w.e.f. 2024-25

SU-24

M.TECH
in
Artificial Intelligence and DataScience

Scheme of Instructions and Syllabus

SU-24

(w.e.f. 2024–2025)

Department of Information Technology
(M.Tech Programme)

SIDDHARTHA
ACADEMY OF HIGHER EDUCATION
An Institution DEEMED TO BE UNIVERSITY
(Under Section 3 of UGC Act, 1956)
(Sponsored by Siddhartha Academy of General & Technical Education), Vijayawada, A.P.

M.TECH ARTIFICIAL INTELLIGENCE AND DATASCIENCE

Curriculum Structure SU-24

SEMESTER I **Contact Hours: 26**

S.No	Course Type	Course Code	Title/Type of the Course	L	T	P	C
1	Programme Core - I	24ITDS501	Mathematical Foundations for Data Science	3	0	0	3
2	Programme Core - II	24ITDS502	Advanced Data Structures and Algorithms	3	0	0	3
3	Programme Core - III	24ITDS503	Machine Learning	2	0	2	3
4	Programme Elective - I	24ITDS504	A.Data Visualization and Interpretation	3	0	0	3
			B.Augment Reality and Virtual Reality	3	0	0	3
			C.Enterprise cloud Concepts	3	0	0	3
5	Programme Elective - II	24ITDS505	A.Artificial Intelligence Essentials and Applications	3	0	0	3
			B.Business Intelligence &Analytics	3	0	0	3
			C.Data Science Applications for NLP	3	0	0	3
6	Mandatory Learning Courses	24UC501	Research Methodology and IPR	2	0	0	0
7	Laboratory - I	24ITDS581	Mathematical Foundations for Data Science Lab	0	0	3	1.5
8	Laboratory - II	24ITDS582	Advanced Data Structures and Algorithms Lab	0	0	3	1.5
9	Project	24ITDS591	Capstone Project 1	0	0	2	1
		Total		16	0	10	19

SEMESTER II **Contact Hours: 28**

S.No	Course Type	Course Code	Title/Type of the Course	L	T	P	C
1	Programme Core–IV	24ITDS506	Scalable Systems for Data Science	3	0	0	3
2	Programme Core – V	24ITDS507	Big Data Frameworks	3	0	0	3
3	Programme Core – VI	24ITDS508	Deep Learning	2	0	2	3
4	Programme Elective – III	24ITDS509	A.Computer Vision and Robotics	3	0	0	3
			B.Spatio-Temporal Data Analytics	3	0	0	3
			C.Big Data Security	3	0	0	3
5	Programme Elective – IV	24ITDS510	A.Web and Social Media Analytics	3	0	0	3
			B.AI and ML Techniques for Cyber Security	3	0	0	3
			C.Conversational AI	3	0	0	3
6	Audit Course	24MTUC502	Technical Report Writing	2	0	0	-
7	Laboratory - I	24ITDS583	Big Data Frameworks Lab	0	0	3	1.5
8	Laboratory - II	24ITDS584	A.Computer Vision and Robotics Lab	0	0	3	1.5
			B.Spatio-Temporal Data Analytics Lab				
			C.Big Data Security Lab				
9	Term Paper	24ITDS592	Term Paper[2]	0	0	2	1
10	Project	24ITDS593	Capstone Project 2	0	0	2	1
Total				18	0	10	20

Semester III **Contact Hours:27**

S.No	Course Type	Course Code	Title/Type of the Course	L	T	P	C
1	Programme Elective - V	24ITDS601	MOOCS Course	3	0	0	3
2	Internship	24ITDS681	Internship/Summer Training in Research Organizations/ Institutions of Higher Learning (After II Sem)	0	0	4	2
3	Project (Part-A)	24ITDS682	Dissertation/ Industrial Project	0	0	20	10
Total				3	0	24	15

Semester IV **Contact Hours:32**

S.No	Course Type	Course Code	Title/Type of the Course	L	T	P	C
1	Project (Part-B)	24ITDS683	Dissertation/ Industrial Project	0	0	32	16
Total				0	0	32	16

Semester	Credits
1	19
2	20
3	15
4	16
Total	70

L – Lecture, T – Tutorial, P – Practical, C – Credits

SEMESTER -I

24ITDS501- MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE

Course Category:	Program Core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:		**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Apply the basic concepts of linear algebra to singular value decomposition
	CO2	Calculate probabilities for continuous probability distributions
	CO3	Predict the joint probabilities for two random variables
	CO4	Explain the methods of point estimation of parameters and Test the significance of regression analysis
	CO5	Analyze residuals to determine whether the regression model is an adequate fit to the data

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	1			2	1
	CO2	2			2	1
	CO3	2			2	1
	CO4	2			2	1
	CO5	2			2	1

UNIT-I: Linear Algebra **10 hrs**

Solving linear equations: Vectors and linear equations, Elimination Using Matrices, Rules of Matrix operations, Inverse Matrices, Elimination=Factorization: A=LU, Vector Spaces and Subspaces: Spaces of Vectors, The Null space of A: Solving Ax=0 and Rx=0, The complete solution to Ax=b, Independence, Basis and Dimensions, Eigenvalues and Eigenvectors, the Singular value Decomposition
(2 by2 matrices only)

