley Wickham and Garrett Grolemund. *R for data science*. (2016).
- Phil Spector. *Data manipulation with R*. Springer Science & Business Media, 2008.

Course Outcome: By the end of the class, students learn to:

CO1. Use RStudio, read R documentation, and write R scripts.
CO2. Import, export and manipulate data.
CO3. Produce statistical summaries of continuous and categorical data.
CO4. Produce basic graphics using standard functions, and produce more advanced graphics using the lattice and ggplot2 packages.
CO5. Perform common hypothesis tests, and run simple regression models in R
CO6. Produce reports of statistical analyses in R Markdown.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/PSOs
CO1	PO2/PSO4
CO2	PO1/PSO1
CO3	PO3/PSO4
CO4	PO2,PO3/PSO1
CO5	PO3/PSO4
CO6	PO2/PSO1

MCSC0806: ALGORITHMS LAB

Objective: The objective of this course is that students will understand and implement simple data structures, able demonstrate different sorting and searching techniques. and will be familiar with graphs and their applications.

Credits: 01 **Semester – I** **L-T-P: 0-0-2**

1. Implementation of sorting algorithms: • Insertion Sort • Bubble Sort • Selection Sort 2. Divide and conquer approach: • Quick Sort • Merge Sort • Heap Sort • Counting Sort 3. Implementation of Searching Techniques: • Linear Search • Binary Search 4. Implementation of Matrix Multiplication 5. Implementation of Convex Hull Implementation of Breadth First Search 6. Implementation of Depth First Search 7. Implementation of Greedy approaches: • Optimal Reliability Allocation. • Knapsack. Minimum 8. Minimum Spanning trees: • Prim's and Kruskal's algorithms 9. Single source shortest paths –Dijkstra's and Bellman Ford algorithms. 10. Implementation of Dynamic Programming: • Longest Increasing Subsequence. o Finding best path in maze. • Matrix Chain Multiplication • 0/1 Knapsack Problem • Resource Allocation Problem	24 Hours

Text/ Reference Book:

- *Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms (4 ed.), The MIT/PHI Press, 2020. ISBN 9780262367505*.
- E. Horowitz and S. Sahani, (2001)" *Fundamentals of Computer Algorithms",* Galgotia, New Delhi.

Note: All Code must be done in Java as well as Python

Course Outcome: After completion of course, student will be able to:

- CO1: Implementation the sorting algorithms like Selection Sort, Bubble Sort, Insertion Sort, Merge Sort, Quick Sort and Heap Sort.
- CO2: Demonstrate and use the appropriate data structures for a given problem
- CO3: Implement the algorithms based on Greedy approach and Dynamic Programming.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO2,PO4/PSO1,PSO2,PSO4
CO2	PO1,PO3,PO4/PSO1,PSO2,PSO3
CO3	PO2,PO3,PO5/PSO1,PSO2,PSO4

MCSC1007: ARTIFICIAL INTELLIGENT AND EXPERT SYSTEMS

Objective: *The learning objectives of this course are to acquaint students with theory and principles of intelligent systems and with representative practical systems.*

Credits: 04 **Semester – I** **L-T-P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Introduction to Artificial Intelligence-** Introduction to AI, Cattell – Horn – Carroll (C-H-C) theory of intelligence, Intelligent agents, Problem solving by searching, Informed search & Exploration – Heuristic search strategies (A * Search, AO* Search) Heuristic Functions, Hill climbing, Simulated Annealing search. Min – Max search, Alpha-Beta search for game playing. **Knowledge & Reasoning-** Propositional Logic, reasoning patterns in Propositional Logic, First order Logic, Inference in First order Logic – Unification & Lifting, Forward & backward chaining, resolution, Herbrand universe, Herbrand interpretation, semantic tree, prof procedure. **Knowledge Representation –** Ontological Engineering, Categories & Objects, Action, Situation & Events, semantic Networks. **Uncertainty –** Basic Probability notion, the Axiom's of probability, Bayes' Rule & its use. **Probabilistic reasoning -** Bayesian Networks, Exact & Approximate inference in Bayesian Networks,	20
II	**Artificial Neural Networks:** Introduction, Neuron Physiology, Artificial Neurons. Learning, Feed forward & feedback network, Training algorithms: Delta rule, Perceptron learning rules, Back propagation, RBFN, Deep learning, Meta Learning, Deep – Meta learning. **Expert System –** Introduction, Expert system: features, characteristics, development, activities, difference with conventional methods. **Genetic Algorithm –** Introduction to GA, representation, initialization and selection, Operations of GA, **Fuzzy Logic –** Introduction to Fuzzy logic, Fuzzy Sets, Classical Relations, Properties of Membership Function, Fuzzification, and Defuzzification, Logic and Fuzzy system, Approximate reasoning based on fuzzy Logic for control and classification problem.	20

References/Text Books*:*

- Nils J Nilsson (1982)" Principles of Artificial Intelligence," Springer- Berlag.
- Chin-Liang Chang & Richards Char- Tung Lee (1973), "Symbolic logic and mechanical theorem Proving", academic press.
- Stuart Russell, Peter Norvig (2009)," Artificial Intelligence – A Modern Approach", Pearson
- Elaine Rich & Kevin Knight (1999)," Artificial Intelligence", TMH.2ND Edition
- NP Padhy(2010),"Artificial Intelligence & Intelligent System", Oxford
- ZM Zurada, "Introduction to Artificial Neural Systems", west Publishing Company
- Timothy J Ross (2004), "Fuzzy Logic with Engineering Applications", John Wiley & Sons Ltd.
- Kumar sankar ray (2014) "Soft computing and its applications : volume I,II, Apple academic press and CRC Press.
- J Ross (2004), "*Fuzzy Logic with Engineering Applications*", John Wiley & Sons Ltd.

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

- CO1: Describe the Basic concepts of artificial Intelligence including searching techniques.
- CO2: Design Knowledge base to implement artificial Intelligence.
- CO3: Develop model based on probability theory.
- CO4: Understand different training Algorithm.
- CO5: Solve the problems of artificial intelligence using artificial neural networks.
- CO6: Understand Expert Systems and its components.
- CO7 : Understand GA with its applications in different areas
- CO8: Understand the Fuzzy logic and its applications.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO2,PO3/PSO1,PSO2
CO2	PO1,PO3,PO4/PSO1,PSO2
CO3	PO1,PO3,PO4/PSO1,PSO4
CO4	PO1,PO2,PO3/PSO1,PSO4
CO5	PO1,PO2/PSO1
CO6	PO1,PO3,PO4/PSO1,PSO4
CO7	PO1,PO2/PSO1
CO8	PO1,PO2/PSO3

MCSC0011: BIG DATA & SCALABLE ALGORITHMS

Objective: *The course objectives for each of the statistical methods are as follows:*

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in for decision support

Credits: 04 **Semester – II** **L–T–P: 4–0–0**

Module No.	Content	Hours
I	**Introduction**: Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analyzing Data with Unix tools, Analyzing Data with Hadoop, Hadoop Streaming, Hadoop Eco-System **Distributed File Systems** : Physical Organization of Compute Nodes, Large-Scale File-System Organization. **MapReduce**: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. **Algorithms Using MapReduce**: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step.	20
II	**The Stream Data Model:** A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. **Sampling Data in a Stream:** Obtaining a Representative Sample, The General Sampling Problem, Varying the Sample Size. **Filtering Streams:** The Bloom Filter, Analysis. **Counting Distinct Elements in a Stream:** The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements. **Counting Ones in a Window**: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows. **Handling Larger Datasets in Main Memory:** Algorithm of Park, Chen, and Yu, The Multistage Algorithm, The Multi-hash Algorithm. The SON Algorithm and MapReduce Counting Frequent Items in a Stream Sampling Methods for Streams, Frequent Itemsets in Decaying Windows. **Introduction to NoSQL**	20

