



**KPR Institute of  
Engineering and  
Technology**

Learn Beyond (Autonomous, NAAC "A")

Avinashi Road, Arasur, Coimbatore.

**Great  
Place  
To  
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**Certified**  
MAR 2023-MAR 2024  
INDIA

# M.TECH. - DATA SCIENCES

## Curriculum and Syllabi

### (Regulations – 2023)

## I. Vision and Mission of the Institute

### Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

### Mission

- ❖ Commitment to offer value-based education and enhancement of practical skills
- ❖ Continuous assessment of teaching and learning processes through scholarly activities
- ❖ Enriching research and innovation activities in collaboration with industry and institutes of repute
- ❖ Ensuring the academic processes to uphold culture, ethics and social responsibilities

## II. Vision and Mission of the Department

### Vision

To foster the needs of students by providing learner centric teaching environment, continuous learning, research and development to become thriving professionals and entrepreneurs to excel in the field of computer science and contribute to the society.

### Mission

- Providing value-based education and contented learning experience to the students.
- Educating the students with the state of art technologies and cultivating their proficiency in analytical and designing skills.
- Enabling the students to achieve a successful career in Data Sciences and Computer Science and Engineering or related fields to meet the changing needs of various stakeholders.
- Guiding the students in research by nurturing their interest in continuous learning towards serving the society and the country.

## III. Program Educational Objectives (PEOs)

PEO1: To enable graduates to pursue research or take up successful career in academia or industries allied with Data Sciences or become entrepreneurs.

PEO2: To equip students with advanced techniques, tools and competency in applying technology to develop innovative and sustainable solutions.

PEO3: To empower students with critical analysis, leadership and decision-making skills guided by professional, ethical, and societal considerations to serve the nation.

## IV. Program Outcomes (POs)

PO1: Demonstrate proficiency in the applied fields of Data Sciences and Computer Science.

PO2: Write and present a substantial technical report/document

PO3: Independently carry out research investigation and development work to solve practical problems

PO4: Perform self-learning and to keep oneself up-to-date in the field of Data Science and computer science engineering.



PO5: Develop creative, innovative solutions for real life problems.

PO6: Demonstrate team building, goal setting and leadership development skills to create successful entrepreneurs.

V. PEO/PO Mapping

Following three levels of correlation should be used:

- 1: Low
- 2: Medium
- 3: High

	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	1	2	3	2
PEO2	3	2	3	3	3	3
PEO3	3	2	3	3	3	3



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**M.TECH DATA SCIENCES**  
**REGULATIONS – 2023**  
**CHOICE BASED CREDIT SYSTEM**  
**CURRICULUM FOR I TO IV SEMESTERS**

**CONTROLLED COPY**
**SEMESTER I**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
<b>THEORY</b>							
1	P23MA104	Probability and Statistics for Data Sciences	FC	3	0	0	3
2	P23CS101	Advanced Data Structures and Algorithms	PCC	2	0	2	3
3	P23DS101	Foundations of Data Science	PCC	3	0	0	3
4	P23CS103	Machine Learning	PCC	3	0	0	3
5	P23RMC01	Research Methodology and IPR	RMC	3	0	0	3
6		Professional Elective – I	PEC	3	0	0	3
<b>PRACTICALS</b>							
7	P23DS102	Data Science Laboratory	PCC	0	0	4	2
8	P23CS104	Machine Learning Laboratory	PCC	0	0	4	2
<b>TOTAL</b>				<b>17</b>	<b>0</b>	<b>10</b>	<b>22</b>

**SEMESTER II**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
<b>THEORY</b>							
1	P23MA201	Linear Algebra for Data Sciences	FC	3	0	0	3
2	P23DS201	Information and Network Security	PCC	3	0	0	3
3	P23DS202	Big data Frameworks and Applications	PCC	3	0	0	3
4	-	Professional Elective – II	PEC	3	0	0	3
5	-	Professional Elective – III	PEC	3	0	0	3
<b>PRACTICALS</b>							
6	P23DS203	Big data Frameworks and Applications Laboratory	PCC	0	0	4	2
7	P23DS204	Technical Seminar	EEC	0	0	4	2
<b>TOTAL</b>				<b>15</b>	<b>0</b>	<b>8</b>	<b>19</b>

**SEMESTER III**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
<b>THEORY</b>							
1	-	Professional Elective IV	PEC	3	0	0	3
2	-	Professional Elective V	PEC	3	0	0	3
3	-	Professional Elective VI	PEC	3	0	0	3
<b>PRACTICALS</b>							
4	P23DS301	Project Work – Phase I	EEC	0	0	12	6
<b>TOTAL</b>				<b>9</b>	<b>0</b>	<b>12</b>	<b>15</b>

## SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L T P C			
				L	T	P	C
<b>PRACTICALS</b>							
1	P23DS401	Project Work – Phase II	EEC	0	0	24	12
2	P23DSI01	Industrial Training / Internship	EEC	0	0	0	2
<b>TOTAL</b>				<b>0</b>	<b>0</b>	<b>24</b>	<b>14</b>

## LIST OF COURSES BASED ON ITS CATEGORY

## FOUNDATION COURSES (FC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P23MA104	Probability and Statistics for data sciences	FC	3	0	0	3
2	P23MA201	Linear Algebra for data sciences	FC	3	0	0	3

## PROFESSIONAL CORE COURSES (PCC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
<b>THEORY</b>							
1	P23CS101	Advanced Data Structures and Algorithms	PCC	2	0	2	3
2	P23DS101	Foundations of Data Science	PCC	3	0	0	3
3	P23CS103	Machine Learning	PCC	3	0	0	3
4	P23DS102	Data Science Laboratory	PCC	0	0	4	2
5	P23CS104	Machine Learning Laboratory	PCC	0	0	4	2
6	P23DS201	Information and Network Security	PCC	3	0	0	3
7	P23DS202	Big data Frameworks and Applications	PCC	3	0	0	3
8	P23DS203	Big data Frameworks and Applications Laboratory	PCC	3	0	0	3

## PROFESSIONAL ELECTIVES COURSES (PEC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P23DSP01	Data Preparation and Analysis	PEC	3	0	0	3
2	P23DSP02	Web Analytics	PEC	3	0	0	3
3	P23CSP13	Deep Learning	PEC	3	0	0	3
4	P23DSP03	Soft Computing	PEC	3	0	0	3
5	P23DSP04	Fuzzy Logic and Fuzzy Sets	PEC	3	0	0	3
6	P23DSP05	Advanced Algorithms	PEC	3	0	0	3
7	P23DSP06	Artificial Intelligence	PEC	3	0	0	3
8	P23CSP01	Information retrieval techniques	PEC	3	0	0	3
9	P23CSP02	No SQL Database	PEC	3	0	0	3
10	P23CSP04	Vehicular systems	PEC	3	0	0	3
11	P23CSP07	Cyber security practices	PEC	3	0	0	3
12	P23CSP08	Digital Image processing and computer vision	PEC	3	0	0	3
13	P23CSP11	Applied natural language processing	PEC	3	0	0	3
14	P23CSP12	Bio Inspired Computing	PEC	3	0	0	3
15	P23CSP15	Cloud Computing Technologies	PEC	3	0	0	3
16	P23CSP16	Block chain Technologies	PEC	3	0	0	3

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17	P23CSP18	Internet of Things	PEC	3	0	0	3
18	P23CSP19	Robotics	PEC	3	0	0	3
19	P23CSP20	Cognitive science	PEC	3	0	0	3

**RESEARCH METHODOLOGY & IPR COURSES (RMC)**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P23RMC01	Research Methodology and IPR	RMC	3	0	0	3

**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P23DS204	Technical Seminar	EEC	0	0	4	2
2	P23DS301	Project Work – Phase I	EEC	0	0	12	6
3	P23DS401	Project Work – Phase II	EEC	0	0	24	12
4	P23DSI01	Industrial Training / Internship	EEC	0	0	0	2

**VIII. Scheme of Credit distribution – Summary**

S. No	Stream	Credits/Semester				Credits	%	Suggested by AICTE
		I	II	III	IV			
1	Foundation Courses (FC)	3	3	-	-	6	8.57	-
2	Professional Core Courses (PCC)	13	8	-	-	21	30	32.35
3	Professional Elective Courses (PEC)	3	6	9	-	18	25.71	26.47
4	Research Methodology & IPR Courses (RMC)	3	-	-	-	3	4.28	2.94
5	Employability Enhancement Courses (EEC)	-	2	6	14	22	31.42	38.23
<b>Total</b>		<b>22</b>	<b>19</b>	<b>15</b>	<b>14</b>	<b>70</b>	<b>100</b>	<b>100</b>

**TOTAL CREDITS: 70**

  
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M.TECH. -DS- R2023- CBCS

Year	SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	
I Year	SEM I	Probability and Statistics for data sciences	✓	✓	-	✓	-	-	
		Advanced Data Structures and Algorithms	✓	-	✓	✓	✓	-	
		Foundations of Data Science	✓	✓	✓	-	-	-	
		Machine Learning	✓	-	-	✓	✓	-	
	SEM II	Research Methodology and IPR	-	-	-	✓	✓	✓	✓
		Data Science Laboratory	✓	✓	✓	✓	✓	✓	-
		Machine Learning Laboratory	✓	✓	✓	✓	✓	✓	-
		Linear Algebra for data sciences	✓	✓	✓	✓	✓	-	✓
		Information and Network Security	✓	✓	-	-	✓	✓	-
		Big data Frameworks and Applications	✓	✓	✓	-	-	-	-
	SEM III	SEM IV	Big data Frameworks and Applications Laboratory	✓	✓	✓	✓	✓	-
			Technical Seminar	-	-	-	-	✓	✓
		Project Work – Phase I	✓	✓	✓	✓	✓	✓	✓
		Project Work – Phase II	✓	✓	✓	✓	✓	✓	✓
PE		Data Preparation and Analysis	✓	✓	✓	✓	✓	-	
		Web Analytics	✓	✓	-	-	✓	✓	-
		Deep Learning	✓	✓	✓	✓	✓	✓	-
		Soft Computing	✓	✓	✓	✓	✓	✓	-
		Fuzzy Logic and Fuzzy Sets	✓	✓	✓	✓	✓	✓	-
		Advanced Algorithms	✓	✓	✓	✓	✓	✓	-
Artificial Intelligence	✓	✓	✓	✓	✓	✓	-		
Information retrieval techniques	✓	✓	✓	✓	✓	✓	-		

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## SEMESTER I

P23MA104	PROBABILITY AND STATISTICS FOR DATA SCIENCES	Category: FC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES

- To understand the concepts of probability, random variable and distributions that are applicable in the field of engineering
- To understand the concepts of testing of hypothesis for small and large samples which plays an important role in testing of industrial products
- To introduce the principles and techniques of parameter estimation using the method of moments and the maximum likelihood estimation (MLE) method, normal populations, with a focus on applications in data analysis and statistical inference.

## UNIT I PROBABILITY AND RANDOM VARIABLES 9

Classical axiomatic definitions of probability – Conditional probability – Total probability – Bayes' Theorem and independence – Discrete, continuous and mixed random variables – probability mass probability density and cumulative distribution functions – Mathematical expectation – Moments, moment generating function – Foundational Probability Concepts for Data Science Applications

## UNIT II SPECIAL DISTRIBUTIONS 9

Binomial – Poisson – Geometric distributions – Uniform – Exponential – Gamma – Normal distributions – Functions of a Random Variable.

## UNIT III JOINT DISTRIBUTIONS 9

Joint marginal and conditional distributions – Product moments – Correlation – Independence of random variables – Bivariate normal distribution.

## UNIT IV LARGE AND SMALL SAMPLE TESTS 9

Large sample test: Test of significance – Test for population mean, proportion – Test for equality of two means, proportions – Test of variance – Small sample test: Students' t-test, test for population mean, quality of two population means – F-test for equality of two population variances – Chi square test for goodness of fit and for independence of attributes

## UNIT V ESTIMATION 9

The method of moments and the method of maximum likelihood estimation – Confidence intervals for the mean(s) and variance(s) of normal populations.