UNIT II: Continuous Random variable and Probability Distributions **9 hrs**

Probability Distributions and Probability Density Functions, Cumulative Distribution Functions, Mean and Variance of a Continuous Random Variable, Continuous Uniform Distribution, Normal Distribution, Normal Approximation to the Binomial and Poisson Distributions

UNIT III: Joint Probability Distributions **9 hrs**

Joint Probability Distributions for Two Random Variables, Conditional Probability Distributions and Independence, Covariance and Correlation, Common Joint Distributions: Multinomial Probability Distribution, Bivariate Normal Distribution, Linear Functions of Random Variables, Moment-Generating Functions

UNIT IV
Statistical Inferences and Regression Analysis **9 hrs**

Point estimation of Parameters: Point Estimation, Methods of point estimation: Method of Moments-Method of Maximum Likelihood, Hypothesis Testing, Empirical Models, Simple Linear Regression, Properties of the Least Squares Estimators, Hypothesis Tests in Simple Linear Regression: Use of t-Tests, Analysis of Variance Approach to Test Significance of Regression

UNIT V: **8hrs**

Confidence Intervals: Confidence Intervals on the Slope and Intercept, Confidence Interval on the Mean Response, Prediction of New Observations, Adequacy of the RegressionModel:Residual Analysis, Coefficient of Determination(R^2),Correlation, Regression on Transformed Variables, Logistic Regression

Text Book(s):

[1]. Gilbert Strang, Introduction to Linear Algebra (5^{th} Edition),2016, Wellesley-Cambridge Press

[2]. Douglus C. Montgometry, George C. Runger, Applied Statistics and Probability for Engineers (Seventh Edition) ,2018, John Wiley & Sons, Inc

Reference Book(s):

[1]. Kishor S. Trivedi, Probability and Statistics with Reliability,Queuing, and Computer Science Applications, John Wiley &Sons, 2016

[2]. M.Mitzenmacher and E. Upfal,Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge, 2005

[1]. Maggie Myers, Robert van de Geijn, (24.06.2019).Linear Algebra - Foundations to Frontiers,UTAustinX, https://www.edx.org/course/linear-algebra-foundations-to-frontiers-0

24ITDS502– ADVANCED DATA STRUCTURES AND ALGORITHMS

Course Category:	Program Core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	Any Programming Language	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Illustrate different operations of various data structures such as binary trees, binary search trees, AVL Trees, Red-Black Trees, B-trees, Heap trees and Graphs.
	CO2	Identifythe given problems as belonging to P, NP, NP-Hard, or NP-Complete.
	CO3	Analyze the time and space complexity of advanced algorithms using Big O, Big Omega, and Big Theta notations
	CO4	Apply advanced algorithmic techniques such as Divide and Conquer, dynamic programming, greedy algorithms, Backtracking and Branch & Bound Technique to solve complex problems
	CO5	Synthesize design techniques and choose appropriate technique to solve problems.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	1		1	2	
	CO2	1		2	1	
	CO3	2		2	1	
	CO4	2		2	3	
	CO5	2		2	3	

Course Content

UNIT I: **8 hrs**

Introduction: Introduction to Data Structures**,** Algorithm Specification: Pseudo code Conventions, Performance Analysis: Space Complexity, Time Complexity, Asymptotic Notation (Big ―oh, Omega, Theta, Little ―oh).

Graphs: Graph Abstract Datatype, Elementary Graph Operations- DFS, BFS

Trees: Introduction, Binary Trees, Binary Tree traversals, Binary Search Tree – Definition, Search, Insertion, & Deletion

UNIT II: **9 hrs**

Trees:AVL trees: Creation, insertion and deletion operations and Applications**.**

B-Trees: Creation, insertion and deletion operations and Applications**.**

Red-Black Trees: Definition and Properties, Searching a Red-Black Tree, Top-Down Insertion, Bottom-Up Insertion, Deletion operations.

Heap Trees(Priority queues): Min and Max Heaps, Operations and Applications

UNIT III: **10 hrs**

Divide and Conquer: General method, Binary search, Finding the Maximum and

	Minimum, Merge sort, Quick sort, Strassen's matrix multiplication. **Greedy method:** General method, knapsack problem, Job Sequencing with deadlines, Minimum cost spanning trees: Prim's and Kruskal's algorithms, Single source shortest path problem
	UNIT IV: 10 hrs **Dynamic Programming:** General method, All pairs shortest Path problem, Single-source shortest paths: general weights, String Editing, 0/1 knapsack problem, Travelling salesperson problem. **Backtracking:** General method, 8-queens problem, sum of subsets, graph coloring, Hamiltonian cycles
	UNIT V: 8 hrs **Branch and Bound:** The General method, 0/1knapsack problem, Travelling Salesperson Problem. **NP-Hard and NP-Complete problems**: Basic concepts, non-deterministic algorithms, the classes NP Hard and NP Complete
Text books and Reference books	**Text Book(s):** [1]. Ellis Horowitz, SartajSahni, Dinesh Mehta, "FUNDAMENTALS OF DATA STRUCTURES in C++", 2nd edition, University Press. [2] Ellis. Horowitz, SartajSahani, SanguthevarRajasekharan, "FUNDAMENTALS OF COMPUTER ALGORITHMS", 2nd edition, University Press. **Reference Books:** [1]. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, "Introduction to Algorithms", PHI learning Pvt.Ltd., New Delhi, 2010. [2]. Lee, Kent D., Hubbard, Steve, "Data Structures and Algorithms with Python", 1st edition, Springer International Publishing, 2015.
E-resources and other digital material	[1] SudarshanIyengar,AssistantProfessor,CSE department, IIT Ropar, Programming, Data Structures and Algorithms [NPTEL], (26, May, 2021) Available: https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-cs25/ [2] Erik Demaine, professor of Computer Science at the Massachusetts Institute of Technology , Advanced Data Structures [MIT- Open Course Ware], (26, May, 2021) Available: http://ocw.mit.edu/ [3] https://www.tutorialpoint.com/advanced_data_structures/index.asp [4] http://peterindia.net/Algorithms.html