Text/Reference Books:

- Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press,
- Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
- Seema Acharya "Big Data Analytics", Wiley Press

Course Outcome: By the end of the class, students will learn to:

CO1: Understand the key issues in big data management and its associated applications in intelligent business andscientific computing.
CO2: Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NOSQL in big data analytics.
CO3: Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
CO4: Achieve adequate perspectives of big data analytics in various applications like recommender systems, socialmedia applications etc.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1 /PSO1
CO2	PO1,PO3/PSO1
CO3	PO2/PSO2
CO4	PO3/PSO1, PSO2

MCSC0009: IMAGE PROCESSING AND ANALYSIS

Objective: *To cover the basic theory and algorithms that are widely used in digital image processing and analysis.*

Credits: 04 **Semester – II** **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Digital Image Fundamentals:** Image sampling & quantization; Basic relationships between pixels, Some mathematical tools used in digital image processing. **Image perception:** Light, luminance, brightness and contrast, Human Visual System, Colour representation, Chromaticity diagram, Colour Coordinate Systems. **Image Enhancement:** Overview, Contrast Intensification, Smoothing, Sharpening, Basic intensity Transformation functions, Histogram processing, Spatial filters, Image Restoration **Image Transforms:** Discrete Fourier Transform, DCT Transform, KL Transform, Wavelet Transform. Image Enhancement in Frequency Domain	20
II	**Image Compression:** Fundamentals, Lossless Compression: Huffman Coding, Arithmetic Coding, Run-length Coding. Lossy Compression: JPRG Coding. **Image Registration:** Geometric Transformation, Registration by Mutual Information Maximization. **Image Analysis:** Fundamental concepts, Segmentation: Region extraction, Pixel based approach, Thresholding, Region based approach. Canny Edge Detection, **Feature Extraction:** Representation, Topological Attributes, Geometrical Attributes, Spatial Moments, Boundary based Description, Region based Description, and Intensity based Description. **Object Recognition:** Patterns and pattern classes, Recognition based on decision-theoretic methods, structural methods.	20

References Books:

- R. C. Gonzalez and R.E. Woods, "Digital Image Processing", Third Edition, Prentice Hall, 2011.
- Bhabatosh Chanda, D. Dutta Majumder, "Digital image processing and analysis**,** Second Edition, PHI, 2013.
- Anil K. Jain, "Fundamentals of Digital Image Processing"**,** Prentice-Hall, 2011.

Course Outcomes:

- CO1: Understand the need for image transforms and their properties.
- CO2: Develop any image processing application.
- CO3: Learn different techniques employed for the enhancement of images.
- CO4: Learn the spatial and frequency domain techniques of image compression.
- CO5: Learn different feature extraction techniques for image analysis and recognition
- CO6: Learn different causes for image degradation and overview of image restoration techniques.
- CO7: Analyze images in the frequency domain using various transforms.
- CO8: Implement the image processing techniques in real world problems.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1,PO2 /PSO2, PSO3
CO2	PO1,PO3/PSO1,PSO3
CO3	PO2,PO3/PSO2,PSO3
CO4	PO1,PO3/PSO1,PSO2
CO5	PO1, PO2/PSO2,PSO3
CO6	PO1,PO2,PO3/PSO2,PSO3
CO7	PO1,PO3/PSO1,PSO3
CO8	PO2,PO3/PSO1,PSO2,PSO3

MCSC0803: IMAGE PROCESSING AND ANALYSIS LAB

Objective: To illustrate concepts in image processing and analysis through actual processing of images using MATLAB

Credits: 04 **Semester – II** **L-T-P: 4-0-0**

• Relational and Logical Operators, Matrix Manipulation functions • Matrix Element wise operations, Elementary Math functions. • Familiarization with MATLAB Loops • Histogram manipulations, sub sampling an image, flipping an image • Basic Operations on Images – gray level slicing, Contrast Stretching, Transformations, smoothing using linear & order statistics filters of varying sizes • Sharpening an image, linear spatial filtering, handling various types noise • Discrete Fourier Transform and its application on an image • Morphological Operations, boundary extraction, finding connected components. • Implementing various edge detection algorithms and comparing their results. • Image segmentation using global thresholding, segmenting a text page using p-tile method. • Applying Region growing, Region splitting and Region merging techniques for image segmentation. • Program based on Feature Extraction	24 Hours

Reference Books:

- Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, (2013), Digital Image Processing Using MATLAB, TMH.
- Chris Solomon, Toby Breckon (2011), Fundamentals of Digital Image Processing: A Practical Approach with Examples in MATLAB, John Wiley & Sons.
- K. A. Navas, R. Jayadevan, PHI Learning Pvt. Ltd (2014), Lab Primer Through MATLAB Digital Signal Processing.

Course Outcome:

- CO1: Describe and explain basic principles of digital image processing.
- CO2: Design and implement algorithms that perform basic image processing.
- CO3: design and implement algorithms for advanced image analysis.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2 / PSO1, PSO3
CO2	PO2 / PSO2
CO3	PO1, PO3/PSO1, PSO2

MCSC0015: Natural Language Processing & Information Retrieval

Objective: *The course objectives are as follows:*

- *understanding of the fundamental techniques for hyper-*
- *media architectures, design and usability, document management and retrieval, meta data management, and searching the web*
- *To introduce the tools and techniques for performing text and speech analytics in diverse contexts.*
- *To understand the tools and technologies involved in developing text and speech applications.*
- *To demonstrate the use of computing for building applications in text and speech processing.*

Credits: 04 **Semester – II** **L–T–P: 4–0–0**

Module No.	Content	Hours
I	**Introduction to Text Processing and Language Modeling**: Introduction to Natural Language Processing (NLP) and Levels of NLP - Regular Expression - Basic Text processing- Text normalization - Vector Semantics and embedding : Lexical Semantics , Vector Semantics , Words and Vectors - Pointwise Mutual Information, N-gram Language Models : N-grams, Smoothing. **Parts of speech and Named entities**: Parts of Speech Tagging - Hidden Markov Model - Conditional Random Fields. Constituency Grammars: Constituency, Context Free Grammars, Dependency Parsing: Dependency Relations, Dependency Formalism, Neural Dependency Parser. **Logical Representations of Sentence Meaning**: Logical Representations of Sentence Meaning, Word Sense and Word Net, Word Sense Disambiguation, Word Sense Induction.	20
II	**Information Retrieval:** Basic Concepts, Retrieval Process Modeling – A Formal Characterization of IR Models, Classic Information Retrieval (Boolean model, Vector Model, Probabilistic Model), Alterative Set Theoretic Models, Alternative Algebraic Models (Generalized Vector Space Model, Latent Semantic Indexing Model). **Query Languages and Operations**: Keyword based Querying, Pattern Matching, Structural Queries, and User Relevance Feedback. **Text Operations**: Document Pre-processing, Document Clustering, Text Compression. **Evaluation in Information Retrieval:** Retrieval Performance Evaluation Recall, Precision, Mean average Precision, F-Measure, User Oriented Measures, Discounted Cumulated Gain. TREC Web Collections. **Search Engines**: Anatomy of a Large-Scale Hyper textual Web Search Engine, HITS, Page Rank Algorithm. **IR Applications**: Summarization and Question Answering	20

Text/Reference Books:

- Ricardo Baeza-Yate, Berthier Ribeiro-Neto, "Modern Information Retrieval", Second Edition, Addison Wesly, 2011.
- G. G. Chowdhury , "Introduction to Modern Information Retrieval", Second Edition, Neal-Schuman Publishers, 2003.
- David A. Grossman, Ophir Frieder, "Information Retrieval: Algorithms, and Heuristics", Springer, 2004
- Jurafsky, D. and J. H. Martin, Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition (3rd Draft), 2021.