## Contact Periods:

Lecture: 45 Periods      Tutorial: – Periods      Practical: – Periods      Total: 45 Periods

## REFERENCES:

1. Ronald E. Walpole, Raymond H. Meyers and Sharon L. Meyers, "Probability and Statistics for Engineers and Scientists", 9<sup>th</sup> edition, Pearson Education, 2013.
2. Jay L. Devore, "Probability and Statistics for Engineering and Sciences", 9<sup>th</sup> edition, Cengage India Pvt. Ltd., 2020.
3. Trivedi K.S., "Probability and Statistics with Reliability, Queuing and Computer Science Applications", 2<sup>nd</sup> edition, John Wiley & Sons, 2015.
4. Douglas C Montgomery and George C Runger, "Applied Statistics and Probability for Engineers", 6<sup>th</sup> edition, John Wiley & Sons, 2016.



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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

Cos	Statements	K-Level
CO1	Probability axioms and the moments of discrete and continuous random variables	Apply
CO2	Discrete probability distributions including requirements, mean and variance for making decisions	Understand
CO3	Explain the correlation and linear regression with respect to two dimensional random variables	Understand
CO4	Analyze large and small sample tests and perform small sample tests based on Chi-square, t and F distributions	Apply
CO5	Apply the method of moments and maximum likelihood estimation techniques to estimate population parameters and construct confidence intervals for the mean and variance of normally distributed data, supporting data-driven decision making in real-world analytics scenarios	Apply

**COURSE ARTICULATION MATRIX:**

Cos \ Pos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	–	2	2	–
CO2	3	3	–	2	2	–
CO3	3	3	–	2	2	–
CO4	3	3	–	2	2	–
CO5	3	3	–	2	2	–
CO	3	3	–	2	2	–
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER I

P23CS101	ADVANCED DATA STRUCTURES AND ALGORITHMS	Category: PCC			
		L	T	P	C
		2	0	2	3

**COURSE OBJECTIVES:**

- To acquire knowledge in role of algorithms and tree structures
- To gain knowledge on the graphs and linear programming
- To understand the concept of NP completeness and approximation algorithms

**UNIT I ROLE OF ALGORITHMS IN COMPUTING 6**

Algorithms – Algorithms as a Technology – Insertion Sort – Analyzing Algorithms – Designing Algorithms – Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions – Recurrences: The Substitution Method – The Recursion – Tree Method

**UNIT II HIERARCHICAL DATA STRUCTURES 6**

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion– Red–Black trees: Properties of Red–Black Trees – Rotations – Insertion – Deletion – B–Trees: Definition of Btrees – Basic operations on B–Trees – Deleting a key from a B–Tree – Fibonacci Heaps: structure – Mergeable – heap operations

**UNIT III GRAPHS 6**

Elementary Graph Algorithms: Representations of Graphs – Breadth–First Search – Depth – First Search – Topological Sort – Strongly Connected Components – Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim – Single – Source Shortest Paths: The Bellman–Ford algorithm – Single–Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm

**UNIT IV MULTITHREADED ALGORITHMS AND LINEAR PROGRAMMING 6**

Dynamic multithreading – Multithreaded matrix multiplication – Multithreaded merge sort – Linear Programming – Standard and slack forms – Formulating problems as linear programs – Simplex algorithm – Duality – Feasible solution

**UNIT V NP–COMPLETENESS AND APPROXIMATION ALGORITHMS 6**

Polynomial time – verification – NP–completeness and reducibility – NP–completeness proofs – NP–complete problems – Approximation Algorithms – Vertex–cover problem – Traveling–salesman problem – Set–covering problem – Randomization and linear programming – Subset–sum problem

**LIST OF EXPERIMENTS**

1. Write a Python program that reads an infix expression and converts the expression to postfix form.
2. Write a Python program to perform the following operations:
  - a) Construct a binary search tree of elements.
  - b) Search for a key element in the above binary search tree.
  - c) Delete an element from the above binary search tree.
3. Write a Python program to perform the following operations:
  - a) Insertion into a B–tree
  - b) Searching in a B–tree
4. Write a Python program to perform the following operation:

- a) Construct a red black tree of elements.
5. Write a Python program for heap operations
  6. Write a Python program for find single source shortest path for given graph using Dijkstra's Algorithm
  7. Write a Python program for traveling salesman problem using any of the technique

**Contact Periods:**

Lecture: 30 Periods      Tutorial: Periods      Practical: 30 Periods      Total: 60 Periods

**REFERENCES:**

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, Third Edition, Prentice–Hall, 2019
2. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, —Data Structures and Algorithms, Pearson Education, Reprint 2016
3. S.Sridhar, Design and Analysis of Algorithms, 1<sup>st</sup> Edition, Oxford University Press, 2014
4. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Pearson Education, 2<sup>nd</sup> Edition, 2012
5. E. Horowitz, S.Sahni and Dinesh Mehta, "Fundamentals of Data structures in C++", Universities Press, 2010

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the role of algorithms in computing	Understand
CO2	Apply the importance of hierarchical data structures	Apply
CO3	Describe the elementary graph algorithms	Understand
CO4	Analyze the multithreaded algorithms and linear programming	Analyze
CO5	Apply NP Completeness and approximation algorithms	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	2	2	1	–
CO2	3	–	2	2	1	–
CO3	3	–	2	2	1	–
CO4	3	–	2	2	1	–
CO5	3	–	2	2	1	–
CO	3	–	2	2	1	–

Correlation levels:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

## SEMESTER I

P23DS101	FOUNDATIONS OF DATA SCIENCE	Category: PGC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES

- To provide foundational data science knowledge and highlight the significance of statistics and optimization in performing mathematical operations within the field.
- To develop an understanding of handling diverse data types and utilizing visualization techniques for improved comprehension.
- To provide fundamental insights into various open–source data science tools and their practical applications in addressing industrial challenges.

**UNIT I FUNDAMENTALS OF DATA SCIENCE 9**

Introduction to data science – Typology of problems – Importance of linear algebra – Statistics and optimization – Structured thinking – Structured and unstructured data

**UNIT II STATISTICAL FOUNDATIONS 9**

Descriptive statistics – Statistical features – Summarizing data – Outlier analysis – Univariate – Bivariate and multivariate statistics – Dimensionality reduction – Over/under–sampling – Bayesian statistics and Statistical modelling

**UNIT III ALGORITHMIC FOUNDATIONS 9**

Linear algebra (matrices, eigenvalues, eigenvectors) – Distance measures – Projections – Hyperplanes – Spectral graph theory – Graph sampling – Random walks – MCMC algorithms – Learning separators – PAC learning

**UNIT IV OPTIMIZATION 9**

Unconstrained optimization – Gradient descent methods – Constrained optimization – KKT conditions – Least squares optimization – Introduction to non–gradient optimization techniques

**UNIT V PROGRAMMING, DATA HANDLING, AND VISUALIZATION 9**

Python basics (variables, loops, data structures) – Exploratory data analysis (EDA) – Data acquisition and preprocessing – Handling text data – Visualization (charts, workflows) and tools (SciPy, R, Weka)

**Contact Periods:**

Lecture: 45 Periods      Tutorial: – Periods      Practical: – Periods      Total: 45 Periods

**REFERENCES:**

1. R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 8<sup>th</sup> Ed., Pearson Education India, 2019.
2. Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge University Press, 2020.
3. Ani Adhikari and John DeNero, „Computational and Inferential Thinking: The Foundations of Data Science“, GitBook, 2019.
4. Cathy O'Neil and Rachel Schutt, „Doing Data Science: Straight Talk from the Frontline“, O'Reilly Media, 2013.
5. Hossein Pishro–Nik, "Introduction to Probability, Statistics, and Random Processes", Kappa Research, LLC, 2014.

  
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**COURSE OUTCOMES (CO)**

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Obtain foundational knowledge of data science concepts and principles.	Understand
CO2	Demonstrate expertise in conducting statistical analysis on data.	Apply
CO3	Apply mathematical concepts and optimization techniques to execute data science operations.	Apply
CO4	Manage and visualize diverse data types using programming for effective knowledge representation.	Apply
CO5	Utilize various open–source data science tools to address real–world challenges through industrial case studies.	Apply

**COURSE ARTICULATION MATRIX:**

Cos	POs	PO1	PO2	PO3	PO4	PO5	PO6
	CO1	3	2	1	–	–	–
CO2	3	1	1	–	–	–	
CO3	3	2	1	–	–	–	
CO4	3	2	1	–	–	–	
CO5	3	2	1	–	–	–	
CO	3	2	1	–	–	–	
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER I

P23CS103	MACHINE LEARNING	Category: PCC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To acquire knowledge in learning methods to enhance the performance of learning
- To gain knowledge on the suitable machine learning techniques for data handling
- To evaluate the performance of algorithms, provide solution for various real-world applications.

**UNIT I SUPERVISED LEARNING ALGORITHMS** 9

Machine Learning – Applications – Supervised Learning – Learning a Class – Vapnik–Chervonenkis Dimension – Probably Approximately correct learning – Noise – Learning Multiple Classes – Regression – Model selection and Generalization – Dimensions – Bayesian Decision Theory – Classification – Discriminant Functions – Association Rules – Parametric Methods

**UNIT II CLUSTERING AND NON-PARAMETRIC METHODS** 9

Introduction to clustering – Expectation Maximization Algorithm – Mixtures of Latent Variable Models– Spectral Clustering – Spectral Clustering – Choosing the Number of Clusters – Nonparametric Density Estimation – Generalization to Multivariate Data – Nonparametric Classification – Condensed Nearest Neighbor – Nonparametric Regression: Smoothing Models

**UNIT III MULTILAYER PERCEPTRONS AND LOCAL MODELS** 9

Introduction – Training a Perceptron – Learning Boolean Functions – MLP as a Universal Approximator – Backpropagation Algorithm – Training Procedures – Bayesian View of Learning – Learning Time – Deep Learning – Competitive Learning – The Mixture of Experts – Hierarchical Mixture of Experts

**UNIT IV KERNEL MACHINES, GRAPHICAL AND HIDDEN MARKOV MODELS** 9

Optimal Separating Hyperplane – Kernel Trick – Vectorial Kernels – Multiple Kernel Learning – Kernel Machines for Regression and Ranking – Canonical Cases for Conditional Independence – Belief Propagation – Undirected Graphs: Markov Random Fields – Three Basic Problems of HMMs – Learning Model Parameters – Model Selection in HMMs

**UNIT V DESIGN AND ANALYSIS OF MACHINE LEARNING EXPERIMENTS** 9

Introduction – Factors, Response, and Strategy of Experimentation – Response Surface Design – Randomization, Replication, and Blocking – Cross-Validation and Resampling Methods – Measuring Classifier Performance – Interval Estimation – Hypothesis Testing – Comparing Two Classification Algorithms – Comparison over Multiple Datasets – Multivariate Tests

## Contact Periods:

Lecture: 45 Periods      Tutorial: –Periods      Practical: –Periods      Total: 45 Periods

## REFERENCES:

1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India, 3<sup>rd</sup> Edition 2017
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, "Foundations of Machine Learning", MIT Press, 2018
3. Tom Mitchell, "Machine Learning", McGraw Hill, 3<sup>rd</sup> Edition, 2008
4. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2019
5. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2<sup>nd</sup> Edition, CRC Press, 2015

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the concept of supervised learning	Understand
CO2	Use of clustering and non-parametric methods to real world problems	Apply
CO3	Describe the multi-layer perceptrons and local models	Understand
CO4	Analyze the kernel machines, graphical and hidden Markov models	Analyze
CO5	Design and analyze the machine learning experiments using various testing methods	Analyze

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	2	-	-
CO2	3	-	2	2	3	-
CO3	3	-	-	2	-	-
CO4	3	-	2	2	-	-
CO5	3	-	3	3	3	-
CO	3	-	2	2	3	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER I

P23RMC01	RESEARCH METHODOLOGY AND IPR	Category: RMC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To impart knowledge in problem formulation, analysis and solutions
- To impart skills required for technical paper writing / presentation without violating professional ethics.
- To familiarize knowledge on patent drafting and filing patents.