24ITDS503 -MACHINE LEARNING

Course Category:	Program Core			**Credits:**	3
Course Type:	Theory			**Lecture-Tutorial-Practice:**	2-0-2
Prerequisites:	---			**Continuous Evaluation:**	40
				Semester end Evaluation:	60
				Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Summarize the fundamental concepts of machine learning
	CO2	Apply linear, distance based, and decision tree based models for a given scenario
	CO3	Implement basic ensemble methods such as bagging, random forests
	CO4	Evaluate the performance of probabilistic, neural network models using appropriate metrics
	CO5	Design a suitable machine learning model for a real world application

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)	PO1	PO2	PO3	PO 4	PO 5
CO1				1	
CO2	1			2	1
CO3	1	1		2	1
CO4	2	1	1	3	2
CO5	2	2	1	3	2

Course Content

UNIT I: **8 hrs**

The ingredients of machine learning: Tasks, Models, Features

Binary classification and related tasks: Classification, Assessing classification performance, Visualizing classification performance

Beyond binary classification: Multi-class classification, Regression

UNIT II: **9 hrs**

Decision Tree learning: Introduction, Decision tree representation, Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Inductive bias in decision tree, Issues in decision tree learning.

Linear models Part1: The least-squares method, Multivariate linear regression,

UNIT III: **8 hrs**

Linear models Part2: Support vector machines, Soft margin SVM, Going beyond linearity with kernel methods.

Bayesian Learning: Introduction, Bayes theorem, Bayes optimal classifier, Naïve Bayes classifier, Bayesian belief networks.

UNIT IV: **7 hrs**

Distance Based Models: Introduction, Nearest Neighbors classification, Distance based clustering, K-Means algorithms, Clustering around Medoids, Hierarchical Clustering.

	Model Ensembles: Bagging and Random forests, Boosting, Mapping the ensemble landscape, Other ensemble methods
	UNIT V: **8 hrs** **Artificial Neural Networks**: Introduction, appropriate problems for neural network learning, Perceptrons, Multilayer networks and the back propagation **Reinforcement Learning**: Introduction, The Learning task, Q-learning
Text books and Reference books	**Text Book(s):** **[1].** Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012 **[2].** Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education **Reference (Book)s:** **[1].** AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition **[2].** Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014 **[3].** EthemAlpaydın, Introduction to machine learning, second edition, MIT press
E-resources and other digital material	**[1].** Kevin Murphy,"MachineLearning:A Probabilistic Perspective" , MIT Press, 2012, https://www.cs.ubc.ca/~murphyk/MLbook/pml-intro-5nov11.pdf **[2].** Machine Learning by Andrew Ng, Stanford University https://www.coursera.org/learn/machine-learning **[3].** Professor S. Sarkar IIT Kharagpur "Introduction to machine learning" , https://www.youtube.com/playlist?list=PLYihddLFCgYuWNL55Wg8ALkm6u8U7 **[4].** Professor Carl GustafJansson, KTH, Video Course on Machine Learning https://nptel.ac.in/noc/individual_course.php?id=noc19-cs35

Machine Learning- Lab Tasks:

Task No	Task Description
1	**Data Preprocessing** – Consider Breast Cancer Wisconsin (Diagnostic) Dataset and apply all necessary preprocessing techniques suitable. Like cleaning, Feature Scaling, normalization , Encoding Categorical Variables etc
2	**Simple Linear Regression**-Perform simple linear regression on Boston Housing dataset to predict a continuous target variable . Evaluate the model using metrics like Mean Absolute Error (MAE), Mean Squared Error (MSE), and R-squared. Visualize the regression line on a scatter plot of the data. **Multiple linear regression** -Perform multiple linear regression on Auto MPG dataset with multiple features. Evaluate the model using metrics like MAE, MSE, and R-squared.Analyze the coefficients and their significance.
3	**Polynomial Regression**-Use Auto MPG dataset. Perform polynomial regression to capture non-linear relationships in the data. Train a polynomial regression model. Evaluate the model using metrics like MAE, MSE, and R-squared. Visualize the polynomial curve on a scatter plot of the data
4	**Decision Tree Algorithm** – Build and evaluate a decision tree classifier on IRIS dataset. Evaluate the model using metrics such as accuracy, precision, recall, and F1-score.Visualize the decision tree.
5	**Linear SVM**- Train and evaluate a basic Linear SVM classifier on IRIS dataset. Evaluate the model using metrics such as accuracy, precision, recall, and F1-score. Visualize the decision boundaries
6	**NonLinear SVM**- Consider IRIS data. Preprocess the data (handle missing values, encode categorical variables if necessary) Train and evaluate an SVM classifier with an RBF kernel on the dataset. Evaluate the model using metrics such as accuracy, precision, recall, and F1-score.
7	**Naive Bayes Classification**- Train and evaluate a basic Naive Bayes classifier on IRIS dataset. Evaluate the model using metrics such as accuracy, precision, recall, and F1-score
8	**Random Forest Classifier**- Train and evaluate a Random Forest classifier on IRIS dataset. Evaluate the model using metrics such as accuracy, precision, recall, and F1-score.
9	**ANN**- Load a classification dataset (Iris Dataset). Train an Artificial Neural Network (ANN) for a classification task using a dataset. Evaluate the model using metrics such as accuracy, precision, recall, and F1-score. Plot the training and validation loss curves
10	**Case Study1**- Consider Credit Card Fraud Detection .T rain a Linear SVM classifier without handling imbalance and evaluate its performance. Apply techniques such as oversampling, under sampling, or using class weights to handle imbalance. Train the model again with the imbalance handling technique and compare performance.
11	**Case Study 2-** Use Wine Dataset. Determine the optimal number of clusters for K-Means clustering with different K values using methods like the Elbow Method and Silhouette Score.