Course Outcome: By the end of the class, students will learn to:

CO1: Gain an understanding the basic concepts and techniques in Information Retrieval
CO2: Develop tools to analyse the syntax and semantics of a statement written in a natural language.

CO3: Apply machine learning and deep learning techniques to natural language processing.
CO4: Understand the latest technologies for linking, describing and searching the Web. - Understand the relationship between IR, hypermedia, and semantic models.
CO5: Be able to apply and implement techniques for the preprocessing needed for information retrieval systems and can be able to develop a small information retrieval system.
CO6: Apply the different evaluation strategies to the retrieved results for computing the efficiency and accuracy of the information retrieval model.
CO7: Apply IR techniques to XML retrieval and develop retrieval system for web search tasks

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1 /PSO1
CO2	PO1,PO3/PSO1
CO3	PO2/PSO2
CO4	PO3/PSO1, PSO2
CO5	PO1,PO3/PSO1
CO6	PO2/PSO2
CO7	PO2/PSO1

Program Electives (PE)

MCSE0001: COMPUTER VISION

Objective: *To introduce the principles, models and applications of computer vision. To develop an appreciation for various issues in the design of computer vision and object recognition systems*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction:** Overview to Computer Vision, Image formation – Geometric primitives and transformations, Photometric Image formation. **Digital Camera:** Sampling & aliasing, Colour, Compression, Camera model & caliberation, Epipolar Geometry, Stereopsis. **2D Shape –** Hough transform, Shape numbers, Pyramids, Quad Trees, Medial Axix Transform. **Recognition:** Detectors and Descriptors, clustering (K-Mean and Mean Shift), Interest Point Detection, Harris Corner Detector, SIFT, Template Matching, Detection with sliding windows: Viola Jones, Object recognition (Eigenfaces, Active appearance models).	20
II	**Classification:** K-nearest Neighbours Algorithm, Statistical Classification, Bag-of-Words Models, Overview of methods for building Classifies, a part-based generative model (Constellation model) and a part-based discriminative model (Latent SVM). **Motion Analysis:** Motion estimation using Optic Flow, Video Change Detection, moving object detection - Background Subtraction approach, moving object detection using Gaussians Mixture Model (GMM) approach. Object Tracking, Kernel (Mean Shift) based Object Tracking, Motion Models to aid tracking (Kalman Filtering, particle filtering), Data Association, Applications of Object Tracking.	20

References:

- Richard Szeliski ,"Computer Vision: Algorithms and Applications", Springer, 2010.
- D.A. Forsyth and J. Ponce ,"Computer Vision: A Modern Approach", Prentice Hall, 2002
- Milan Sonka, Vaclav Hlavae, Roger Boyle , "Image Processing, Analysis and Machine Vision", Second Edition, Thomson, 2008.
- R. Hartley, and A. Zisserman ,"Multiple View Geometry in Computer Vision", 2nd Edition, Cambridge University Press, 2004
- R.O. Duda, P.E. Hart, and D.G. Stork ,"Pattern Classification" (2nd Edition), Wiley-Interscience, 2000

Course Outcomes: By the end of the class, students will learn to:

- CO1: Understand the basic knowledge, and methods of human and computer vision systems.
- CO2: Identify, formulate and solve the image formation and image modelling process.
- CO3: Analyze, evaluate and test existing practical computer vision systems.
- CO4: Implement the working of live computer vision system effectively.
- CO5: Apply theoretical and practical knowledge to identify the novelty and practicality of proposed computer vision methods.
- CO6: Design and develop practical and innovative computer vision applications or systems.
- CO7: Able to conduct real implication image processing and deep learning methods.
- CO8: Analyze and design algorithms for computer vision applications.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1, PO2/ PSO1
CO2	PO1,PO2,PO4/ PSO4
CO3	PO1,PO2,PO5/ PSO1,PSO3
CO4	PO3,PO4,PO5/ PSO4
CO5	PO3,PO4,PO5,PO6/ PSO1,POS4
CO6	PO3,PO4,PO5,PO6/ PSO1,POS4
CO7	PO1,PO4 / PSO4
CO8	PO2,PO3,PO4,PO6 / PSO3,PSO4

MCSE0004: PATTERN RECOGNITION

Objective: *Understand the concept of a pattern and the basic approach to the development of pattern recognition and machine intelligence algorithms.*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Contents	Teaching Hours
I	**Introduction:** Basics of pattern recognition, Design principles of pattern recognition system, Learning and adaptation, Pattern recognition approaches, Mathematical foundations – Linear algebra, Probability Theory, Expectation, mean and covariance, Normal distribution, multivariate normal densities, Chi squared test. **Statistical Patten Recognition:** Bayesian Decision Theory, Classifiers, Normal density and discriminant functions,	20
II	**Parameter estimation methods:** Maximum-Likelihood estimation, Bayesian Parameter estimation, Dimension reduction methods - Principal Component Analysis (PCA), Fisher Linear discriminant analysis, Expectation-maximization (EM), Hidden Markov Models (HMM), Gaussian mixture models. **Nonparametric Techniques:** Density Estimation, Parzen Windows, K-Nearest Neighbor Estimation, Nearest Neighbor Rule, Fuzzy classification. **Unsupervised Learning & Clustering:** Criterion functions for clustering, Clustering Techniques: Iterative square - error partitional clustering – K means, agglomerative hierarchical clustering, Cluster validation.	20

References Books:

- Richard O. Duda, Peter E. Hart and David G. Stork ,"Pattern Classification", 2nd Edition, John Wiley, 2006.
- C. M. Bishop ,"Pattern Recognition and Machine Learning", Springer, 2009.
- S. Theodoridis and K. Koutroumbas ,"Pattern Recognition", 4th Edition, Academic Press, 2009.

Course Outcome: After the completion of the course, the student will be able to:

- CO1: Understand a variety of pattern recognition algorithms, along with pointers on which algorithms work best under what conditions, so that students can make sound decisions on what approaches to take when faced with a real world problem.
- CO2: Understanding the various applications Pattern Recognition in real life applications.
- CO3 Formulate PR models based different classifiers.
- CO4: Apply the Statistical Patten Recognition methods for improving classification
- CO5: Identifying the parameter estimation methods for feature extraction.
- CO6: Analyze the non-parameter Techniques for Pattern classification.
- CO7: Design model based on Machine Learning to Pattern Classification.
- CO8: Analyze the use of Unsupervised Learning for pattern clustering.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2, PO7 /PSO1
CO2	PO1, PO3,PO4/PSO2, PSO3
CO3	PO1, PO2, PO4/PSO3, PSO4
CO4	PO1, PO5/PSO2
CO5	PO2, PO3/PSO4
CO6	PO1,PO2/PSO3
CO7	PO1,PO2, PO3/PSO3, PSO4
CO8	PO1, PO7/PSO3