**UNIT I RESEARCH PROBLEM FORMULATION 9**

Meaning of research problem – Sources of research problem – Criteria characteristics of a good research problem – Errors in selecting a research problem – Scope and objectives of research problem. Approaches of investigation of solutions for research problem – Data collection – Analysis – Interpretation– Necessary instrumentations

**UNIT II LITERATURE REVIEW AND DATA COLLECTION 9**

Effective literature studies approaches – Analysis – Plagiarism and research ethics. Method of data collection – Types of data – Primary Data – Scales of measurement – Source and collection of data observation method – Secondary data

**UNIT III TECHNICAL WRITING / PRESENTATION 9**

Effective technical writing: How to write report – Paper – Developing a research proposal – Format of research proposal – Presentation and assessment by a review committee

**UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 9**

Nature of Intellectual Property: Patents – Designs – Trade and Copyright. Process of Patenting and Development – technological research – Innovation – Patenting – Development – International Scenario – International cooperation on Intellectual Property – Procedure for grants of patents – Patenting under PCT

**UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 9**

Patent Rights: Scope of Patent Rights – Licensing and transfer of technology – Patent information and databases – Geographical Indications – New Developments in IPR – Administration of Patent System – IPR of Biological Systems – Computer Software etc

**Contact Periods:**

Lecture: 45 Periods      Tutorial: –Periods      Practical: –Periods      Total: 45 Periods

**REFERENCES:**

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners", 3rd edition, Sage Publications, 2010
2. Cooper, DR and Schindler, P S., "Business Research Methods", 9th edition, Tata McGraw Hill, 2014
3. Robert P. Merges, Peter S, Menell, Mark A. Lemley, "Intellectual Property in New Technological age", Volume I, Clause 8 Publishing, 2022

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

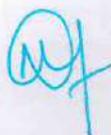
COs	Statements	K-Level
CO1	Formulate research problem	Apply
CO2	Carryout research analysis	Analyze
CO3	Develop research proposal	Evaluate
CO4	Draft process of patenting	Apply
CO5	File and publish patents in R&D	Evaluate

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	–	–	–	1	3	1
CO2	–	–	–	1	3	1
CO3	–	–	–	1	3	1
CO4	–	–	–	1	3	1
CO5	–	–	–	1	3	1
CO	–	–	–	1	3	1

Correlation levels:            1: Slight (Low)   2: Moderate (Medium)        3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER I

P23DS102	DATA SCIENCE LABORATORY	Category: PCC			
		L*	T	P	C
		0	0	4	2

**COURSE OBJECTIVES:**

- To provide hands-on experience with foundational techniques in data science, including data analysis, dimensionality reduction, and statistical modelling.
- To enable students to implement mathematical and optimization algorithms in Python for solving real-world data science problems.

**List of Experiments**

1. Implement descriptive statistics (mean, median, mode, variance, standard deviation) of a dataset.
2. Implement outlier detection algorithms (Z-score, IQR) and handle missing values.
3. Implement univariate statistical analysis and visualize data using bar plots and histograms.
4. Implement bivariate analysis using scatter plots and calculate correlation coefficients.
5. Implement Principal Component Analysis (PCA) for dimensionality reduction and visualize the results.
6. Implement t-SNE for non-linear dimensionality reduction.
7. Implement basic linear algebra operations (matrix multiplication, determinant, inversion) and compute eigenvalues/eigenvectors.
8. Implement distance measures like Euclidean, Manhattan, and Cosine distances.
9. Implement the gradient descent algorithm for minimizing a quadratic function and visualize its convergence.
10. Implement constrained optimization problems using KKT conditions and visualize the process.

**Contact Periods:**

Lecture: – Periods      Tutorial: – Periods      Practical: 60 Periods      Total: 60 Periods

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

Cos	Statements	K-Level
CO1	Demonstrate the ability to implement statistical techniques such as descriptive statistics and outlier detection on datasets.	Apply
CO2	Apply dimensionality reduction methods like PCA and t-SNE to simplify high-dimensional data and visualize patterns.	Apply
CO3	Implement linear algebra operations and distance measures essential for data representation and analysis.	Apply
CO4	Develop optimization algorithms like gradient descent and constrained optimization using KKT conditions.	Apply
CO5	Demonstrate expertise in using programming and visualization tools to address real-world data science challenges.	Apply

**COURSE ARTICULATION MATRIX:**

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	1	-
CO2	3	1	2	1	1	-
CO3	3	1	2	1	1	-
CO4	3	1	2	1	1	-
CO5	3	1	2	1	1	-
CO	3	1	2	1	1	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)



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## SEMESTER I

P23CS104	MACHINE LEARNING LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

**COURSE OBJECTIVES:**

- To acquire knowledge in learning methods to enhance the performance of learning
- To implement the suitable machine learning techniques for data handling
- To evaluate the performance of algorithms and to provide solution for various real-world applications

**List of Experiments**

1. Implement Decision Tree learning
2. Implement Logistic Regression
3. Implement classification using Multilayer perceptron
4. Implement classification using SVM
5. Implement Bagging using Random Forests
6. Implement k-nearest Neighbours algorithm
7. Implement K-means, K-Modes Clustering to Find Natural Patterns in Data
8. Implement Hierarchical clustering
9. Implement Gaussian Mixture Model Using the Expectation Maximization
10. Implement Principal Component Analysis for Dimensionality Reduction

**Contact Periods:**

Lecture: – Periods      Tutorial: – Periods      Practical: 60 Periods      Total: 60 Periods

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Implement the concept of supervised learning	Apply
CO2	Use of clustering and non-parametric methods to real world problems	Apply
CO3	Implement the multi-layer perceptrons and local models using classification techniques	Apply
CO4	Analyze the K-means, K-Modes Clustering to Find Natural Patterns in Data	Apply
CO5	Implement Principal Component Analysis for Dimensionality Reduction	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	1	-
CO2	3	1	2	1	1	-
CO3	3	1	2	1	1	-
CO4	3	1	2	1	1	-
CO5	3	1	2	1	1	-
CO	3	1	2	1	1	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

  
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## SEMESTER II

P23MA201	LINEAR ALGEBRA FOR DATA SCIENCES	Category: FC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES

- To understand the concepts of decomposition of matrices
- To understand the concepts of independence, basis and dimensions in vector spaces
- To understand the concepts of inner product spaces and orthogonality

**UNIT I MATRICES** 9

Vectors and Linear combinations – Rank of a matrix – Solution of system of linear equations by Gaussian elimination, Gauss Jordan and LU decomposition methods

**UNIT II VECTOR SPACE** 9

Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear dependence and independence – Bases and dimensions

**UNIT III INNER PRODUCT SPACE** 9

Introduction to linear transformation – Inner product – Norm – Angle – Orthogonality: definition and simple problems – Projections – Gram Schmidt orthogonalization and QR decomposition

**UNIT IV EIGENVALUE PROBLEMS** 9

Linear transformations – Range, kernel and problems – Eigenvalues and eigenvectors – Hermitian and unitary matrices (simple problems)

**UNIT V PRINCIPAL COMPONENT ANALYSIS** 9

Positive definite matrices – Cayley–Hamilton theorem – Singular value decomposition and principal component analysis using the covariance method – Introduction to their applications in image processing and machine learning (problems not included)

**Contact Periods:**

Lecture: 45 Periods    Tutorial: – Periods    Practical: – Periods    Total 45 Periods

**REFERENCES:**

1. Howard Anton and Chris Rorres, "Elementary Linear Algebra – Applications version", 9<sup>th</sup> edition, John Wiley & Sons, 2005.
2. David C. Lay, "Linear Algebra and its Applications", 5<sup>th</sup> edition, Pearson College Division, 2014.
3. Steven J. Leon, "Linear Algebra with Applications", 9<sup>th</sup> edition, Pearson College Division, 2014.
4. Gilbert Strang, "Introduction to Linear Algebra", 5<sup>th</sup> edition, Wellesley Publishers, 2016.
5. Gonzalez R C and Woods R E, "Digital Image Processing", 4<sup>th</sup> edition, Pearson Education, 2018.

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Implement the various matrix techniques in solving the system of linear equations	Understand
CO2	Use the concept of vector spaces to predict an orthonormal basis	Understand
CO3	Attribute a set of vectors in an inner product space using Gram–Schmidt orthogonalisation and decompose a given matrix using QR decomposition	Understand
CO4	Discuss the Eigen values and Eigen vectors of the linear transformations for the simple real–life problems	Understand
CO5	Apply the Singular value decomposition and Principal component analysis technique to real world datasets for performing the dimensional reduction on the given data	Apply

**COURSE ARTICULATION MATRIX:**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1	–	1
CO2	3	2	1	1	–	1
CO3	3	2	1	1	–	1
CO4	3	2	2	1	–	1
CO5	3	2	2	1	–	1
CO	3	2	1	1	–	1
Correlation levels:      1: Slight (Low)      2: Moderate (Medium)      3: Substantial (High)						

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER II

P23DS201	INFORMATION AND NETWORK SECURITY	Category: PCC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To understand the concepts of information security, various types of attacks, and the role of encryption and authentication in securing systems
- To learn the principles and mechanisms of intrusion prevention, detection, and firewall technologies.
- To develop the ability to analyze, detect, and apply preventive measures against security threats and attacks.

**UNIT I FUNDAMENTALS OF INFORMATION SECURITY 9**

Critical characteristics of Information – NSTISSC Security Model – Components of information System – SDLC – Information assurance – Security Threats and vulnerabilities – Overview of Security threats – Security Standards

**UNIT II CRYPTOGRAPHY AND ACCESS CONTROL 9**

Classical Cryptography – Symmetric Cryptography – Asymmetric Cryptography – Modern Cryptography – Access Control – DRM – Steganography – Biometrics

**UNIT III NETWORK AND E-COMMERCE SECURITY 9**

Network Security – Intrusion Prevention – Detection and Management – Firewall – Ecommerce Security – Computer Forensics – Security for VPN and Next Generation Networks

**UNIT IV HOST & APPLICATION SECURITY 9**

Host and Application security – Control hijacking – Software architecture and a simple buffer overflow – Common exploitable application bugs – Shellcode – Buffer Overflow – Side-channel attacks – Timing attacks – Power analysis – Cold-boot attacks – Defences – Malware – Viruses and worms spyware, key loggers, and botnets; defences auditing, policy – Defending weak applications – Isolation, sandboxing, virtual machines

**UNIT V MOBILE & WIRELESS SECURITY 9**

Mobile, GSM and Wireless LAN security – Protection measures – Business risk analysis – Information Warfare and Surveillance – Case study on Attack prevention, detection and response

**Contact Periods:**

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total 45 Periods

**REFERENCES:**

1. William Stallings, "Cryptography and Network Security: Principles and Practice", 6<sup>th</sup> Edition, PHI, 2014.
2. Michael E. Whitman and Herbert J Mattord, "Principles of Information Security", 6<sup>th</sup> Edition, Vikas Publishing House, 2017.
3. Bill Nelson, Amelia Phillips, F. Enfinger and Christopher Stuart, "Guide to Computer Forensics and Investigations", 4<sup>th</sup> Edition, Thomson Course Technology, 2010.
4. Matt Bishop, "Computer Security: Art and Science", 1<sup>st</sup> Edition, Addison-Wesley Professional, 2015.

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the critical characteristics of information, security models, and standards, along with threats and vulnerabilities	Understand
CO2	Apply the System Development Life Cycle (SDLC) and information assurance principles in designing secure systems	Apply
CO3	Describe the principles of classical, symmetric, and asymmetric cryptography, as well as modern techniques such as biometrics and DRM	Apply
CO4	Explain the optical properties of materials	Apply
CO5	Explain the fundamentals of intrusion detection, firewalls, VPNs, and e-commerce security.	Apply

#### COURSE ARTICULATION MATRIX:

POs \ COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	–	2	–
CO2	2	2	3	2	2	2
CO3	2	2	3	2	2	2
CO4	2	3	3	2	3	–
CO5	2	3	3	2	3	–
CO	3	2	–	–	2	–

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER II

P23DS202	BIGDATA FRAMEWORKS AND APPLICATIONS	Category: PCC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To provide knowledge of functional programming and big data frameworks for effective data science applications.
- To familiarize students with the production-level challenges of ML models and impart knowledge on MLOps principles, tools, and platforms.
- To develop skills for designing and deploying scalable machine learning systems and handling real-time data problems in enterprise settings.