12	**Case Study3-** Load Titanic Dataset . rain and evaluate various models:Single models (e.g., Logistic Regression, Decision Tree).,Bagging (e.g., Random Forest).,Boosting (e.g., Gradient Boosting). Compare the models' performance based on metrics such as accuracy, precision, recall, and F1-score.

24ITDS504A–DATA VISUALIZATION AND INTERPRETATION

Course Category:	Program Elective	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	-	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Illustrate Visualizations That Represent The Relationships Contained In Complex Data Sets And Their Interpretation.
	CO2	Analyze Data To Create Visualization For A Particular Research Application.
	CO3	Identify Appropriate Visualization Chart To Present And Represent Design Solutions.
	CO4	Choose Leading Open Source Software Packages To Create And Publish Visualizations That Enable Clear Interpretations Of Big, Complex And Real World Data.
	CO5	Examine Skill In Designing Real Time Interactive Information Visualization System.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)

	PO1	PO2	PO3	PO 4	PO 5
CO1				1	1
CO2	1				2
CO3			2		2
CO4	2			3	3
CO5					3

Course Content

UNIT I: 9 hrs

THE CONTEXT OF DATA VISUALIZATION: Visualization as a Discovery Tool, The Bedrock of Visualization Knowledge, Defining Data Visualization, Visualization Skills for The Masses, The Data Visualization Methodology.

SETTING THE PURPOSE AND IDENTIFYING KEY FACTORS: Establishing Intent – The Visualization's Function, Establishing Intent – The Visualization's Tone, Key Factors Surrounding a Visualization Project, The " Eight Hats" Of Data Visualization Design.

UNIT II: 8 hrs

Conceiving and Reasoning Visualization Design Options: Data visualization design is all about choices, The visualization anatomy – data representation, The visualization anatomy –data presentation.

UNIT III: 9 hrs

Taxonomy of Data Visualization Methods: Data visualization methods, Choosing the appropriate chart type, Assessing hierarchies and part-to-whole relationships.

	UNIT IV: **8 hrs** **Constructing and Evaluating Your Design Solution:** For constructing visualizations, technology matters, the construction process, Approaching the finishing linePost-launch evaluation. **Case Studies on real-time applications.**
	UNIT V: **9 hrs** **An Introduction to Connecting to Data**: An Introduction to Connecting to Data in Tableau, Shaping Data for Use with Tableau, Getting a Lay of the Land: Tableau Terminology, View the Underlying Data, View the Number of Records, Dimension Versus Measure, what is a Measure, what is a Dimension, Discrete Versus Continuous. **Five Ways to Make a Bar Chart/An Introduction to Aggregation:** Five Ways to Create a Bar Chart in Tableau an Introduction to Aggregation in Tableau, Line Graphs, Independent Axes, And Date Hierarchies, How to Make a Line Graph in Tableau, Independent Axes in Tableau, Date Hierarchies in Tableau, Marks Cards, Encoding, and Level of Detail, An Explanation of Level of Detail, An Introduction to Encoding, Label and Tooltip Marks Cards.
Text books and Reference books	**Text Book(s):** **[1].** Andy Kirk, "Data Visualization: a successful design process", Packt Publishing (26 December 2012) **[2].** Ryan Sleeper, Practical Tableau, O'Reilly Media, Inc. April 2018 **Reference (Book)s:** **[1].** Chakrabarti, S,"Mining the web: Discovering knowledge from hypertext data", Morgan Kaufman Publishers, 2003. **[2].** Fry, Visualizing data, Sebastopo,O'Reily, 2007.
E-resources and other digital material	**[1].** Dr. Gauravdixit, Department of Management Studies, Indian Institute of Technology, Roorkee: https://Nptel.Ac.In/Courses/110107092/7,2017 **[2].** P Adam Marcus, and Eugene Wu. RES.6-009 How to Process, Analyze and Visualize Data. January IAP 2012. Massachusetts Institute of Technology: MIT Open Courseware, https://ocw.mit.edu.,2012. **[3].** Prof.Shankarnarasimhan,Ragunathan, Rengasamy,Iit Madras Data Visualization In R Basic Graphics, https://Nptel.Ac.In/Courses/106106179/11,2016 **[4].** Statistics and Visualization for Data Analysis and Inference, Dr. Ed Vul, Dr. Mike Frank, Massachusetts Institute of Technology, https://ocw.mit.edu/courses/res-9-0002-statistics-and-visualization-for-data-analysis-and-inference-january-iap-2009/resources/lec1_visulzatn/