MCSE0002: WIRELESS SENSOR NETWORKS

Objective: *To make students understand the protocols, algorithms and tools needed to support the deployment and functionality of wireless sensor networks.*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Applications and Design Model:** Examples of available sensor nodes, Sample sensor networks applications, Design challenges, Contemporary network architectures, Operational and computational models, Performance metrics, Software and hardware setups. **Network Bootstrapping:** Sensor deployment mechanisms, Issues of coverage, Node discovery protocols **Physical and Link layers:** Radio energy consumption model, Power Management, Medium access arbitration: Low duty cycle protocols and wakeup concepts, Contention-based protocols, Schedule-based protocols, Optimization mechanisms **Localization and Positioning:** Properties of positioning, Possible approaches, Mathematical basics for the lateration problem, Single-hop localization, Positioning in multi-hop environments, Impact of anchor placement.	20
II	**Topology control:** Motivation and basic ideas, Flat network topologies, Hierarchical networks by dominating sets, Hierarchical networks by clustering, Combining hierarchical topologies and power control, Adaptive node activity. **Naming and Addressing:** Address and name management in wireless sensor networks, Assignment of MAC addresses, distributed assignment of locally unique addresses, Content-based and geographic addressing. **Routing protocols:** The many faces of forwarding and routing, Gossiping and agent-based unicast forwarding, Energy-efficient unicast, Broadcast and multicast, Geographic routing, Coping with energy constraints, Mobile nodes. **Data-centric and content-based networking:** Introduction, Data-centric routing, Data aggregation, Data-centric storage. **Dependability Issues:** Security challenges, Threat and attack models, Quality of service provisioning, Time Synchronization: Introduction to the time synchronization problem, Protocols based on sender/receiver synchronization, Protocols based on receiver/receiver synchronization, Supporting fault tolerant operation.	20

References Books:

- Dorothea Wagner and Roger Wattenhofer , “Algorithms for Sensor and Ad Hoc Networks, Advanced Lectures”, Lecture Notes in Computer Science 4621, 2007.
- Waltenegus Dargie, Christian Poellabauer , “Fundamentals of Wireless Sensor Networks: Theory and Practice”, John Wiley & Sons , 2010.
- Carlos De Morais Cordeiro, Dharma Prakash Agrawal , “Ad Hoc and Sensor Networks: Theory and Applications”, World Scientific, 2011.
- Holger Karl, Andreas Willig , “Protocols and Architectures for Wireless Sensor Networks”, Wiley Publications, 2005.
- Cauligi S. Raghavendra, Krishna Sivalingam, Taieb M. Znati ,“Wireless Sensor Networks”, Springer, 2005.

Course Outcomes: After the completion of the course, the student will be able to:

- CO1: Understand the basic concepts of wireless sensor networks, sensing, computing and communication tasks.
- CO2: Understand the Sensor management, sensor network middleware, operating systems.
- CO3: Analyze the assess coverage and conduct node deployment planning,
- CO4: Devise appropriate data dissemination protocols and model links cost,
- CO5: Determine suitable medium access protocols and radio hardware.
- CO6: Understand the architectures, features, and performance for wireless sensor network systems and platforms
- CO7: Identify quality of service, fault-tolerance, security and other dependability requirements and conduct trade-off analysis between performance and resources.
- CO8: Evaluate the performance of sensor networks and identify bottlenecks.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1, PO2, PO7 /PSO1
CO2	PO1, PO4/PSO2, PSO3
CO3	PO1, PO2, PO4/PSO3, PSO4
CO4	PO1/PSO2
CO5	PO2, PO3/PSO4
CO6	PO1/PSO3
CO7	PO1, PO3/PSO3, PSO4
CO8	PO1, PO7/PSO3

MCSE0009: INTERNET OF THINGS (IOT)

Objective: *The objective of the course is to introduce with the basic fundamental concept of IoT system for explore future research foundation.*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Overview of wireless sensor networks:** Introduction of sensor device, Node architecture, Hardware components, Network characteristics, Unique constraints and challenges, Enabling technologies for wireless sensor networks, Types of wireless sensor networks. **Introduction to logical design of IoT:** Sensing, Actuation, blocks/pillars/components of IoT, Functional, Explain the IoT network layer architecture and its protocol. Types of sensor nodes and its real time application in IoT based sensor networks. **Communication policy of IoT:** Request and response model, Publisher and subscriber model, Push and pull model and Exclusive pair.	20
II	**IoT devices design and Communication models:** IEEE.802.15.4,Zigbee, 6LoWPAN, Bluetooth, Z-Wave, NFC, LoRA and RFID. **Basic physical principles architecture of IoT networks:** IoT & M2M Machine to Machine, Difference between IoT and M2M. Properties of RFID module architecture and MQTT architecture, CoAP model architecture and Cloud based IoT architecture. **Applications of Internet of Things (IoT): Indoor and outdoor applications-** Green smart city, Traffic management, Smart lighting on streets, green agriculture and smart farming, Industrial IoT for manufacturing (4.0), and Healthcare monitoring. **Issues of IoT sensor networks:** Security and Energy (Research paradigm).	20

Text Book:

- Internet of Things – A Hands on Approach by Arshdeep Bahga.

Reference Books:

- Internet of Things (IoT) – Architecture and Design Principle by Raj Kamal.
- IoT For Beginners: Explore IoT Architecture Principle by Vibha Soni.

Course Outcome: By the end of the class, students will learn to:

- CO1: Discover the basic concept of wireless sensor networks and IoT System.
- CO2: Explain and relate basic IoT concept to develop the self-smart module.
- CO3: Choose appropriate technique to solve real application problem.
- CO4: Design and develop the smart intelligence device for real world application.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1, PO2 / PSO3
CO2	PO2 / PSO3
CO3	PO1, PO3/PSO3
CO4	PO1, PO2/ PSO1, PSO3

MCSC0006: MOBILE AD-HOC NETWORKS

Objective: *This course will enable the students to understand the detailed concept related to Mobile Ad-hoc Networks.*

Credits: 04 **L–T–P: 4-0-0**

Module No.	Contents	Teaching Hours
I	**Ad Hoc Wireless Networks:** Issues in Ad Hoc Wireless Networks, Ad Hoc Wireless Internet; **MAC Protocols for Ad Hoc Wireless Networks:** Issues in Designing a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols; **Routing Protocols for Ad Hoc Wireless Networks:** Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classifications of Routing Protocols, Power Aware Routing Protocols.	20
II	**Transport Layer:** Issues and Design Goals, Split TCP, Ad-Hoc TCP, TCP-Bus Key Management. Secure Routing in Ad Hoc Wireless Networks **Energy Management in Ad Hoc Wireless Networks**: Classification of Energy Management Schemes, Transmission Power Management Schemes, System Power Management Schemes. **QoS in Ad-hoc Networks**: Issues, PHY, MAC, Network Layer Solutions Cross Layer Design	20

References:

- C S. Ram Murthy, B. S. Manoj ,"Ad Hoc Wireless Networks: Architectures and Protocols", Second Edition, Prentice Hall of India, 2005.
- R. Hekmat, "Ad hoc Networks: Fundamental Properties and Network Topologies", First Edition, Springer, 2006.
- B. Tavli and W. Heinzelman ,"Mobile Ad Hoc Networks: Energy Efficient Real Time Data Communications", First Edition, Springer, 2006.
- G. Anastasi, E. Ancillotti, R. Bernasconi, and E. S. Biagioni ,"Multi Hop Ad Hoc Networks from Theory to Reality", Nova Science Publishers, 2008.