**UNIT I FOUNDATIONS OF BIG DATA 9**

Understanding Big Data: Concepts and terminology – Big Data Characteristics – Types of Data – Identifying Data Characteristics – Big Data Architecture – Big Data Storage – File System vs Distributed File System – NoSQL Databases – Sharding – Replication – ACID and BASE Properties

**UNIT II HADOOP ECOSYSTEM AND MAPREDUCE 9**

Hadoop Architecture – Hadoop Distributed File System (HDFS) – YARN Overview – Hadoop I/O – MapReduce Framework – Developing MapReduce Applications – Workflow – Types and Formats – Features of MapReduce – Sorting – Joins and Pipelining

**UNIT III HADOOP TECHNOLOGIES – PIG AND HIVE 9**

Introduction to Pig: Pig Architecture – Data Model – Grunt – Pig Latin (Input, Output, Relational Operators, User-Defined Functions) – Working with Scripts – Introduction to Hive – Modules – Data Types – File Formats – HiveQL (Data Definition and Manipulation) – Views – Queries – Scripts – Indexes – Bucketing vs Partitioning

**UNIT IV SPARK FRAMEWORK AND PROGRAMMING 9**

Overview of Spark – Comparison of Hadoop vs Spark – Cluster Design and Management – Spark Context – Resilient Distributed Datasets (RDD) – RDD Operations – Lazy Evaluation – Spark Jobs – Writing Spark Applications – Programming in Scala – Python – R and Java – Application Execution

**UNIT V ADVANCED SPARK: SQL AND GRAPHX 9**

Spark SQL – SQL Context – Data Import / Export – Data Frames – Using SQL Queries – GraphX Overview – Creating Graphs – Graph Algorithms for Big Data Analysis – Real-world Applications of Spark SQL and GraphX

**Contact Periods:**

Lecture: 45 Periods    Tutorial:    – Periods    Practical: – Periods    Total: 45 Periods

**REFERENCES:**

1. Tanvir Habib Sardar and Bishwajeet Kumar Pandey, Big Data Computing: Advances in Technologies, Methodologies, and Applications, 2024.
2. Thomas Erl, WajidKhattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers & Techniques, Pearson India Education Service Pvt. Ltd., First Edition, 2016.
3. Zaigham Mahmood (Editor), Data Science and Big Data Computing: Frameworks and Methodologies, Springer, 2016.
4. Big Data Analytics: Theory, Techniques, Platforms, and Applications, 2023 Edition.
5. Technologies and Applications for Big Data Value, 2021 Edition.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Understand the need of new frame work to deal with huge amounts of Data.	Understand
CO2	Demonstrate the Hadoop framework Hadoop Distributed File System and MapReduce.	Apply
CO3	Demonstrate the Pig architecture and evaluation of pig scripts.	Apply
CO4	Describe the Hive architecture and execute SQL queries on sample data sets.	Apply
CO5	Demonstrate spark programming with different programming languages and graph algorithms.	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	–	–	–
CO2	3	1	1	–	–	–
CO3	3	2	1	–	–	–
CO4	3	2	1	–	–	–
CO5	3	2	1	–	–	–
CO	3	2	1	–	–	–

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER II

P23DS203	BIG DATA FRAMEWORKS AND APPLICATION LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

**COURSE OBJECTIVES:**

- To gain practical experience with Big Data frameworks and tools for processing, analyzing, and managing large datasets.
- To develop skills in building, deploying, and optimizing machine learning models in big data environments.

**List of Experiments:**

1. Set up a multi-node Hadoop cluster and perform advanced HDFS operations like distcp and snapshots.
2. Develop a MapReduce program for calculating word frequency, demonstrating the use of combiners and partitioners.
3. Implement a MapReduce program with Avro file format and evaluate its performance for structured data.
4. Set up Hive, create tables using partitioning and bucketing, and write HiveQL queries for data analysis.
5. Write Pig scripts to process large-scale log data, extract meaningful patterns, and store the results in HDFS.
6. Use Distributed Cache to perform a Map-side join for relational datasets and compare performance with Reduce-side join.
7. Build a Spark application to filter, group, and aggregate large-scale data using Data Frames.
8. Perform complex RDD transformations, including joins, cartesian products, and custom partitioning in Spark.
9. Create a real-time data streaming application using Spark Streaming to process live data from a socket or file source.
10. Use Spark SQL to query large-scale structured data, integrate it with a NoSQL database, and visualize the results.

**Contact Periods:**

Lecture: – Periods    Tutorial: – Periods    Practical: 60 Periods    Total: 60 Periods

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Analyze and optimize big data workflows using Hadoop, Spark, and related tools for processing large datasets.	Apply
CO2	Develop and implement data processing applications with MapReduce, Hive, and Spark for structured and real-time data.	Apply
CO3	Deploy machine learning models in production, focusing on handling real-time data streams.	Apply
CO4	Address challenges in data processing, such as data drift, using Spark and other big data tools.	Apply
CO5	Demonstrate how to integrate Big Data tools to solve real-world problems efficiently.	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2		2	3	–
CO2	3	3	2	2	3	–
CO3	3	2	1	1	–	–
CO4	3	3	1	2	–	–
CO5	3	3	2	2	3	–
CO	3	2	1	1	3	–

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## SEMESTER III

P23DS301	PROJECT WORK - PHASE I	Category: PCC			
		L	T	P	C
		0	0	12	6

**COURSE OBJECTIVES:**

- To develop the ability to identify and solve a specific problem in the field of Computer Engineering
- To train the students in preparing project reports and to face reviews and viva voce examination

**Contact Periods:**

Lecture: – Periods    Tutorial: – Periods    Practical: 90 Periods    Total: 90 Periods

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Formulate a real-world problem, specify the needs, and design potential solutions	Apply
CO2	Review relevant literature to acquire insights into contemporary concepts, approaches, and methodologies	Apply
CO3	Employ modern tools, algorithms, and techniques to derive project results	Apply
CO4	Test, validate, and compare the developed project with the standards and existing methodologies	Apply
CO5	Compile a report and deliver oral presentations to showcase the project's outcomes	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	1
CO2	3	3	3	3	3	1
CO3	3	2	3	3	3	1
CO4	3	3	3	3	3	1
CO5	3	3	3	3	3	1
CO	3	2	3	3	3	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

  
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## SEMESTER IV

P23DS401	PROJECT WORK - PHASE II	Category: PCC			
		L	T	P	C
		0	0	24	12

## COURSE OBJECTIVES:

- To develop the ability to identify and solve a specific problem in the field of Computer Engineering
- To train the students in preparing project reports and to face reviews and viva voce examination

## Contact Periods:

Lecture: – Periods	Tutorial: – Periods	Practical: 180 Periods	Total: 180 Periods
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## COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Formulate a real-world problem, specify the needs, and design potential solutions	Apply
CO2	Review relevant literature to acquire insights into contemporary concepts, approaches, and methodologies	Apply
CO3	Employ modern tools, algorithms, and techniques to derive project results	Apply
CO4	Test, validate, and compare the developed project with the standards and existing methodologies	Apply
CO5	Compile a report and deliver oral presentations to showcase the project's outcomes	Apply

## COURSE ARTICULATION MATRIX:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	1
CO2	3	3	3	3	3	1
CO3	3	2	3	3	3	1
CO4	3	3	3	3	3	1
CO5	3	3	3	3	3	1
CO	3	2	3	3	3	1

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

  
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## PROFESSIONAL ELECTIVE

P23DSP01	DATA PREPARATION AND ANALYSIS	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To prepare and preprocess diverse datasets using appropriate data gathering, cleaning, and transformation techniques
- To apply exploratory data analysis methods for identifying patterns, relationships, and generating hypotheses
- To develop meaningful and interactive data visualizations using modern tools and technologies

**UNIT I DATA GATHERING AND PREPARATION 9**

Data Formats – Structured – Semi-structured – Unstructured data (CSV, JSON, XML, SQL tables, log files) – Parsing and Transformation – Extracting raw data – Parsing techniques for text – web scraping – APIs–Data normalization – Aggregation – Feature extraction – Scalability & Real-Time Issues – Big data challenges (volume, velocity, variety) – Batch vs. real-time data processing (Hadoop, Spark, Kafka)

**UNIT II DATA CLEANING 9**

Consistency Checking – Removing duplicates – Fixing typos – Ensuring integrity – Heterogeneous & Missing Data–Handling multiple sources / formats – Missing values: deletion – Imputation – Interpolation – Data Transformation & Segmentation – Scaling – Encoding – Normalization – Splitting datasets (train/test, clusters, segments)

**UNIT III EXPLORATORY ANALYSIS 9**

Descriptive & Comparative Statistics – Mean – Median – Variance – Standard deviation – Correlations – Comparative measures: t-test – Chi-square – Clustering & Association – K-means – Hierarchical clustering – DBSCAN – Market basket analysis – Association rules (Apriori, FP-Growth) – Hypothesis Generation – Formulating testable assumptions – Statistical testing – Significance

**UNIT IV VISUALIZATION 9**

Designing Visualizations – Principles: clarity – Minimalism – Storytelling – Time Series – Trend – Seasonality – Forecasting plots – Geo located Data – Heat maps – Choropleth maps – GPS – based visualizations – Correlations & Connections – Scatter plots – Pair plots – Network graphs – Hierarchies & Networks – Tree maps – Dendrograms – Graph visualizations – Interactivity – Dashboards – Interactive plots

**UNIT V VISUALIZATIONS USING R OR PYTHON 9**

R Libraries – Ggplot2 – Plotly – Shiny – Python Libraries – Matplotlib – Sea born – Plotly – Bokeh – Dash – Case Studies – Real-world datasets – Building interactive dashboards

**Contact Periods:**

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total 45 Periods

**REFERENCES:**

1. Anil Maheshwari – Data Analytics Made Accessible, 2<sup>nd</sup> Edition, Kindle Direct Publishing, 2017.
2. Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar – Introduction to Data Mining, 2<sup>nd</sup> Edition, Pearson, 2019.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman – The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2<sup>nd</sup> Edition, Springer, 2017.

4. Alex Gutman, Jordan Goldmeier – Becoming a Data Head: How to Think, Speak, and Understand Data Science, Statistics, and Machine Learning, Wiley, 2021.
5. Glenn J. Myatt, "Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining", 2<sup>nd</sup> Edition, John Wiley Publishers, 2014.

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Analyze structures and unstructured datasets	Apply
CO2	Data cleaning and transformation methods to handle inconsistencies, missing values, and heterogeneous data sources	Apply
CO3	Statistical, clustering, and association techniques to explore datasets and generate testable hypotheses	Apply
CO4	Statistical, clustering, and association techniques to explore datasets and generate testable hypotheses	Apply
CO5	R and Python visualization libraries to build interactive dashboards and analyze real-world datasets	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	–
CO2	3	3	2	2	2	–
CO3	3	3	2	3	2	–
CO4	2	2	3	2	3	–
CO5	2	2	3	2	3	–
CO	3	2	2	2	3	–

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23DSP02	WEB ANALYTICS	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To understand the importance of qualitative data and apply appropriate techniques for gaining insights
- To develop a customer–centric approach in analyzing and interpreting data for decision–making
- To apply principles, tools, and methods of web intelligence and analytics in real–world business situations.