24ITDS504B–AUGMENT REALITY AND VIRTUAL REALITY

Course Category:	Program Elective	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand and recall the fundamental concepts and components of Virtual Reality, including input and output interfaces.
	CO2	Apply the principles of computer graphics to solve problems related to stereoscopic display technologies and real-time rendering.
	CO3	Develop and demonstrate interactive techniques such as body tracking, hand gestures, and object grasping using VR development tools.
	CO4	Analyze the differences between AR and VR technologies, including their respective challenges and methods for enhancing interactivity.
	CO5	Evaluate the concept, characteristics, and technologies of the Metaverse, assessing its evolution and future trends.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)

	PO1	PO2	PO3	PO 4	PO 5
CO1	3		2	1	
CO2	2		2	3	
CO3		2	3		2
CO4			3	2	
CO5	2		3	2	

Course Content

UNIT I: 9 hrs

Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality - Primary Features andPresentDevelopmentonVirtualReality - MultipleModelsofInputandOutputInterfaceinVirtualReality:Input-Tracker - Sensor - Digital Glove - Movement Capture - Video-based Input - 3D Menus & 3DScannerOutput -Visual/Auditory/HapticDevices.

UNIT II: 9 hrs

VisualComputationinVirtualReality:FundamentalsofComputerGraphics – SoftwareandHardwareTechnologyon Stereoscopic Display - Advanced Techniques in CG: Management of Large Scale Environments & Real TimeRendering.

UNIT III: 9 hrs

InteractiveTechniquesinVirtualReality:BodyTrack-HandGesture-3D Manus-ObjectGrasp.Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3DStandard;Vega-MultiGen-Virtools.

Application of VR in Digital Entertainment:VR Technology in Film & TV Production - VR Technology in Physical Exercises and Games - Demonstration of Digital Entertainment by VR.

	UNIT IV: **9 hrs** **AugmentedandMixedReality:**Taxonomy-technologyandfeaturesofaugmentedreality-differencebetweenARand VR - Challenges with AR - AR systems and functionality - Augmented reality methods – visualizationtechniquesforaugmentedreality-wireless displays ineducationalaugmentedreality applications-mobileprojection interfaces - marker-less tracking for augmented reality - enhancing interactivity in AR environments - evaluating ARsystems.
	UNIT V: **9 hrs** The Metaverse and the Real-World Universe: Background of the Metaverse, Concept and Characteristics of the Metaverse, Main Technologies Involved in the Metaverse, Evolution of the Metaverse.
Text books and Reference books	**Text Book(s):** 1. Burdea,G. C.,P.Coffet.,VirtualRealityTechnology,SecondEdition,Wiley-IEEEPress, November 2017. 2. AlanB.Craig,UnderstandingAugmented Reality,ConceptsandApplications,Morgan Kaufmann,2013. 3. F. Richard Yu, Angela W. Yu, ABrief History of Intelligence From the Big Bang to the Metaverse, Springer, 2023. **Reference Books:** 1. Steve Aukstakalnis, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VRAddison-Wesley Professional, 08-Sept-2016 2.Alan Craig, William Sherman, Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
E-resources and other digital material	[1] Brian Hui, Product Designer XR Healthcare: Intro to AR/VR and Its Applications in Healthcare, 17 Jun 2021, https://www.youtube.com/watch?v=Ch4RKOD8uHk [2] Prof.Sudip Misra IIT Kharagpur,Industry 4.0: Augmented Reality and Virtual Reality,July 2018 https://www.youtube.com/watch?v=zLMgdYI82IE [3]Prof Steven LaValle, Visiting Professor, IITM, UIUC Virtual Reality. 25 Jan 2016 https://www.youtube.com/watch?v=aNC5YMUTcQ4&list=PLbMVogVj5nJSyt80VRXYC-YrAvQuUb6dh

24ITDS504C–ENTERPRISE CLOUD CONCEPTS

Course Category:	Programme Elective			**Credits:**		3
Course Type:	Theory			**Lecture-Tutorial-Practice:**		3-0-0
Prerequisites:	Computer Networks			**Continuous Evaluation:**		40
				Semester end Evaluation:		60
				Total Marks:		100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Understand key concepts in cloud computing platforms and infrastructure				
	CO2	Illustratecloud computing technologies and its management				
	CO3	Analyze cloud infrastructure solutions for business applications				
	CO4	Outline the cloud computing architecture and its working in real time applications				
	CO5	Explore next generation cloud services with high end solutions				
Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	1				
	CO2	1				
	CO3				2	
	CO4				2	
	CO5	1				