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

- CO1: Understand the need for ad hoc networks.
- CO2: Explain the constraints of physical layer that affect the design and performance of ad hoc network.
- CO3: Understand the concepts of protocols required for wired network may not work for wired network at MAC, Network and Transport Layer.
- CO4: Explain the operations and performance of different MAC layer protocols.
- CO5: Explain the different routing protocols proposed for ad hoc networks.
- CO6: Understand the basics of unicast and multicast routing protocols.
- CO7: Understand security issues and QoS requirements in MANETs.
- CO8: Explain about the energy management in adhoc networks.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO2,PO3/PSO1,PSO2
CO2	PO1,PO3,PO4/PSO1,PSO2
CO3	PO1,PO3,PO4/PSO1,PSO4
CO4	PO1,PO2,PO3/PSO1,PSO4
CO5	PO1,PO2/PSO1
CO6	PO1,PO3,PO4/PSO1,PSO4
CO7	PO1,PO2/PSO1
CO8	PO1,PO2/PSO3

MCSE0005: HIGH PERFORMANCE COMPUTING

Objective: *This subject introduces students to the essential tools and techniques of high-performance computing. The main objectives are to introduce students to different frameworks of parallel and distributed computing that they can use in their specific areas of interest. The students may learn to program multi-core processors as well as clusters of personal computers using the widely used computer languages.*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Contents	Teaching Hours
I	**Overview of Parallel Techniques:** Classification of Instruction Set Architectures, Instruction level, Thread level and Process level. **Pipelining**: Instruction and functional pipelines, Hazards in a pipeline, Branch prediction techniques; Superscalar Techniques. **Memory Hierarchies:** Basic hierarchical memory concepts, Cache design, Virtual memory design &uses, Memory hierarchy performance. **Parallel Programming Concepts:** Abstract Machine Models – RAM& PRAM, various parallel algorithms on them. **Introduction:** Cloud Computing, Computing Platforms and Developments, Virtualization.	20
II	**Cloud Computing Architecture:** Reference Model, Types of Cloud, Concurrent Computing, High Throughput Computing. **Cloud Applications:** Application in Industry, General Cloud Applications, Advanced Topics in Cloud Computing. **Introduction**: Definition of Grid Computing, Grid Architecture Standard for Grid, Data Management in Grid, Grid Scheduling **Grid Security & Middleware:** Trust and Security in Grid, Grid Middle ware, Architectural Overview of Grid Projects. **Grid Computing Methods:** Monte Carlo Method, Partial Differential Equations, Some Grid Tool- Globus, glite.	20

References:

- John L Hennessy & David A, "Patterson-Computer Architecture: A Quantitative Approach", Morgan Kaufmann, 2011.
- Kai Hwang ,"Advanced Computer Architecture", Tata McGraw Hill Edition, 2013.
- Rajkumar Buyya, Christian Vecchiola & S, Thamarai Selvi ' " Mastering Cloud Computing", Tata McGraw Hill Edition, 2013.
- Fredric Magoules, Jie Pan, Kiat-An Tan & Abhinit Kumar , "Introduction to Grid Computing", CRC Press, Taylor & Francis Group, 2007.

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

- CO1:Understand architecture of computing technology.
- CO2: Design, formulate and implement high performance versions single threaded algorithms
- CO3: Demonstrate the architectural features of High performance computers
- CO4: Design programs to extract maximum performance in a multicore, shared memory execution environment processor.
- CO5: Design and deploy large scale parallel programs on tightly coupled parallel systems using the message passing paradigm.
- CO6: Administration, scheduling, code portability and data management in an HPC environment.
- CO7: Analyze the suitability of different HPC solutions to problems found in Computational Science.
- CO8: Implement parallel programs on different hardware architectures and software environments.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1,PO2/ PSO1
CO2	PO1,PO3,PO4/ PSO2
CO3	PO1,PO2,PO4/ PSO1
CO4	PO1,PO4,PO5,PO6/ PSO2,PSO4
CO5	PO1,PO3,PO5/ PSO2
CO6	PO1,PO2,PO5/ PSO1
CO7	PO1,PO4,PO6/ PSO1,PSO4
CO8	PO2,PO3,PO4/ PSO1,PSO2

MCSE0003: SOFTWARE AND SERVICE ORIENTED ARCHITECTURE

Objective: *To understand basic concepts, theories, and techniques used in service-oriented architecture, along with governance strategies and trends in SOA.*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	Software Architecture – Types of IT Architecture, SOA Evolution, Key components, perspective of SOA, Enterprise-wide SOAArchitecture, Enterprise Applications, Solution Architecture for enterprise application Software platforms for enterprise Applications, Patterns for SOA, SOA programming models. Service-oriented Analysis and Design – Design of Activity, Data, Client and business process services. Technologies of SOA – SOAP, WSDL. Service integration with ESB	20
II	Web Services and Contemporary SOA- Message exchange patterns, Service activity, coordination. Atomic transactions, Business activities, Orchestration and Choreography- Issues Introduction to XML – Overview and Security. Introduction to Web Services and Security, SOA implementation and Governance strategy , trends in SOA, event-driven architecture, software as a service. SOA Delivery Strategies- SOA delivery lifecycle phases. Transaction processing – paradigm, protocols and coordination, transaction specifications, SOA in mobile, research issues in SOA	20

References:

- Shankar Kambhampaly ,"Service –Oriented Architecture for Enterprise Applications", Wiley India Pvt. Ltd, 2008.
- Eric Newcomer, Greg Lomow, "Understanding SOA with Web Services", PearsonEducation.
- Mark O' Neill, et al , "Web Services Security",Tata McGraw-Hill Edition, 2003.
- Thomas Erl , " Service-Oriented Architecture: Concepts, Technology & Design", Pearson Education Pvt. Ltd, 2008.
- Thomas Erl ,"SOA Principles of Service Design", Pearson Exclusives, 2007.
- Thomas Erl and Grady Booch, "SOA Design Patterns", Prentice Hall, 2008.

Course Outcomes: After the completion of the course, the student will be able to:

- CO1: Understand primary concepts of SOA
- CO2: Design the software Platforms using SOA
- CO3: Understand Web Services and Contemporary SOA
- CO4: Understand Security issues of SOA
- CO5: Implement XML in designing SOA
- CO6: Know the integration of SOA technological points with Web Services.
- CO7: Implement SOA in development cycle of Web Services
- CO8: Implement SOA in Transaction Processing

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1, PO2 /PSO1
CO2	PO3/PSO2
CO3	PO1/PSO1
CO4	PO1/PSO1
CO5	PO5/ PSO4
CO6	PO5/PSO4
CO7	PO5/PSO4
CO8	PO5/PSO4

MCSC0012: ADVANCES IN CLOUD COMPUTING

Objective: *This course covers aims to explain various technologies related to Cloud Computing and their practical implementations, discuss different architectural models of cloud computing, the concepts of virtualization and cloud orchestration*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Overview of Cloud Computing:** Introduction to Cloud Computing, Traditional vs. Cloud Computing, Benefits and Challenges of Cloud Computing, **Cloud Computing Architecture:** NIST Cloud Computing Architecture, Service Models, Deployment Models. **Introduction to virtualization:** Basics of Virtualization, Types of Virtualization, Implementation Levels of Virtualization, Virtualization Structures, Virtualization of CPU, Network and Storage Virtualization. **Overview of Multi-Cloud Management Systems:** Explain concept of multicloud management, Challenges in managing heterogeneous clouds, benefits of multi-cloud management systems. **Cloud vendor selection:** SLA, Security and privacy, periodic update and maintenance, data location and Jurisdiction, Measurability, Pricing, Interoperability and lock in, Exit process, track record. **VM migration:** Introduction to VM Migration, Pre-copy Migration, Post-Copy Migration and Live Migration, performance metrics for migration.	20
II	**Cloud Storage:** Cloud Storage and its Advantages, Cloud Storage Providers, Storage-as-a-Service. **Resource Management:** Inter Cloud Resource Management, Resource Provisioning and Resource Provisioning Methods, Global Exchange of Cloud Resources **Load balancing:** Types of Load Balancing Scenarios in Cloud Computing Environment, Static, Dynamic and Centralized algorithms, **Energy Efficiency in Clouds:** Data Center Power Consumption, Green Data Centers. **Migrating into a Cloud:** Introduction, Challenges while migrating to Cloud, Broad approaches to migrating into the cloud, why migrate -deciding on cloud migration, the Seven-step model of migration into a cloud, Migration Risks and Mitigation. **Cloud Security:** Security Overview, Cloud Security, Challenges, Infrastructure Security, Network level security, Host level security, Application level security, Data security, Storage Data, privacy and security Issues, Virtual Machine Security. Identity and Access Management (IAM) Software-as-a-Service Security.	20

Text Books:

- Raj Kumar Buyya, James Broberg, Andrezei M. Goscinski, "Cloud Computing": Principles and paradigms, 2011.