**UNIT I WEB ANALYTICS** 9

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

**UNIT II QUALITATIVE ANALYSIS** 9

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

**UNIT III WEB ANALYTIC CONCEPTS** 9

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

**UNIT IV SEARCH ENGINE ANALYTICS** 9

Search Engine Analytics – Analytics – Cookies – Accounts vs Property – Tracking Code – Tracking Unique Visitors – Demographics – Page Views & Bounce Rate Acquisitions – Custom Reporting

**UNIT V GOALS & FUNNELS** 9

Goals & Funnels – Filters – Ecommerce Tracking – Real Time Reports – Customer Data Alert – Ad Words Linking – Ad Sense Linking – Attribution Modelling – Segmentation – Campaign Tracking – Multi–Channel Attribution

**Contact Periods:**

Lecture: 45 Periods Tutorial: – Periods Practical: Periods Total 45 Periods

**REFERENCES:**

1. Avinash Kaushik, "Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity", 1<sup>st</sup> Edition, Sybex, 2009.
2. Michael Beasley, "Practical Web Analytics for User Experience: How Analytics can help you Understand your Users", 1<sup>st</sup> Edition, Morgan Kaufmann, 2013..
3. Magy Seif El–Nasr, Anders Drachen, Alessandro Canossa, "Game Analytics: Maximizing the Value of Player Data", 1<sup>st</sup> Edition, Springer, 2013.
4. Bing Liu, "Web Data Mining: Exploring Hyperlinks, Content, and Usage Data", 2<sup>nd</sup> Edition, Springer, 2011.
5. Justin Cutroni, "Google Analytics", 1<sup>st</sup> Edition, O'Reilly, 2010. Eric Fettman, Shiraz Asif, Feras Alhlou, "Google Analytics Breakthrough", John Wiley & sons, 2016.

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain traditional and modern web data collection methods such as clickstream, logs, beacons, and tags	Understand
CO2	Design and implement effective website surveys to gather customer-centric insights	Apply
CO3	Apply search analytics techniques (internal search, SEO, PPC) for improving website visibility and performance.	Apply
CO4	Develop custom reports to measure visitor acquisition, page engagement, and bounce	Apply
CO5	Apply e-commerce tracking and integration tools (Ad Words, Ad Sense, real-time reports to evaluate marketing effectiveness	Apply

**COURSE ARTICULATION MATRIX:**

POs \ COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	–	2	–
CO2	2	2	3	2	2	2
CO3	2	2	3	2	2	2
CO4	2	3	3	2	3	–
CO5	2	3	3	2	3	–
CO	3	2	–	–	2	–

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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## PROFESSIONAL ELECTIVE

P23CSP13	DEEP LEARNING	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To explain the basic concepts of neural networks and deep networks.
- To discuss the major architectures of deep networks.
- To demonstrate the applications of deep learning

**UNIT I BASICS OF NEURAL NETWORKS 9**

Neural Network Basics–Binary Classification, Logistic Regression, Gradient Descent, Derivatives, Computation graph, Vectorization, Training Neural Networks – Activation Functions – Loss Functions – Hyper parameters.

**UNIT II FUNDAMENTALS OF DEEP NETWORKS 9**

Defining Deep Learning – Common Architectural Principles of Deep Networks – Building Blocks of Deep Networks.

**UNIT III MAJOR ARCHITECTURES OF DEEP NETWORKS 9**

Unsupervised Pre-Trained Networks – Convolutional Neural Networks – Recurrent Neural Networks – Recursive Neural Networks – Tuning Deep Networks.

**UNIT IV TUNING SPECIFIC DEEP NETWORK ARCHITECTURES 9**

Convolution Neural Networks (CNNs)– Recurrent Neural Networks– Restricted Boltzmann Machines– DBNs.

**UNIT V APPLICATIONS 9**

Large–Scale deep learning – Computer Vision – Speech Recognition – Natural Language Processing– Recommender systems. Case Study– Applications of Deep Learning in Health care, Deep learning tools–TensorFlow, Keras, MatConvNet.

**Contact Periods:**

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

**REFERENCES:**

1. Adam Gibson, Josh Patterson, "Deep Learning, A Practitioner's Approach", O'Reilly Media, 2017.
2. Ian Goodfellow, YoshuaBengio and Aaron Courville, "Deep Learning", MIT Press, 2016.
3. Python Machine Learning by Example, Yuxi (Hayden) Liu, First Edition, 2017.
4. Daniel Graupe, "Deep Learning Neural Networks: Design and Case Studies", World Scientific Publishing, 2016.
5. Yu and Li Deng, "Deep Learning: Methods and Applications", Now Publishers Inc 2014.



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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Distinguish neural and deep networks	Understand
CO2	Select the appropriate deep network architecture.	Understand
CO3	Analyze the performance of a deep learning network.	Analyze
CO4	Apply deep learning for solving real world problems.	Apply
CO5	Develop new deep network models	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	–
CO2	3	3	2	2	3	–
CO3	3	3	3	3	3	–
CO4	3	3	3	3	3	–
CO5	3	3	3	3	3	–
CO	3	2	2	2	3	–

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23DSP03	SOFT COMPUTING	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES

- To understand the fundamental concepts of neural networks and fuzzy logic.
- To study neural network architectures, learning algorithms, fuzzy reasoning, and inference systems.
- To apply soft computing techniques for solving complex engineering and optimization problems.

## UNIT I INTRODUCTION TO SOFT COMPUTING AND ANN

9

Computational Intelligence: Definition and scope – Biological basis for neural networks – Artificial Neural Networks (ANN) – Biological basis of evolutionary computation – Behavioral motivations for fuzzy logic – Myths about computational intelligence – Evolutionary computation: Adoption, types, self-organization, and evolution – Historical views of computational intelligence – Computational intelligence vs Artificial Intelligence – Soft computing vs Hard computing

## UNIT II EVOLUTIONARY COMPUTATION

9

Evolutionary computation concepts and paradigms – History and overview of evolutionary computation – Genetic Algorithms: Principles and strategies – Genetic Programming – Particle Swarm Optimization – Evolutionary computation implementation issues – Genetic Algorithm implementation – Particle Swarm Optimization implementation

## UNIT III NEURAL NETWORK CONCEPTS AND PARADIGMS

9

Neural network components and terminology – Network topologies – Adaptation and comparison of neural networks – Other information processing methods – Stochastic and Kalman filters – Linear and nonlinear regression and correlation – Bayesian classification – Vector quantization – Radial Basis Functions (RBF): preprocessing and post-processing

## UNIT IV FUZZY SYSTEM

9

Fuzzy systems concepts and paradigms – Fuzzy sets and fuzzy logic – Approximate reasoning – Development of fuzzy controllers – Fuzzy rule-based system implementation

## UNIT V PERFORMANCE METRICS AND APPLICATIONS

9

General issues in soft computing – Pattern partitioning for training, testing, and validation (cross-validation) – Fitness and fitness functions – Parametric and non-parametric statistics – Evolutionary algorithm effectiveness metrics – Receiver Operating Characteristic (ROC) curves – Computational intelligence tools for explanation facilities – Case studies on practical applications of computational intelligence

## Contact Periods:

Lecture: 45 Periods      Tutorial: – Periods      Practical: – Periods      Total: 45 Periods

## REFERENCES:

1. Russell C. Eberhart and Yuhui Shi, "Computational Intelligence: Concepts to Implementations, Morgan Kaufmann Publishers (Elsevier)", 2007.
2. Andries P. Engelbrecht, "Computational Intelligence: An Introduction, 2nd Edition", Wiley, 2007.
3. John Fulcher and Lakhmi C. Jain, "Computational Intelligence: A Compendium", Springer, 2008.
4. David B. Fogel and Charles J. Robinson, "Computational Intelligence: The Experts Speak", Wiley-IEEE Press, 2004.

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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

Cos	Statements	K-Level
CO1	Demonstrate the principles of Soft Computing and Artificial Neural Network models.	Understand
CO2	Describe evolutionary computation concepts and paradigms.	Understand
CO3	Apply neural network concepts and architectures for problem-solving.	Apply
CO4	Apply fuzzy system concepts and paradigms in real-world applications.	Apply
CO5	Design solutions using genetic algorithms and compare them with traditional problem-solving approaches.	Apply

**COURSE ARTICULATION MATRIX:**

Cos \ Pos	Pos					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	–	2	2	–
CO2	3	3	–	2	2	–
CO3	3	3	–	2	2	–
CO4	3	3	–	2	2	–
CO5	3	3	–	2	2	–
CO	3	3	–	2	2	–
Correlation levels:      1: Slight (Low)                      2: Moderate (Medium)                      3: Substantial (High)						

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23DSP04	FUZZY LOGIC AND FUZZY SETS	Category: FC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES

- To understand the fundamentals of fuzzy sets and fuzzy logic.
- To analyse differences between classical and fuzzy approaches in handling uncertainty.
- To study fuzzy arithmetic, fuzzy operations and inference mechanisms.

**UNIT I FUZZY SETS AND UNCERTAINTY** 9

Introduction to fuzzy sets – Concept of uncertainty – Newtonian mechanics – Probability theory – Organized simplicity – Disorganized complexity – Trans computational problems

**UNIT II CRISP SETS AND REPRESENTATION OF FUZZY SETS** 9

Crisp sets: An overview – Fuzzy sets: Basic types and basic concepts – Fuzzy sets versus crisp sets – Alpha-cuts and properties – Representation of fuzzy sets

**UNIT III OPERATIONS ON FUZZY SETS** 9

Types of fuzzy set operations – Fuzzy complements – Fuzzy intersections (t-norms) – Fuzzy unions (t-conorms) – Combination of operations – Aggregation operations

**UNIT IV FUZZY LOGIC AND REASONING** 9

Classical logic – Propositional logic – Logical operations and formulas – Tautologies – Inference rules – Boolean algebra and its properties – Predicate logic – Multi-valued logic – Fuzzy propositions – Fuzzy quantifiers – Linguistic hedges

**UNIT V FUZZY INFERENCE AND MODELLING** 9

Inference from conditional fuzzy propositions – Inference from quantified propositions – Mamdani fuzzy model – Sugeno fuzzy model – Tsukamoto fuzzy model – Input space partitioning – Fuzzy modelling techniques

**Contact Periods:**

Lecture: 45 Periods      Tutorial: – Periods      Practical: – Periods      Total: 45 Periods

**REFERENCES:**

1. Li Min Fu, "Neural Networks in Computer Intelligence", 1st Edition, McGraw–Hill, 1994.
2. George J. Klir and Boyuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", 4th Edition, PHI Learning, 2015.
3. S.R. Jang, "C.T. Sun and E. Mizutani, "Neuro–Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", Pearson Education, 1996.
4. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley India, 2010.



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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

Cos	Statements	K-Level
CO1	Explain the concepts of fuzzy sets and uncertainty modelling	Understand
CO2	Differentiate between crisp sets and fuzzy sets with appropriate representations	Understand
CO3	Apply fuzzy set operations and aggregation techniques	Apply
CO4	Analyze fuzzy logic principles and reasoning mechanisms	Analyze
CO5	Design fuzzy inference systems using Mamdani, Sugeno and Tsukamoto models	Apply

**COURSE ARTICULATION MATRIX:**

Cos \ Pos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	–	2	2	–
CO2	3	3	–	2	2	–
CO3	3	3	–	2	2	–
CO4	3	3	–	2	2	–
CO5	3	3	–	2	2	–
CO	3	3	–	2	2	–
Correlation levels:      1: Slight (Low)                      2: Moderate (Medium)                      3: Substantial (High)						

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23DSP05	ADVANCED ALGORITHMS	Category: FC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES

- To analyse the asymptotic performance of algorithms.
- To synthesize efficient algorithms in common engineering design situations.
- Apply important algorithmic design paradigms and methods of analysis.

**UNIT I BASICS OF ALGORITHM ANALYSIS** 9

Computational Tractability – Asymptotic Order of Growth – Stable Matching Algorithm Using Lists and Arrays – Survey of Common Running Times – Priority Queues

**UNIT II GRAPHS AND GREEDY ALGORITHMS** 9

Graph Basics – Connectivity – Traversal – BFS – DFS – Greedy Strategy – Interval Scheduling – Optimal Caching – Minimum Spanning Tree – Kruskal's Algorithm – Union-Find – Clustering – Huffman Coding

**UNIT III DIVIDE AND CONQUER** 9

Merge Sort – Recurrences – Counting Inversions – Closest Pair of Points – Integer Multiplication – Dynamic Programming – Memoization – Subset Sum – Knapsack – Shortest Paths

**UNIT IV NETWORK FLOW** 9

Maximum Flow Problem – Ford-Fulkerson Algorithm – Maximum Flow and Minimum Cut – Augmenting Paths – Bipartite Matching – Disjoint Paths

**UNIT V NP AND COMPUTATIONAL INTRACTABILITY** 9

Polynomial-Time Reductions – Efficient Certification – Definition of NP – NP-Complete Problems – Sequencing Problems – Partitioning Problems – Graph Coloring – Co-NP – Asymmetry of NP

**Contact Periods:**

Lecture: 45 Periods      Tutorial: – Periods      Practical: – Periods      Total: 45 Periods

**REFERENCES:**

1. Jon Kleinberg and Éva Tardos, "Algorithm Design", Pearson Education Limited, 2014.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", MIT Press, 2009.
3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, Hyderabad, 2008.
4. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2008.