Course Content	**UNIT I: 9 hrs** **Understanding Cloud Computing:**Origins and influences, Basic Concepts and Terminology, Goals and Benefits, Risks and Challenges. **Fundamental Concepts and Models:**Roles and Boundaries, Cloud Characteristics, Cloud Delivery Models,Cloud Deployment Models.
	UNIT II: 9 hrs **Cloud-Enabling Technology:** Broadband Networks and Internet Architecture, Data Center Technology,Virtualization Technology. **Cloud Infrastructure Mechanisms**:Logical Network Perimeter, Virtual Server, Cloud Storage Device,Cloud Usage Monitor, Resource Replication.
	UNIT III: 9 hrs **CloudManagementMechanisms:**RemoteAdministrationSystem,ResourceManagementSystem,SLA Management System, Billing Management System, Case Study Example **Fundamental Cloud Architectures:**Workload Distribution Architecture, Resource Pooling Architecture, Dynamic Scalability Architecture, Elastic Resource Capacity Architecture, Service Load Balancing Architecture , Cloud Bursting Architecture, Elastic Disk ProvisioningA rchitecture, Redundant Storage Architecture, Case Study Example
	UNIT – IV: 9 hrs **Cloud-Enabled Smart Enterprises:** Introduction, Revisiting the Enterprise

	Journey, Service-Oriented Enterprises, Cloud Enterprises, Smart Enterprises, The Enabling Mechanisms of Smart Enterprises **Cloud-Inspired Enterprise Transformations:** Introduction, The CloudScheme for Enterprise Success, Elucidating the Evolving CloudI dea, Implications of the Cloud on Enterprise Strategy,Establishing a Cloud-Incorporated Business Strategy
	UNIT – V: 9 hrs **Transitioning to Cloud-Centric Enterprises:** The Tuning Methodology, Contract Management in the Cloud **Cloud-Instigated IT Transformations:** Introduction, Explaining Cloud Infrastructures, A Briefing on Next-Generation Services, Service Infrastructures, Cloud Infrastructures, Cloud Infrastructure Solutions, Clouds for Business Continuity, The Relevance of Private Clouds, The Emergence of Enterprise Clouds
Text books and Reference books	**Text Book(s):** **[1].** Erl Thomas, Puttini Ricardo, MahmoodZaigham, Cloud Computing: Concepts, Technology & Architecture 1st Edition **[2].** Pethuru Raj, Cloud Enterprise Architecture, CRC Press **Reference (Book)s:** **[1].** James Bond,The Enterprise Cloud, O'Reilly Media, Inc. **[2].** GauthamShroff, Enterprise Cloud Computing Technology, Architecture, Applications
E-resources and other digital material	**[1].** John R Williams, Abel Sanchez , MIT Professional Education, ―Cloud DevOps, 2022 https://professional.mit.edu/course-catalog/cloud-devops-continuous-transformation **[2].** Prof.SowmyaKantiGhosh,IITKharagpur, ― Cloud Computing 2022https://nptel.ac.in/courses/106/105/106105167/ **[3].** Enterprise Cloud Infrastructure with Erik Reinert https://www.youtube.com/watch?v=qpR6ABJD9c8 **[4].** The Evolution of Large Scale Enterprise Public Cloud Adoption https://www.youtube.com/watch?v=aJXG3N3iBv0

24ITDS505A–ARTIFICIAL INTELLIGENCE ESSENTIALS AND APPLICATIONS

Course Category:	Program Elective	**Credits:**	3
Course Type:	Theory	**LectureTutorialPractice:**	3-0-0
Prerequisites:		**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand foundational AI concepts and the role of intelligent agents in various environments.
	CO2	Solve problems using uninformed and informed search strategies, and apply local search algorithms.
	CO3	Analyze AI techniques in diagnosing diseases and evaluate case studies in systems biology
	CO4	Explore AI principles and applications in medical imaging, including CAD, machine learning, and radiomics
	CO5	Apply prompt engineering to guide generative AI models and compare major large language models.

Contribution of Course Outcomes towards achievement of Program Outcomes (1Low, 2 Medium, 3 High)						
		PO1	PO2	PO3	PO 4	PO 5
	CO1			3	2	
	CO2	3			3	
	CO3	3		2	3	
	CO4		2	3		3
	CO5	2	2	3	3	

Course Content

UNIT I: **8 hrs**

Artificial Intelligence

Introduction, The Foundations of Artificial Intelligence, The History of Artificial Intelligence

Intelligent Agents: Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments. The Structure of Agents.

UNIT II: **9 hrs**

Solving Problems by Searching, ProblemSolving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions.

Local Search Algorithms and Optimization Problems Local Search in Continuous Spaces, searching with Nondeterministic Actions,

Knowledge Representation, Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information, The Internet Shopping World.

Knowledge Graphs: Motivation, Definition, Principles, Choosing the best organizing principle for the knowledge graph.