Reference Book:

- Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter Cloud Computing: A Practical Approach,2010.
- McGraw Hill. Rittinghouse, John, W, Cloud computing: Implementation, management and security.
- Barrie Sosinsky, Cloud Computing Bible, Wiley.2011.
- Rhoton, John, Cloud Computing Architected: Solution Design Handbook.
- Krutz, Ronald L.; Vines, Russell Dean, Cloud Security, A comprehensive Guide to Secure Cloud Computing.

Course Outcome: After successful completion of this student will be able to:

- CO1: Describe importance of virtualization along with their technologies like system, network, and storage virtualizations.
- CO2: Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, XaaS, Public Cloud, Private Cloud, Hybrid Cloud and the core issues of cloud computing such as security, privacy, and interoperability.
- CO3: Justify the need of new technology of Virtualization & Cloud Computing and its ecological impact.
- CO4: Identify the known threats, risks, vulnerabilities and privacy issues associated with Cloud based IT services
- CO5: Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/PSOs
CO1	PO1,PO3,PO5,PO7/PSO2
CO2	PO1,PO3,PO7/PSO1
CO3	PO1,PO7/PSO1
CO4	PO1,PO3,PO5/PSO4
CO5	PO1,PO3,PO5,PO7/PSO4

MCSE0006: Web Mining

Objective: *Introduce students to the basic concepts and techniques Web Mining for extracting knowledge from the web.*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction:** Basic Concepts of Web Mining, Classification of Web Mining: Web Content Mining, Web Structure Mining, Web Usage Mining, Issues in Web Mining, Crawling the Web, Hyperlink Analysis, Basics of HTML, HTTP, HTTPS and scripting. **Web Content Mining:** document indexing and retrieval in the web environment, web documents categorization and clustering, Text and Web Page Pre-Processing. **Web Structure Mining:** Anchor Text, Hyperlink Analysis, Static and Dynamic Hyperlinks, Web Graph, Web Search, Query Expansion, Primary web browsing (crawling), Link topology analysis.	20
II	**Social Network Analysis:** Social Sciences and Bibliometry, Prestige, Centrality, Co- citation, PageRank and HITS, Stochastic HITS and Other Variants, Enhanced Models and Techniques, Avoiding Two- Party Nepotism, Outlier Elimination, Exploiting Anchor Text. **Evaluation of Topic Distillation**: HITS Algorithm. **Web Usage Mining Process and Techniques:** Data collection and Pre Processing, Data modeling for web usage mining, Discovery and analysis of web usage patterns, Session and visitor analysis, Cluster analysis and visitor segmentation. **Resource Discovery:** Collecting important pages preferentially, crawling as guided search in a graph, Keyword-Based graph search, Similarity search using Link Topology. **The Future Of Web Mining:** Natural Language Processing, Lexical Networks and Ontologies, Part- of- Speech and Sense Tagging, Parsing and Knowledge Representation, Profiles, Personalization, Collaboration, Opinion mining.	20

References:

- Soumen Chakrabarti, "Mining the Web: discovering knowledge from hypertext data, Part 2", Morgan Kaufmann Publisher, 2010.
- Bing Liu ,"Web Data Mining: exploring hyperlinks, contents, and usage data", Springer, 2007.
- Gordon Linoff and Michael Berry ,"Mining the Web: Transforming Customer Data into Customer Value", John Wiley & Sons , 2002.
- C. Manning, P. Raghavan, and H. Schütze ,"Introduction to Information Retrieval", Cambridge University Press, 2008.
- Ricardo Baeza-Yate, Berthier Ribeiro-Neto, ,"Modern Information Retrieval", Second Edition, Addison Wesly, 2011

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

- CO1: Understand the fundamental of Web Mining Principles for effective web information retrieval.
- CO2: Understand the functionality of the various web mining components for knowledge discovery.

- CO3: Compare and evaluate different web mining techniques for structured, unstructured and semi structured data.
- CO4:Extract knowledge using web mining techniques for computing rank of the retrieved results.
- CO5:Acquire statistical techniques to analyze complex information from the content, structure and usages of the web application.
- CO6:Acquire statistical techniques to analyze complex information and social networks;
- CO7:Learn to critically read and connect a significant amount of scientific literature;Apply technical and analytic skills to develop a significant research project.
- CO8:Describe key concepts such as deep web, surface web, semantic web, web log, hypertext, social network, and evaluation measures such as precision and recall.
- CO9: Analyze and explain what web mining problems are satisfiably solved, what is worked upon at the research frontier and what still lies beyond the current state-of-the-art.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1,PO2 ,PO4/ PSO3
CO2	PO1,PO2,PO6/PSO4
CO3	PO2,PO3/PSO4
CO4	PO1,PO3/PS1,PS2
CO5	PO1, PO2/PS2,PS3
CO6	PO1,PO2,PO3/PS2,PS3
CO7	PO1,PO3/PS1,PS3
CO8	PO2,PO3/PS1,PS2,PS3
CO9	PO1,PO2,PO3/PSO2,PSO4

MCSC0004: ADVANCED CONCEPTS IN NETWORKING

Objective: To make students understand the protocols, algorithms and tools needed to support the development and delivery of advanced network services over networks.

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Introduction:** Networking overview, MAC layer issues, Ethernet 802.3, ARP, IP addressing and Subnetting, NAT and PAT, Variable Length Subnet Masking, CIDR **Advanced routing in the Internet and traffic engineering:** Intra domain routing: OSPF and IS-IS, Inter domain routing: BGP, Traffic Engineering **MPLS network**: MPLS basics, MPLS signaling, MPLS VPN **Internet multicasting:** IP multicasting, Application layer (Overlay) multicasting **TCP connection establishment and termination**: Sliding window concepts, other issues: wrap around, silly window syndrome, Nagle's algorithm, adaptive retransmission, TCP extensions. **End-to-End Congestion Control:** Tahoe, Reno, Vegas,	25
II	**Network based congestion control:** RED and ECN, Multicast congestion control. **Multimedia networking:** Introduction to multimedia networking, Video streaming over the Internet. **Internet QoS:** QoS fundamentals, Internet Differentiated services, Internet Integrated Services. **Peer-to-Peer networks and applications:** Peer-to-Peer file sharing networks, Peer-to-Peer streaming networks, Concept of overlays, Unstructured Overlays: Gnutella, Concepts of Distributed Hash Table, Structured Overlays: Chord, CAN, Pastry. **Wireless mobile networks:** Introduction to wireless networks, Wireless LAN, Cellular Networks, Mobile IP	25

Reference Books:

- Peterson and Davie ,"Computer Networks: A Systems Approach", 5th Edition MorganKauffman,2011.
- Kurose and Ross ,"Computer Networking: Top Down Approach", 6th Edition. PearsonEducation,2011.

Reading List

- V. Paxson, "End – to - end Internet packet dynamics," in IEEE/ACM Transactions onNetworking, Vol. No. 3,June, 1999.
- W. Stevens, "TCP Slow Start, Congestion Avoidance, Fast Retransmit, and Fast Recovery Algorithms,"RFC2001.
- K.Fall and S. Floyd, "Simulation - based comparison of Tahoe, Reno, and SACK TCP,"Computer Communication Review, vol. 26, pp. 5 - 21, July1996.
- L. Brakmo and L. Peterson, " TCP Vegas: End – to - End Congestion Avoidance on a Global Internet," IEEE Journal on Selected Areas in Communications, 13(8), October 1995, 1465 --1480.
- A. Rowstron, P. Druschel,"Pastry: Scalable, decentralized object location and routing for large - scale peer – to - peer systems". Middleware, 2001, 329—350.