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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

Cos	Statements	K-Level
CO1	Analyze algorithms to determine correctness and computational complexity.	Apply
CO2	Evaluate time efficiency using asymptotic analysis and advanced data structures.	Understand
CO3	Apply various algorithm design techniques such as Divide and Conquer, Greedy, and Dynamic Programming.	Understand
CO4	Design and implement efficient algorithms to solve real-world computational problems.	Apply
CO5	Explain NP-Completeness and analyze tractability of computational problems.	Apply

**COURSE ARTICULATION MATRIX:**

Cos	Pos	PO1	PO2	PO3	PO4	PO5	PO6
	CO1		3	3	–	2	2
CO2		3	3	–	2	2	–
CO3		3	3	–	2	2	–
CO4		3	3	–	2	2	–
CO5		3	3	–	2	2	–
CO		3	3	–	2	2	–
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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## PROFESSIONAL ELECTIVE

P23DSP06	ARTIFICIAL INTELLIGENCE	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES

- To understand the fundamental principles and approaches of Artificial Intelligence.
- To explain the concepts of intelligent agents, search strategies, and knowledge representation.
- To apply inference, logic, and learning techniques in AI problem-solving.

**UNIT I INTRODUCTION TO AI AND PRODUCTION SYSTEMS 9**

Introduction to AI–Problem formulation, Problem Definition –Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics – Specialized production system– Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions –Hill Climbing–Depth first and Breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.

**UNIT II REPRESENTATION OF KNOWLEDGE 9**

Game playing–Knowledge representation, Knowledge representation using Predicate logic–Introduction to predicate calculus – Resolution–Use of predicate calculus, Knowledge representation using other logic–Structured representation of knowledge.

**UNIT III KNOWLEDGE INFERENCE 9**

Knowledge representation –Production based system– Frame based system– Inference – Backward chaining– Forward chaining– Rule value approach–Fuzzy reasoning – Certainty factors– Bayesian Theory–Bayesian Network–Dempster – Shafer theory.

**UNIT IV LEARNING 9**

Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication– perceiving and acting– Probabilistic language processing, perception.

**UNIT V AI IN ROBOTICS 9**

Robotic perception–localization–mapping– configuring space– planning uncertain movements– dynamics and control of movement– Ethics and risks of artificial intelligence in robotics.

**Contact Periods:**

Lecture: 45 Periods      Tutorial: – Periods      Practical: – Periods      Total: 45 Periods

**REFERENCES:**

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill 2008.
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007.
3. David Jefferis, "Artificial Intelligence: Robotics and Machine Evolution", Crabtree Publishing Company, 1999.
4. Peter Jackson, "Introduction to Expert Systems", 3 rd Edition, Pearson Education, 2007.
5. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2 nd Edition, Pearson Education 2007.
6. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

Cos	Statements	K-Level
CO1	Identify problems that are amenable to solution by AI methods.	Apply
CO2	Identify appropriate AI methods to solve a given problem.	Understand
CO3	Formalize a given problem in the language/framework of different AI methods.	Understand
CO4	Implement basic AI algorithms	Apply
CO5	Summarize the need for AI in Robotics	Apply

**COURSE ARTICULATION MATRIX:**

Cos \ Pos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	–	2	2	–
CO2	3	3	–	2	2	–
CO3	3	3	–	2	2	–
CO4	3	3	–	2	2	–
CO5	3	3	–	2	2	–
CO	3	3	–	2	2	–
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP01	INFORMATION RETRIEVAL TECHNIQUES	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- To understand the machine learning techniques for text classification and clustering
- To understand the various applications of information retrieval giving emphasis to multimedia IR, web search, and digital libraries

## UNIT I INTRODUCTION 9

Retrieval Process Architecture – Boolean Retrieval – Retrieval Evaluation – Open Source IR Systems – History of Web Search – Web Characteristics – The impact of the web on IR – IR Versus Web Search – Components of a Search engine

## UNIT II MODELING 9

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model – Term Weighing – Scoring and Ranking – Language Models – Set Theoretic Models – Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing

## UNIT III INDEXING 9

Static and Dynamic Inverted Indices – Index Construction and Index Compression – Searching – Sequential Searching and Pattern Matching – Query Operations – Query Languages – Query Processing – Relevance Feedback and Query Expansion – Automatic Local and Global Analysis Measuring Effectiveness and Efficiency

## UNIT IV CLASSIFICATION AND CLUSTERING 9

Text Classification and Naïve Bayes – Vector Space Classification – Support vector machines and Machine learning on documents – Flat Clustering – Hierarchical Clustering – Matrix decompositions and latent semantic indexing – Fusion and Meta learning

## UNIT V SEARCHING THE WEB 9

Searching the Web – Structure of the Web – IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis – XML Retrieval Multimedia IR – Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries

## Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

## REFERENCES:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, "Introduction to Information Retrieval", Cambridge University Press, First South Asian Edition, 2008
2. Implementing and Evaluating Search Engine', The MIT Press, Cambridge, Massachusetts London, England, 2010
3. Ricardo Baeza-Yates, Berthier Ribeiro – Neto, "Modern Information Retrieval: The concepts and Technology behind Search" (ACM Press Books), Second Edition, 2011
4. C. D. Manning, P. Raghavan, and H. Schütze, "An Introduction to Information Retrieval", Cambridge University Press, 2009
5. R. Baeza-Yates and B. Ribeiro-Neto "Modern Information Retrieval", Pearson Education, 1999

## COURSE OUTCOMES:

  
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Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Discuss the basic concepts and processes of information retrieval systems	Understand
CO2	Build an information retrieval system using the available tools	Apply
CO3	Make use of the common algorithms and techniques for document indexing, retrieval, and query processing	Analyze
CO4	Apply machine learning techniques to text classification and clustering which is used for efficient information retrieval	Apply
CO5	Apply ranking, crawling and indexing principles for web search	Apply

### COURSE ARTICULATION MATRIX:

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	2	-	-
CO2	3	1	2	3	3	-
CO3	3	-	2	3	3	-
CO4	3	-	3	3	3	-
CO5	3	-	2	3	3	-
CO	3	-	2	3	3	-

Correlation levels:  
 1: Slight (Low). 2: Moderate (Medium) 3: Substantial (High)



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## PROFESSIONAL ELECTIVE

P23CSP02	NOSQL DATABASE	Category: PEC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- Explore the origins of NoSQL databases and the characteristics that distinguish them from traditional relational database management systems
- Elucidate the architectures and common features of NoSQL databases (key-value stores, document databases, column-family stores, graph databases)
- Compare and contrast the criteria that decision makers should consider when choosing between relational and non-relational databases and techniques for selecting the NoSQL database that best addresses specific use cases

**UNIT I DATA MODELS AND DATA MANAGEMENT 9**

Data Management - Information Systems and Databases - SQL Databases - Big Data - NoSQL databases - Organisation of Data Management - Data Modeling - From Data Analysis to Database - The Entity Relationship Model - Implementation in the Relational model - Implementation in the Graph Model - Enterprise-Wide Data Architecture - Database design

**UNIT II NOSQL AND AGGREGATE DATA MODELS 9**

Reasons for NoSQL - The value of relational databases - Impedance mismatch - Application and Integration Databases - The emergence of NoSQL - Aggregate data models - Key-value and document data models - Column-family stores - Relationships - Graph databases - Schema-less databases - Materialised views - Modeling for data access.

**UNIT III KEY VALUE DATABASES 9**

Key-value store, key-value store features, use cases - session maintenance - user profile maintenance - shopping cart management - Understanding when not to use

**UNIT IV DOCUMENT DATABASES 9**

Document database features - consistency - transactions - availability - query features - scaling - use cases - event logging - content management systems, blogging platforms - web analytics - real time analytics - e-commerce applications - when not to use - complex transactions - varying aggregate structure

**UNIT V COLUMN FAMILY STORES AND GRAPH DATABASES 9**

Column family data store - features - consistency - transactions - availability - query features - scaling - use cases - event logging - content management systems - counters - expiring usage - graph databases - features of graph databases - use cases

**Contact Periods:**

Lecture: 45 Periods    Tutorial: – Periods    Practical: – Periods    Total: 45 Periods

**REFERENCES:**

1. Andreas Meier, Michael Kaufmann, "SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management", Springer vieweg, 1st ed. 2019
2. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Pearson Education 2012
3. Luc Perkins, Redmond, E. & Wilson, "Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement", A Kindle 2<sup>nd</sup> Edition, 2018
4. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addison Wesley, 2012
5. Adam Fowler, NoSQL for Dummies, For Dummies, 2015

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Illustrate data modeling and data management	Understand
CO2	Explain NoSQL and aggregate data models	Understand
CO3	Implement key value databases	Apply
CO4	Develop document databases	Apply
CO5	Develop column family stores and graph databases	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	3	-	-
CO2	3	3	-	3	-	-
CO3	3	-	2	2	2	-
CO4	3	-	2	2	2	-
CO5	3	-	2	2	1	-
CO	3	2	2	2	1	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)



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## PROFESSIONAL ELECTIVE

P23CSP04	VEHICULAR SYSTEMS	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To understand the need and fundamentals of vehicular networks
- To analyze how information is disseminated in Adhoc Routing networks
- Conceptualize autonomous driving technologies and evaluate the systems

## UNIT I INTRODUCTION

9

History - Overview of Vehicular Networks – Architecture, Applications. Overview of Enabling Technologies – 5G, Mobile Edge computing, Network virtualization, SDN, Computation offloading, Blockchain, Information centric Networks, edge caching, artificial intelligence

## UNIT II FUNDAMENTALS OF VEHICULAR COMMUNICATION

9

Physical Layer – MAC Layer – Message Sets – Decentralized congestion control – Multichannel operations, Coexistence and spectrum sharing – Forwarding in VANETs – GeoNetworking, Use of IPV6, Security and Privacy.

## UNIT III EVALUATION

9

Mobility models – Channel models – Simulation tools and techniques – Field operational tests and deployment plans.

## UNIT IV AUTONOMOUS DRIVING

9

Deep Learning based Autonomous Driving in Vehicular Networks – Overview, Architecture, Learning with Groups, Simulation.

## UNIT V FUTURE DIRECTIONS

9

Trading Mechanisms – Big Data – QoE Aware Services – IoT based Smart Transportation Systems – Resource Integration and Allocation- Intelligent Road side Infrastructure for Automated vehicle – Software defined networking for emergency traffic management in smart cities.