UNIT III: **9 hrs**

AI in diagnosis of Genetic Diseases – Cancer – Diabetes – AI in Diagnosis of

	Syndromes – AI in diagnosis of Psychiatric Disorders – Depression – Alzheimer's Disease – Autism Spectrum Disorder – Anxiety – Parkinson's Disease – AI in other Diagnosis – Infectious Disease – Lung and Brain Disease – Case studies on AI in systems Biology – AI technologies in Systems Biology towards Pharmacogenomics – AI in Systems Biology for Cancer Cure –AI Powered technology for an inclusive world
	UNIT IV: 9 hrs **Introduction to Medical Imaging**, Applying Artificial Intelligence (AI) in Medical Imaging, ComputerAided Detection (CAD), Principles of ComputerAided Image Analysis in Medical Imaging, Machine Learning (ML) and Deep Learning (DL), ContentBased Image Retrieval (CBIR), Radiomics and Radiogenomics. Opportunities and Applications, Challenges, Pitfalls, Guidelines for Success, Regulatory and Ethical Issues.
	UNIT V: 9 hrs **Prompt Engineering for Generative AI** Overview of the Five Principles of Prompting, Introduction to Large Language models for Text Generation – GPT-4, Google's Gemini, Meta's Llama and Open Source, GPT-4(Vision), Model Comparison.
Text books and Reference books	**Text Book(s):** 1. Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education 2.Kaliraj, P., & Devi, T. (Eds.). (2021). Artificial Intelligence Theory, Models, and Applications (1st ed.). CRC Press, Taylor & Francis Group, Boca Raton, Auerbach Publications. https://doi.org/10.1201/9781003175865 3. James Phoenix and Michael Taylor(2024), Prompt Engineering for Generative AI, O'Reilly Media. **Reference (Book)s:** 1. Artificial Intelligence, Kevin Knight, Elaine Rich, B. Shivashankar Nair, 3rd Edition,2008 2. Artificial Neural Networks B. YagnaNarayana, PHI. 3. Artificial Intelligence, 2nd Edition, E.Rich and K.Knight (TMH). 4. Artificial Intelligence and Expert Systems – Patterson PHI. 5. Expert Systems: Principles and Programming Fourth Edn, Giarrantana/ Riley, Thomson. 6. PROLOG Programming for Artificial Intelligence. Ivan Bratka Third Edition – Pearson Education. 7. Neural Networks Simon Haykin PHI. 8. Artificial Intelligence, 3rd Edition, Patrick Henry Winston., Pearson Edition. 9. KnowledgeGraphsData in Context forResponsive BusinessesJesúsBarrasa, Amy E. Hodler& Jim Webber, 2021, Orielly Publications
Eresources and other digital material	1. A comprehensive introductory course covering ai concepts, algorithms, and applications. Https://www.youtube.com/playlist?list=plrqwxv7uu6ypswt06y_aeytqiwbeam3y 2. Machine learning techniques, neural networks, deep learning, and ai applications.https://www.youtube.com/playlist?list=plzhqobowtqdnu6r1_67000dx_zcjb3pi\ 3. Deep learning by andrewng. Https://www.youtube.com/playlist?list=pl1swssczt4ue1hrcgrz4eo1wzkcgkzc0e

	Ai & machine learning for healthcarehttps://www.youtube.com/playlist?list=pltymylg7qlf0cgimjf0ey2vbffkvedqeq Ai in robotics: https://www.youtube.com/playlist?list=pl5q_lef6zvkas7mdyjtcwzhaoxjf8boes Luger, g. F., &stubblefield, w. A. (2004). *Artificial intelligence: structures and strategies for complex problem solving* (5th ed.). Addisonwesley. Available from: https://www.amazon.com/artificialintelligencestructuresstrategiescomplex/dp/0321545893/

24ITDS505B–BUSINESS INTELLIGENCE &ANALYTICS

Course Category:	Program Elective			**Credits:**	3
Course Type:	Theory			**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:				**Continuous Evaluation:**	40
				Semester end Evaluation:	60
				Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Identify the objectives and practices for deploying a business intelligence (BI) program
	CO2	Apply processes to transform an organization‘s data into actionable knowledge.
	CO3	Analyze and model probability distributions, enabling them to make informed decisions based on various types of data.
	CO4	Develop appropriate forecasting techniques, demonstrating an ability to analyze time series data and implement statistical models for accurate predictions.
	CO5	Integrate optimization methods and decision analysis for solving complex business problems by applying linear optimization and decision-making strategies.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	1		2		2
	CO2	1			2	2
	CO3	2			2	2
	CO4	3		2	3	3
	CO5			2	3	3

Course Content

UNIT I: **9 hrs**

Business Intelligence and Information Exploitation- Improving the Decision Making Process, A Business Intelligence Program, Business Intelligence and Program Success, The Analytics Spectrum, Taming the Information Explosion. **The Value of Business Intelligence**- Value Drivers and Information Use, Performance Metrics and Key Performance Indicator, Using Actionable Knowledge, Horizontal Use Cases for Business Intelligence, Vertical Use Cases for Business Intelligence

UNIT II: **9 hrs**

Planning for Success-Introduction, Organizational Preparedness for Business Intelligence and Analytics ,Initial Steps in Starting a Business Intelligence Program, Bridging the Gaps between Information Technology and the Business Users, Knowing the Different Types of Business Intelligence Users, Business Intelligence Success Factors: A Deeper Dive, Moreon Building Your Team, Strategic Versus Tactical Planning