Course Outcomes: After the completion of the course, the student will be able to:

- CO1: Understand and explain Data Communications System and its components.
- CO2: Identify the different types of network devices and their functions within a network.
- CO3: Understand and building the skills of subnetting and routing mechanisms.
- CO4: Differentiate among flow control, congesting control and congestion avoidance.
- CO5: Demonstrate the different congestion control mechanism.
- CO6: Calculate congestion window size in TCP congestion mechanism.
- CO7:Understand and analyze the challenges of P2P networks and wireless networks.
- CO8: Explain the limitations of wireless networks.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1,PO2,PO3/PSO1,PSO2
CO2	PO1,PO2,PO3,PO4/PSO1,PSO2
CO3	PO1,PO2,PO3,PO4/PSO1,PSO4
CO4	PO1,PO2,PO3,PO6/PSO1,PSO4
CO5	PO1,PO2,PO3/PSO1,PSO4
CO6	PO1,PO2,PO3,PO4/PSO1,PSO4
CO7	PO1,PO2/PSO1
CO8	PO1,PO2/PSO3

MCSE0008: Social Network Analytics

Objective*: This course covers aims to explain the components and entities of the social network, Analyze social media data to comprehend user sentiments and recommend the essential information appropriately and Model and visualize the social network*

Credits: 04 **L–T–P: 4–0–0**

Module No.	Content	Teaching Hours
I	**Fundamentals of Social Network Analysis:** Social Network Perspective, Fundamentals concepts in Network Analysis: Sociogram, Sociometry. Social Network Data: Types of Networks: One-Mode, Two-Mode, Affiliation, Ego-centered and Special Dyadic Networks, Network Data, Measurement and Collection, Notations for Social Network Data: Graphs, Directed, Singed, Valued graphs, Multigraph, Relations and Matrices. **Centrality and Prestige:** Prominence: Actor-Centrality, Prestige, Group-Centrality, Prestige, Non directional Relations-Degree, Closeness, Betweenness, Eigen Vector Centrality, Directional Relations-Centrality, Prestige **Structural Balance and Transitivity:** Structural Balance: Signed Non directional, Signed Directional Relations, Checking for Balance, Index for Balance, Clusterability-Theorems, Clustering Coefficient and Transitivity.	20
II	**Cohesive Subgroups:** Social Group and Subgroup-Notation, Subgroups Based on Complete Mutuality: Clique, Reachability and Diameter: n-cliques, n-clans and n-clubs, Subgroups Based on Nodal Degree: k-plexes, k-cores, Measures of Subgroup Cohesion, Community detection using Subgroups and Betweenness. **Roles and Positions:** Structural Equivalence: Definition, Social Roles and , Positional Analysis, Measuring Structural Equivalence, Representation of Network Positions, Block Models-Introduction, Network Positions and roles-Introduction **Dyadic and Triadic Methods:** Dyads: Definitions, Dyad Census, Index, Simple Distributions, Triads: Random Models and Substantive Hypotheses, Triad Census, Distribution of a Triad Census- Mean and Variance, Testing Structural Hypotheses. **Models in Social Network:** Small world network- Watt Strogatz networks - statistical models for social networks - network evaluation model - Preferential attachment - power law - Random Model : Erdos -Renyi model - Barabasi Albert model - Epidemic model - Case study: Text and opinion Analysis	20

Text/Reference Books:

- Ricardo Baeza-Yate, Berthier Ribeiro-Neto, “Modern Information Retrieval”, Second Edition, Addison Wesly, 2011.
- G. G. Chowdhury , “Introduction to Modern Information Retrieval”, Second Edition, Neal-Schuman Publishers, 2003.
- David A. Grossman, Ophir Frieder, “Information Retrieval: Algorithms, and Heuristics”, Springer, 2004
- Jurafsky, D. and J. H. Martin, Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition (3rd Draft), 2021.

Course Outcome: By the end of the class, students will learn to:

- CO1: Gain an understanding the basic concepts and techniques in Information Retrieval
- CO2: Develop tools to analyse the syntax and semantics of a statement written in a natural language.

- CO3: Apply machine learning and deep learning techniques to natural language processing.
- CO4: Understand the latest technologies for linking, describing and searching the Web. - Understand the relationship between IR, hypermedia, and semantic models.

- CO5: Be able to apply and implement techniques for the preprocessing needed for information retrieval systems and can be able to develop a small information retrieval system.
- CO6: Apply the different evaluation strategies to the retrieved results for computing the efficiency and accuracy of the information retrieval model.
- CO7: Apply IR techniques to XML retrieval and develop retrieval system for web search tasks

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1 /PSO1
CO2	PO1,PO3/PSO1
CO3	PO2/PSO2
CO4	PO3/PSO1, PSO2
CO5	PO1,PO3/PSO1
CO6	PO2/PSO2
CO7	PO2/PSO1

Open Elective

MCSE0010 RESEARCH METHODOLOGY

Objective

- *To give an overview of the research methodology and explain the technique of defining a research problem*
- *To explain the functions of the literature review in research.*

Credits: 03 **Semester – I** **L–T–P: 3–0–0**

Module No.	Contents	Teaching Hours
I	**Introduction to research**: motivation and objectives, Uniqueness of Thesis research, Research Philosophy, structure of research (The research hourglass) research process, research design, different types of research design (Exploratory, descriptive, experimental). **Introduction to Intellectual Property rights**: Ethics in Research, Plagiarism – definition, forms and consequences. Elementary statistics; Statistical models, population and sample, fitting the sample with the real world, Literature review.	20
II	**Identifying and Defining Research problems**: Guidelines for writing research proposals, Thesis, Research Paper, Patents. Guidelines according APA Format, MLA Format, Chicago Style Manual and IEEE Editorial Style Manual. **Measurement & Scaling**: Concept of Validity, Questionnaire design, Types and collection of Data, Fundamentals of Sampling & Sampling Design, Data Analysis- Various Statistical tools and techniques (Measure of Central Tendency & Dispersion, correlation, regression, Parametric Tests & Non-Parametric tests, factor analysis, cluster analysis). **Simulation and Numerical**: methods, Concepts of Artificial intelligence and Associated Techniques.	20

Test/Reference Books:

- Business Research Methods- Donald Cooper & Pamela Schindler, TMGH, 9th editions.
- Business Research Methods- Alan Bryman & Emma Bell, Oxford University Press, 2020.
- Research Methodology- C. R. Kothari, New Age International Publisher, 2019.

Course Outcome: By the end of the class, students learn to

- CO1: carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- CO2: Understand various research designs and their characteristics.
- CO3: Able to explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.
- CO4: Art of interpretation and the art of writing research reports.
- CO5: Various forms of the intellectual property.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs/ PSOs
CO1	PO1,PO2 /PSO2, PSO3
CO2	PO5, PO8, PO9, PO11/ PSO4
CO3	PO3, PO4, PO5, PO11/ PSO1
CO4	PO6, PO7, PO8 / PSO3, PSO4
CO5	PO1, PO3/ PSO2

RESEARCH ETHICS

Objective:

- focusing on basics of philosophy of science and ethics, research integrity, publication ethics. Sessions are designed to identify research misconduct and predatory publications.