## Contact Periods:

Lecture: 45 Periods    Tutorial:    – Periods    Practical: – Periods    Total: 45 Periods

## REFERENCES:

1. Zhou Su, Yilong Hui, Tom H Luan, Qiaorong Liu, Rui Xing, "The Next Generation Vehicular Networks, Modeling, Algorithm and Applications", Springer 2021
2. Claudia Campolo, Antonella Molinaro, Riccardo Scopigno, "Vehicular ad hoc networks – Standards, Solutions and Research", Springer 2015
3. Anis Laouiti, Amir Qayyum, Mohammed Naufal, Mohammed Saad, "Vehicular Ad-hoc Networks for Smart Cities", Third International Workshop on Advances in Intelligent Systems and Computing, Springer, 2019
4. Mohammed Wafaa, "Advances in Vehicular ad-hoc networks – Developments and Challenges", Information Science Reference, Newyork, IGI Global, 2010
5. Stephen Olariu, Michele Weigle, "Vehicular Networks: From Theory to Practice", Chapman & Hall, 2017

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the need for vehicular networks	Analyze
CO2	Summarize the applications of vehicular systems in near future	Apply
CO3	Analyze the architecture and evaluate the performance of vehicular networks	Apply
CO4	Create Use cases to evaluate autonomous driving vehicles	Apply
CO5	Apply the concepts and techniques in multiple disciplines	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	-	-
CO2	3	2	2	2	-	-
CO3	2	1	1	2	-	-
CO4	3	2	2	2	3	-
CO5	3	2	2	2	3	-
CO	3	2	2	2	3	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP07	CYBER SECURITY PRACTICES	Category: PEC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To learn the core fundamentals of system and network security concepts
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and encryption Concepts

**UNIT I SYSTEM SECURITY 9**

Building a secure organization- A Cryptography primer- detecting system Intrusion- Preventing system Intrusion- Fault tolerance and Resilience in cloud computing environments- Security web applications, services and servers

**UNIT II NETWORK SECURITY 9**

Internet Security - Botnet Problem- Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security- Optical Network Security- Optical wireless Security

**UNIT III SECURITY MANAGEMENT 9**

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System - Intrusion and Detection and Prevention System

**UNIT IV CYBER SECURITY AND CRYPTOGRAPHY 9**

Cyber Forensics- Cyber Forensics and Incidence Response - Security e-Discovery - Network Forensics - Data Encryption- Satellite Encryption - Password based authenticated Key establishment Protocols

**UNIT V PRIVACY AND STORAGE SECURITY 9**

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials

**Contact Periods:**

Lecture: 45 Periods    Tutorial:    – Periods    Practical: – Periods    Total: 45 Periods

**REFERENCES:**

1. John R.Vacca, "Computer and Information Security Handbook", Second Edition, Elsevier, 2013
2. Michael E. Whitman, Herbert J. Mattord, "Principal of Information Security", Fourth Edition, Cengage Learning, 2012
3. Richard E.Smith, "Elementary Information Security", Second Edition, Jones and Bartlett Learning, 2016

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain fundamentals of system security	Understand
CO2	Apply the network security concepts related to networks in wired and wireless scenario	Apply
CO3	Implement the security essentials in IT sector	Apply
CO4	Explain the concepts of cyber security and encryption	Understand
CO5	Implement privacy and security measures for storage	Apply

**COURSE ARTICULATION MATRIX:**

POs \ COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	3	-	-
CO2	3	-	3	3	2	-
CO3	3	-	3	3	3	-
CO4	3	-	2	3	-	-
CO5	3	-	3	3	2	-
CO	3	-	2	3	2	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP08	DIGITAL IMAGE PROCESSING AND COMPUTER VISION	Category: PEC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To understand the basic principles of digital image processing techniques for computer vision
- To understand image processing theory for developing applications involving image processing
- To apply a variety of computer vision techniques for real- world applications

**UNIT I INTRODUCTION 9**

Motivation & Perspective, Applications, Components of Image Processing System, Steps in Image Processing, Image Sampling and Quantization, Some relationships like Neighbours, Connectivity, Distance Measures between pixels.

**UNIT II IMAGE ENHANCEMENT 9**

Point processing, Neighborhood processing, Basic Gray Level Transformations, Histogram Processing, Enhancement using arithmetic and logic operations, Zooming, Spatial Filters, Smoothing and Sharpening, Combining Spatial Enhancement Methods.  
Fourier Transform Frequency Domain, Smoothing and Sharpening, Frequency Domain Filters.

**UNIT III IMAGE RESTORATION AND IMAGE COMPRESSION 9**

Image Degradation / Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position-Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Geometric Mean Filter, Geometric Transformations

Data Redundancies, Image Compression models, Elements of Information Theory, Lossless and Lossy compression, Huffman Coding, Run Length Coding, Loss less predictive Coding, Bit Plane Coding, Image compression standards.

**UNIT IV IMAGE AND MORPHOLOGICAL IMAGE PROCESSING 9**

Discontinuity based segmentation, similarity based segmentation, Edge linking and boundary detection, Threshold, Region based Segmentation Introduction to Morphology, Dilation, Erosion, Basic Morphological Algorithms.

**UNIT V OBJECT REPRESENTATION AND COMPUTER VISION TECHNIQUES 9**

Morphology, Morphological Algorithms, Representation, Boundary Descriptors, Regional Descriptors, Chain Code, Structural Methods, Computer Vision applications; Fuzzy-Neural algorithms for computer vision applications.

**Contact Periods:**

Lecture: 45 Periods    Tutorial:    – Periods    Practical: – Periods    Total: 45 Periods

**REFERENCES:**

1. Rafael C. Gonzalez & Richard E. Woods, "Digital Image Processing", 2nd Edition, Pearson Education. 2008, New Delhis
2. David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", Prentice Hall, 2012
3. A.K. Jain, "Fundamental of Digital Image Processing", PHI, 2006
4. Simon J.D. Prince, "Computer Vision: Models, Learning and Interface", Cambridge University Press, 2012



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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the principles of image processing and computer vision	Understand
CO2	Demonstrate the use of image enhancement in the spatial and frequency domain	Apply
CO3	Apply various image restoration and compression techniques	Apply
CO4	Analyze various segmentation and morphological image processing techniques	Analyze
CO5	Demonstrate the representation of objects in computer vision	Analyze

**COURSE ARTICULATION MATRIX:**

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	2	1	-
CO2	3	-	2	2	2	-
CO3	3	-	2	2	2	-
CO4	3	-	2	2	2	-
CO5	3	-	-	2	2	-
CO	3	-	2	2	2	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP11	APPLIED NATURAL LANGUAGE PROCESSING	Category: PEC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To acquire knowledge in language models and semantics
- To understand the role of grammars and parsing in NLP
- To learn the concept of Lexicons, Coreference and Coherence

**UNIT I TEXT NORMALIZATION AND N-GRAM LANGUAGE MODELS 9**

Regular Expressions – Words – Corpora – Text Normalization – Minimum Edit Distance – N-Grams – Evaluating Language Models – Generalization and Zeros – Smoothing –Kneser-Ney Smoothing – Huge Language Models and Stupid Backoff – Perplexity's Relation to Entropy

**UNIT II SEMANTICS AND SEQUENCE LABELING FOR PARTS OF SPEECH 9**

Lexical Semantics – Vector Semantics – Words and Vectors – TF-IDF: Weighing terms in the vector –Pointwise Mutual Information (PMI) – Applications of the TF-IDF or PPMI vector models – Word2vec – English Word Classes – Part-of-Speech Tagging – Named Entities and Named Entity Tagging – HMM Part-of-Speech Tagging – Conditional Random Fields –Evaluation of Named Entity Recognition

**UNIT III CONSTITUENCY GRAMMARS AND PARSING 9**

Constituency – Grammar Rules for English – Treebanks– Grammar Equivalence and Normal Form – Lexicalized Grammars – Ambiguity – CKY Parsing: Dynamic Programming Approach – Span-Based Neural Constituency Parsing – Evaluating Parsers – Partial Parsing – CCG Parsing

**UNIT IV LOGICAL REPRESENTATIONS AND INFORMATION EXTRACTION 9**

Computational Desiderata for Representations – Model-Theoretic Semantics – First-Order Logic – Event and State Representations – Relation Extraction – Algorithms – Extracting Times – Extracting Events and their Times – Template Filling

**UNIT V LEXICONS, COREFERENCE RESOLUTION AND COHERENCE 9**

Emotion – Creating Affect Lexicons by Human Labeling– Semi-supervised Induction of Affect Lexicons – Supervised Learning of Word Sentiment –Coreference Tasks and Datasets – Architectures for Coreference Algorithms – Evaluation of Coreference Resolution – Coherence Relations – Discourse Structure Parsing – Global Coherence

**Contact Periods:**

Lecture 45 Periods    Tutorial: – Periods    Practical: – Periods    Total: 45 Periods

**REFERENCES:**

1. Daniel Jurafsky, James H. Martin Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2020.
2. Breck Baldwin, Language Processing with Java and Ling Pipe Cookbook, Atlantic Publisher, 2015.
3. Richard M Reese, Natural Language Processing with Java, O'Reilly Media, 2015
4. NitinIndurkha and Fred J. Damerau, Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010
5. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, First Edition, O'Reilly Media, 2009

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the concept of text normalizations and language models	Understand
CO2	Apply the semantics and sequence labeling	Apply
CO3	Implement the constituency grammars and parsing in NLP	Apply
CO4	Analyze the logical representation and information extraction	Analyze
CO5	Interpret the concept of Lexicons, Coreference	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	1	2	3	-
CO2	1	-	1	2	3	-
CO3	1	-	1	2	3	-
CO4	1	-	1	2	3	-
CO5	1	-	1	2	3	-
CO	1	-	1	2	3	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP12	BIO-INSPIRED COMPUTING	Category: PEC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To learn bio-inspired theorem, algorithms and techniques
- To understand random walk and simulated annealing and genetic algorithms
- To learn swarm optimization and ant colony for feature selection

**UNIT I INTRODUCTION 9**

Introduction to algorithm – Newton 's method – optimization algorithm – Search for Optimality - No-Free-Lunch Theorems – Nature-Inspired Metaheuristics – Analysis of Algorithms – Nature Inspired Algorithms – Parameter tuning and parameter control

**UNIT II RANDOM WALK AND SIMULATED ANNEALING 9**

Random variables –Isotropic random walks – Levy distribution and flights – Optimization as Markov chains – step sizes and search efficiency – Modality and intermittent search strategy –importance of randomization– Eagle strategy–Annealing and Boltzmann Distribution –parameters –SA algorithm – Unconstrained Optimization –Basic Convergence Properties – SA Behavior in Practice - Stochastic Tunneling

**UNIT III GENETIC ALGORITHM AND DIFFERENTIAL EVOLUTION 9**

Introduction to genetic algorithms – role of genetic operators – choice of parameters – GA variants – schema theorem – convergence analysis – introduction to differential evolution – Variants –choice of parameters – convergence analysis –implementation

**UNIT IV PARTICLE SWARM OPTIMIZATION AND FIREFLY ALGORITHM 9**

Swarm intelligence –PSO algorithm – accelerated PSO –implementation – convergence analysis – binary PSO –The Firefly algorithm – algorithm analysis – implementation –variants– Ant colony optimization toward feature selection. – Applications

**UNIT V APPLICATION IN IMAGE PROCESSING 9**

Bio-Inspired Computation and its Applications in Image Processing: An Overview – Fine– Tuning Enhanced Probabilistic Neural Networks Using Meta-heuristic-driven Optimization – Fine-Tuning Deep Belief Networks using Cuckoo Search

**Contact Periods:**

Lecture: 45 Tutorial – Periods Practical: – Periods Total: 45 Periods

**REFERENCES:**

1. Xin-She Yang, "Nature Inspired Optimization Algorithm,Elsevier First Edition 2014
2. Yang ,Cui,Xiao,Gandomi,Karamanoglu ,"Swarm Intelligence and Bio-Inspired Computing", Elsevier First Edition 2013
3. Eiben A.E.,Smith,James E, "Introduction to Evolutionary Computing", Springer 2015.
4. Helio J.C. Barbosa, "Ant Colony Optimization - Techniques and Applications", Intech 2013
5. Xin-She Yang ,Jaao Paulo papa, "Bio-Inspired Computing and Applications in Image Processing"Elsevier, 2016

**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Elucidate the foundations bio-inspired algorithms	Understand
CO2	Explain random walk and simulated annealing	Understand
CO3	Implement genetic algorithms	Apply
CO4	Explain swarm intelligence and ant colony and optimize different evolution for feature selection	Understand
CO5	Apply bio-inspired techniques for image processing	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	-	-
CO2	3	-	2	-	-	-
CO3	3	-	3	-	3	-
CO4	3	-	2	-	-	-
CO5	3	-	3	2	3	-
CO	3	-	2	-	3	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP15	CLOUD COMPUTING TECHNOLOGIES	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To understand the concepts of virtualization and virtual machines
- To gain knowledge on the concept of virtualization fundamental to cloud computing
- To understand the security issues in grid and the cloud

## UNIT I VIRTUALIZATION 9

Virtual Machines –Process Virtual Machines – System Virtual Machines – Emulation –Interpretation – Binary Translation – Taxonomy of Virtual Machines. Virtualization – Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization

## UNIT II VIRTUALIZATION INFRASTRUCTURE 9

Comprehensive Analysis – Resource Pool – Testing Environment – Server Virtualization – Virtual Workloads – Provision Virtual Machines – Desktop Virtualization – Application Virtualization – Implementation levels of virtualization – Virtualization structure – Virtualization of CPU, Memory and I/O devices – Virtual Clusters and Resource Management – Virtualization for data center automation

## UNIT III CLOUD PLATFORM ARCHITECTURE 9

Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Infrastructure, platform, software –Cloud Architecture Design – Layered cloud Architectural Development – Virtualization Support and Disaster Recovery – Architectural Design Challenges – Public Cloud Platforms : GAE,AWS

## UNIT IV PROGRAMMING MODEL 9

Hadoop Framework – Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job – Developing Map Reduce Applications – Design of Hadoop file system – Setting up Hadoop Cluster

## UNIT V CLOUD SECURITY 9

Cloud Infrastructure security: network, host and application level – aspects of data security, provider data and its security, Identity and access management architecture, IAM practices in the cloud, SaaS, PaaS, IaaS availability in the cloud –privacy issues in the cloud – Cloud Security and Trust Management

## Contact Periods:

Lecture: 45Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

## REFERENCES:

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012
2. Danielle Ruest, Nelson Ruest, Virtualization: A Beginner's Guidell, McGraw-Hill Osborne Media, 2009
3. Jim Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005
4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009
5. Tim Mather, SubraKumaraswamy, and ShahedLatif , "Cloud Security and Privacy", O'Reilly Media, Inc.,2009

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Employ the concepts of storage virtualization, network virtualization and its management	Apply
CO2	Apply the concept of virtualization in the cloud computing	Apply
CO3	Explain the architecture, infrastructure and delivery models of cloud computing	Understand
CO4	Develop services using cloud computing	Apply
CO5	Apply the security models in the cloud environment	Understand

**COURSE ARTICULATION MATRIX:**

POs \ COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	-	2	-	-
CO2	3	-	-	2	2	-
CO3	3	1	-	3	-	-
CO4	3	-	-	2	3	-
CO5	3	-	3	2	2	-
CO	3	1	2	2	2	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP16	BLOCK CHAIN TECHNOLOGIES	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To understand the basic concepts of block chain technology.
- To familiarize bit coin and crypto currency principles.
- To explore distributed consensus of block chain technology.

**UNIT I BLOCKCHAIN FUNDAMENTALS 9**

Blockchain– Public Ledgers, Blockchain as Public Ledgers –Bitcoin, Blockchain 2.0, Smart Contracts, Block in a Blockchain, Transactions – Distributed Consensus, The Chain and the Longest Chain – Cryptocurrency to Blockchain 2.0 – Permissioned Model of Blockchain, Cryptographic Hash Function, Properties of a hash function–Hash pointer and Merkle tree.

**UNIT II BITCOIN AND CRYPTOCURRENCY 9**

Crypto currency, Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.

**UNIT III BITCOIN CONSENSUS 9**

Bitcoin Consensus, Proof of Work (PoW) – HashcashPoW , BitcoinPoW, Attacks on PoW ,monopoly problem – Proof of Stake – Proof of Burn–Proof of Elapsed Time – Bitcoin Miner, Mining Difficulty, Mining Pool–Permissioned model and use cases.

**UNIT IV DISTRIBUTED CONSENSUS 9**

RAFT Consensus – Byzantine general problem, Byzantine fault tolerant system–Agreement Protocol, Lamport – Shostak – Pease BFT Algorithm – BFT over Asynchronous systems, Practical Byzantine Fault Tolerance.

**UNIT V HYPER LEDGER FABRIC & ETHERUM 9**

Blockchain Hyperledger – Architecture of Hyperledger fabric v1.1 –, chain code – Ethereum: Ethereum network, EVM, Transaction fee, Mist Browser, Ether, Gas, Solidity, Smart contracts, Truffle Design and issue Crypto currency, Mining, DApps, DAO.

**Contact Periods:**

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

**REFERENCES:**

1. EladElrom; The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects, Apress, 1st Edition, 2019
2. Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, 2017.

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the public ledger and blocks in block chain	Understand
CO2	Distinguish the concepts of bitcoin and cryptocurrency	Understand
CO3	Classify the bitcoin consensus	Understand
CO4	Identify and understand the distributed consensus of blockchain	Understand
CO5	Implement the hyper ledger fabric and ethereum network framework	Apply

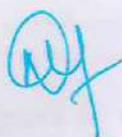
**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	2	-	-
CO2	3	1	1	2	-	-
CO3	3	2	2	-	-	-
CO4	3	3	2	-	-	-
CO5	3	3	3	-	-	-
CO	3	1	2	-	-	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP18	INTERNET OF THINGS	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To understand the fundamentals of Internet of Things and its protocols
- To learn the data analytics and cloud in the context of IoT
- To apply the concept of Internet of Things in the real-world scenario

**UNIT I FUNDAMENTALS OF IoT** 9

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

**UNIT II IoT PROTOCOLS** 9

Protocol Standardization for IoT–Efforts–M2M and WSN Protocols–SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol Modbus –Zigbee Architecture - Network layer – 6LowPAN – CoAP– Security

**UNIT III DESIGN AND DEVELOPMENT** 9

Design Methodology – Embedded computing logic – Microcontroller, System on Chips – IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming.

**UNIT IV DATA ANALYTICS AND SUPPORTING SERVICES** 9

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

**UNIT V CASE STUDIES/INDUSTRIAL APPLICATIONS** 9

Cisco IoT system – IBM Watson IoT platform – Manufacturing – Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model – Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

**Contact Periods:**

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

**REFERENCES:**

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, —IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2. Arshdeep Bahga, Vijay Madiseti, —Internet of Things – A hands-on approach, Universities Press, 2015
3. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012 (for Unit 2)
4. Jan Ho" Iler, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014
5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011



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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Illustrate the fundamentals of IoT design methodology	Understand
CO2	Analyze the various types of protocols in IoT	Analyze
CO3	Design a portable IoT application using Raspberry Pi	Apply
CO4	Apply the data analytics concepts for IoT	Apply
CO5	Apply the concepts of IoT for a real-world scenario	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	3	-	-
CO2	3	-	3	2	1	-
CO3	3	2	3	3	3	-
CO4	3	-	2	3	3	-
CO5	3	-	2	3	3	-
CO	3	2	2	3	3	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

  
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## PROFESSIONAL ELECTIVE

P23CSP19	ROBOTICS	Category: PEC			
		L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:**

- To understand the basic knowledge of mobile robots
- To understand perception in case of robots
- To solve the problems of SLAM and understand mobile robot path planning

**UNIT I INTRODUCTION** 9

Introduction to robots, various components of robot, applications of robots, classification of robots, mobile robot actuators, advantages and disadvantages of robots. Types of mobile robot locomotion in robots, legged mobile robots, wheeled mobile robots

**UNIT II ROBOT FUNDAMENTALS** 9

Elements of Robots-Joints, Links, Actuators, and Sensors - Classification of end effectors-tools as end effectors-drive system for grippers, mobile robot kinematics: kinematic models and constraints, mobile robot maneuverability, mobile robot work space, motion control

**UNIT III PERCEPTION** 9

Mobile robot perception, sensors for mobile robots, representing uncertainty, feature extraction, Mobile robot mapping, sonar sensor model, laser sensor mapping, fundamentals of vision sensor

**UNIT IV VISION SYSTEM** 9

Robotic vision systems-image representation-object recognition-and categorization-depth measurement- image data compression-visual inspection-software considerations

**UNIT V PLANNING AND NAVIGATION** 9

Introduction, path planning-overview-road map path planning-cell decomposition path planning-potential field path planning-obstacle avoidance-case studies. Applications - Ariel robots-collision avoidance robots for agriculture-mining-exploration-underwater-civilian- and military applications-nuclear applications-space applications-Industrial robots-artificial intelligence in robots

**Contact Periods:**

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

**REFERENCES:**

1. Richard D.Klafter.Thomas Achmielewski and Mickael Negin, "Robotic Engineering an Integrated approach", Prentice hall of India, Newdelhi-2001
2. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, "Robotics – Modelling Planning and Control", Springer, 2009
3. Saeed B.Nikku, Introduction to Robotics, analysis, control and applications Wiley-India 2nd edition-2011
4. Tsunco Yoshikawa, "Foundations of Robotics, Analysis and Control", prentice Hall of India, 2001
5. Craig J J, "Introduction to Robotics: Mechanics and Control", 2nd Edition, Boston, Addison – Wesley, 2004

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Explain the basic concepts of working of robot	Understand
CO2	Understand the function of sensor in robot and design the robotic arm with various tools	Apply
CO3	Understand perception in case of robots	Understand
CO4	Explain the working of vision system	Understand
CO5	Understand mobile robot path planning	Understand

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	-	-	-
CO2	3	-	2	-	2	-
CO3	3	-	2	-	-	-
CO4	3	-	2	-	-	-
CO5	3	-	2	-	-	-
CO	3	-	2	-	-	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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## PROFESSIONAL ELECTIVE

P23CSP20	COGNITIVE SCIENCE	Category: PEC			
		L	T	P	C
		3	0	0	3

## COURSE OBJECTIVES:

- To learn the basics of Cognitive Science with focus on acquisition, representation and use of knowledge by individual minds, brains, and machines.
- To gain the role of neuro-science in the cognitive field.
- To learn about computational models for semantic processing.

**UNIT I INTRODUCTION 9**

The Cognitive view –Some Fundamental Concepts – Computers in Cognitive Science –The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation - The Nature of Artificial Intelligence - Knowledge Representation – Artificial Intelligence: Search, Control, and Learning

**UNIT II COGNITIVE NEUROSCIENCE 9**

Brain and Cognition Introduction to the Study of the Nervous System – Neural Representation – Neuropsychology- Computational Neuroscience - The Organization of the mind - Organization of Cognitive systems - Strategies for Brain mapping – A Case study: Exploring mindreading

**UNIT III LANGUAGE ACQUISITION, SEMANTICS AND PROCESSING MODELS 9**

Milestones in Acquisition – Theoretical Perspectives- Semantics and Cognitive Science – Meaning and Entailment – Reference – Sense – Cognitive and Computational Models of Semantic Processing – Information Processing Models of the Mind- Neural networks and distributed information processing- Neural network models of Cognitive Processes

**UNIT IV HIGHER-LEVEL COGNITION 9**

Reasoning – Decision Making – Computer Science and AI: Foundations & Robotics – New Horizons - Dynamical Systems and Situated Cognition- Challenges – Emotions and Consciousness – Physical and Social Environments

**UNIT V APPLICATIONS 9**

Models of Language Learning – Object Perception and folk physics – Machine Learning to Deep Learning – Cognitive science of Consciousness – Looking Ahead: Challenges and Opportunities.

**Contact Periods:**

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

**REFERENCES:**

1. José Luis Bermúdez, "Cognitive Science: An Introduction to the Science of the Mind", Third Edition, Cambridge University Press, New York, 2020
2. Neil Stillings, Steven E. Weisler, Christopher H. Chase and Mark H. Feinstein, Jay L. Garfield and Edwin L. Rissland, "Cognitive Science: An Introduction", Second Edition, MIT Press, 1995
3. Robert L. Solso, Otto H. MacLin and M. Kimberly MacLin, "Cognitive Psychology, Pearson Education, 2007.
4. J. Friedenberg and G. Silverman, "Cognitive Science: An Introduction to the Study of Mind", 2011.
5. Steven Pinker, "How the mind works", W. W. Norton & Company; Reissue edition, 2009.

  
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**COURSE OUTCOMES:**

Upon completion of the course, the student will be able to

COs	Statements	K-Level
CO1	Analyze the methods of knowledge representation in cognitive processing	Analyze
CO2	Design cognitive architectures	Apply
CO3	Explain the connection between brain and cognition	Apply
CO4	Apply neural network models to cognition	Apply
CO5	Apply reasoning & decision making to design dynamic systems	Apply

**COURSE ARTICULATION MATRIX:**

POs COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	-	-
CO2	3	2	2	2	-	-
CO3	2	1	1	2	-	-
CO4	3	2	2	2	3	-
CO5	3	2	2	2	3	-
CO	3	2	2	2	3	-

Correlation levels:

1: Slight (Low) 2: Moderate (Medium). 3: Substantial (High)

\*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.



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