Credits: 02 **Semester – II** **L–T–P: 2–0–0**

Module No.	Contents	Teaching Hours
I	**Philosophy and Ethics** Introduction to Philosophy: definition, nature and scope, concept, branches Ethics: Definition, moral philosophy, nature of moral judgments and reactions. **Scientific Conduct** Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP, Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data. **Publication Ethics** Publication ethics: definition, introduction and importance Best practices/standards setting initiatives and guidelines: COPE, WAME etc. Conflicts of interest, Publication misconduct: Definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals.	20
II	**Open Access Publishing** Open access publications and initiatives, Software tool to identify predatory publications developed by SPPU: UGC-CARE list of journals, Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. **Publication Misconduct** Group discussions, Subject specific ethical issues, FFP, authorship Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad **Databases and research metrics** Databases, Indexing databases, Citation databases: Web of Science, Scopus etc., Research Metrics, Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score Metrics: h-index, g-index, i-10 index, altmetrics	20

Test/Reference Books:

- Nicholas H. Steneck. Introduction to the Responsible Conduct of Research. Office of
- Research Integrity. 2007. Available at: https://ori.hhs.gov/sites/default/files/rcrintro.pdf
- The Student's Guide to Research Ethics By Paul Oliver Open University Press, 2003
- Responsible Conduct of Research By Adil E. Shamoo; David B. Resnik Oxford
- University Press, 2003
- Ethics in Science Education, Research and Governance Edited by Kambadur Muralidhar,
- Amit Ghosh Ashok Kumar Singhvi. Indian National Science Academy, 2019.

Course Outcome:

- CO1: Be aware about the publication ethics and publication misconducts
- CO 2. Understand the philosophy of science and ethics and research integrity
- CO 3. Develop hands-on skills to identify research misconduct and predatory publications.
- CO 4. Differentiate indexing and citation databases, open access publication and research metrics

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO3,PO3 /PSO1, PSO3
CO2	PO5, PO8, PO9, PO11/ PSO4
CO3	PO3, PO4, PO5, PO11/ PSO1
CO4	PO6, PO7, PO8 / PSO3, PSO4

DEEP LEARNING AND ITS APPLICATIONS

Course Objectives: *The course is designed to provide an introduction to deep learning and its applications*

Module No.	Content	Hours
I	**Machine Learning Basics**: Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic Gradient cent, Curse of Dimensionality. **Deep Learning Architectures:** Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks. **Activation functions:** Sigmoid, Linear, Tanh, ReLU, Leaky ReLU, SoftMax, loss functions, First and Second order optimization methods, Optimizers: Gradient Descent (GD), Batch Optimization, Momentum Based GD, Stochastic GD, AdaGrad, RMSProp, Adam; Introduction to Self Organizing Maps; Sequence to sequence models, RNN, Vanishing and Exploding Gradients, GRU, Restricted Boltzmann Machines, LSTM for NLP Applications. **Convolutional Neural Network**, Building blocks of CNN, Transfer Learning; Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Dropout.	**16**
II	**Autoencoders :** Unsupervised Learning with Deep Network, Autoencoders, Stacked, Sparse, Denoising Autoencoders, Variational Autoencoders; Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, GoogleNet, DensenNet, SqueezNet, MobileNet, NasNet Models. **Transfer Learning:** Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet. **Probabilistic Generative Models**: DBN, RBM	**16**

Credits: 04 **L–T–P-J: 4–0–0-0**

Text Books:

- Goodfellow,I., Bengio.,Y., and Courville,A., (2016), Deep Learning, The MIT Press .
- Charniak, E. (2019), Introduction to deep learning, The MIT Press.
- Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
- Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.

Reference Books:

- Simon Haykin, “Neural Networks, A Comprehensive Foundation”, 2nd Edition, Addison Wesley Longman, 2001.
- Deep Learning From Scratch: Building with Python from First Principles by Seth Weidman published by O`Reilley.
- Grokking Deep Learning by Andrew W. Trask published by Manning Publications.

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

CO1. Recognize the characteristics of deep learning models that are useful to solve real-world problems.
CO2. Understand different methodologies to create application using deep nets.
CO3. Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.
CO4. Implement different deep learning algorithms
CO5. Design the test procedures to assess the efficacy of the developed model.
CO6. Combine several models in to gain better results

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1, PO2 / PSO3
CO2	PO2 / PSO3
CO3	PO1, PO3/PSO3
CO4	PO1, PO2/ PSO1, PSO3
CO5	PO2/ PSO3
CO6	PO2/ PSO1, PSO3

DATA ANALYTICS FOR BUSINESS

Course Objectives: *The aim of the course is to build knowledge and understanding of Data Analytics and its tool among the students. The course seeks to give detailed knowledge about the PowerBI and Tableau.*

Credits: 04 **L–T–P-J: 4–0–0-0**

Module No.	Contents	Teaching Hours (Approx.)
I	**Introduction to PowerBI:** Getting Started with PowerBI, Overview of PowerBI and its features, Understanding the PowerBI interface, Data Sources and Connections, Connecting to various data sources (Excel, databases, web sources), Data transformation and cleaning techniques, Data Modeling in PowerBI, Introduction to data modeling concepts (tables, relationships, measures), Creating relationships between tables **Data Visualization in PowerBI:** Basic Visualizations, Creating basic visualizations (bar charts, line charts, pie charts), Formatting and customizing visualizations, Advanced Visualizations, Exploring advanced visualization types (maps, scatter plots, tree maps), Using custom visuals and integrating them into reports **Advanced Analytics with PowerBI:** DAX Functions, Introduction to DAX (Data Analysis Expressions) functions, Writing DAX expressions for calculated columns and measures, Advanced Data Analysis Techniques, Implementing advanced analytics techniques (time intelligence, ranking, forecasting), Using PowerBI for statistical analysis, Dashboard Creation and Sharing, Designing interactive dashboards, Publishing and sharing reports and dashboards with stakeholders.	20
II	**Introduction to Tableau:** Tableau features, Understanding the Tableau interface, Data Connections in Tableau, Connecting to various data sources (Excel, databases, web sources), Data preparation and cleaning techniques in Tableau, Basic Visualizations in Tableau, Creating basic visualizations (bar charts, line charts, scatter plots), Formatting and customizing visualizations **Intermediate Data Visualization Techniques:** Advanced Chart Types, Exploring advanced visualization types (maps, heat maps, box plots), Using dual-axis and combination charts, Interactive Dashboards in Tableau, Designing interactive dashboards with multiple sheets and filters, Implementing actions and interactivity in dashboards **Advanced Analytics and Dashboard Development:** Calculations and Parameters in Tableau, Introduction to calculated fields and table calculations, Using parameters for dynamic analysis and filtering, Advanced Data Analysis Techniques, trend lines, forecasting, clustering, Using statistical functions and LOD (Level of Detail) calculations, Dashboard Optimization and Publishing, design and layout of dashboard, Publishing and sharing dashboards on Tableau Server or Tableau Public	20

Outcomes: After completion of the course, student will be able to:

CO1. Understand How to import data into Tableau & PowerBI.
CO2. Understand Tableau concepts of Dimensions and Measures.
CO3. Develop Programs and understand how to map Visual Layouts and Graphical Properties.
CO4. Create a Dashboard that links multiple visualizations.
CO5. Use graphical user interfaces to create Frames for providing solutions to real world problems.

Text Books:

- Microsoft Power BI cookbook, Brett Powell, 2nd edition.
- Jones, Ben. Communicating data with Tableau: Designing, developing, and delivering data visualizations. " O'Reilly Media, Inc.", 2014.

Reference Books:

- Baldwin, David. Mastering Tableau. Packt Publishing Ltd, 2016.
- Murray, Daniel G. Tableau your data!: fast and easy visual analysis with tableau software. John Wiley & Sons, 2013.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	**POs/ PSOs**
CO1	PO1, PO2 / PSO3
CO2	PO2 / PSO3
CO3	PO3, PO3/PSO3
CO4	PO5, PO6/ PSO1, PSO3
CO5	PO2/ PSO3