Developing Your Business Intelligence Roadmap-The Business Intelligence and

	Analytics Spectrum, The Business Intelligence Roadmap: Example, Planning the Business Intelligence Plan. Case Study: BI for Finance Department
	UNIT III: **9 hrs** **Data Requirements Analysis-**Introduction, Business Uses of Information, Metrics: Facts, Qualifiers and Models, Data Requirements Analysis. **Foundations of Business Analytics** Introduction, Evolution of Business Analytics, Scope of Business Analytics, Data for Business Analytics, Models in Business Analytics, Problem Solving with Analytics. Case Study: Employee Data Analysis using Microsoft Power BI
	UNIT IV: **9 hrs** **Predictive Analytics:** **Forecasting Techniques** - Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Selecting Appropriate Time-Series-Based Forecasting Models , Regression Forecasting with Causal Variables. **Monte Carlo Simulation and Risk Analysis**- Spreadsheet Models with Random Variables, Monte Carlo Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model. Case Study : Enhancing Patient Care and Operational Efficiency using Microsoft Power BI
	UNIT V: **9 hrs** **Prescriptive Analytics:** **Applications of Linear Optimization-**Process Selection Models, Solver Output and Data Visualization, Blending Models, Portfolio Investment Models, Transportation Models. **Decision Analysis**: Formulating Decision Problems, Decision Strategies without Outcome Probabilities, Decision Strategies with Outcome Probabilities, Decision trees, The value of information, Utility and decision making. Case Study: Automatically set pricing and marketing messages to increase customer repurchase propensity using Microsoft Power BI
Text books and Reference books	**Text Book(s):** **[1].** Business Intelligence: The Savvy Managers Guide, David Loshin, The Morgan Kaufmann Series,2nd edition,2013 **[2].** James Evans, "Business Analytics, Second Edition, Pearson Publications, 2017. **Reference (Book)s:** **[1].** Power BI, Excel and Tableau - Business Intelligence Clinic: Create and Learn: 5 , Paperback – Import, 7 April 2020 ,Daniane Silva, Roger F Silva **[2].** U. Dinesh Kumar, "Business Analytics - The Science of Data Driven Decision Making", First Edition, Wiley Publications, 2017. **[3].** SeemaAcharya R N Prasad, "Fundamentals of Business Analytics", 2nd Edition, Wiley Publications, 2016
E-resources and other digital	**[1].** Data Visualization Power BI ,Prof Santosh & Prof Abhishek Singh,IIT Roorkee,https://www.youtube.com/watch?v=IxbLLU9AEBw **[2].** BusinessAnalytics&TextMiningModelingUsingPython,Prof.GauravDixit,Department of

material	Management,IITRoorkee,https://nptel.ac.in/courses/110/107/110107092/ **[3].** "Business Analytics for Beginners", 2016 https://www.youtube.com/watch?v=an9PXNtTSSc

24ITDS505C–DATA SCIENCE APPLICATIONS FOR NLP

Course Category:	Program Elective			**Credits:**		3
Course Type:	Theory			**Lecture-Tutorial-Practice:**		3-0-0
Prerequisites:	---			**Continuous Evaluation:**		40
				Semester end Evaluation:		60
				Total Marks:		100

Course Outcomes	Upon successful completion of the course, the student will be able to:					
	CO1	Apply text processing techniques to normalize and analyze textual data.				
	CO2	Build and evaluate n-gram language models and implement Naive Bayes classifiers for various NLP tasks.				
	CO3	Implement sequence labeling techniques for parts-of-speech tagging and named entity recognition, and design simple chatbots.				
	CO4	Understand machine translation models and parse sentences using context-free grammars.				
	CO5	Represent sentence meaning using logical representations and analyze word senses and relations using WordNet.				
Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1		2			
	CO2	1	3			
	CO3	3		3	3	
	CO4	3			2	
	CO5	2		2		

Course Content	**UNIT I: 9 hrs** **Regular Expressions, Text Normalization, Edit Distance:** Regular Expressions, Words, Corpora, TextNormalization, Word Tokenization, Word Normalization, Lemmatization and Stemming, Minimum Edit Distance, The Minimum Edit Distance Algorithm.
	UNIT II: 9 hrs **N-gram Language Models –** N Grams, Evaluating Language Models, Perplexity, Sampling sentences from a language model, Generalization and Zeros Smoothing-Laplace smoothing, Add-k Smoothing, Back off and Interpolation,Huge Language Models and Stupid Backoff,Advanced:Kneser-Ney Smoothing. **Naive Bayes and Sentiment Classification –** Naive Bayes Classifiers, Training the Naïve Bayes Classifier, Worked example, Optimizing for Sentiment Analysis, Naive Bayes for other text classification tasks, Naive Bayes as a Language Model.
	UNIT III: 9 hrs **Sequence Labeling for parts of Speech and Named Entities:**English Word Classes, Parts-of-speech-Tagging, Named Entities and Named Entities Tagging, HMM Parts of Speech Tagging, Markov Chains, The Hidden Markov Model, The

	components of an HMM tagger. **Chatbots& Dialogue Systems:** Properties of Human Conversation,Chatbots, Rule-based chatbots,Corpus-based chatbots,Hybrid architectures.
	UNIT IV: 9 hrs **Machine Translation:** Language divergences and Typology,MachineTransalation using Encoder-Decoder,Details of the Encoder-Decoder Model,The Encoder-Decoder Model,Encoder-Decoder with RNNs. **Context-Free Grammars and Constituency Parsing:**Constituency, Context-Free Grammars, Formal Definition of Context-Free Grammar, Treebanks, Grammar Equivalence and Normal Form, Ambiguity, CKY Parsing: A Dynamic Programming Approach - Conversion to Chomsky Normal Form, CKY Recognition, CKY Parsing, CKY in Practice.
	UNIT V: 9 hrs **Logical Representations of Sentence Meaning:**Computational Desiderata for Representations, Model-Theoretic Semantics, First-Order Logic, Variables and Quantifiers, Lambda Notation, The Semantics of First-Order Logic, Inference, Event and State Representations, Description Logics. **Word Senses and WordNet:**Word Senses, Defining Word Senses, How many senses do words have, Relations Between Senses, WordNet: A Database of Lexical Relations, Sense Relations in WordNet,Word Sense Disambiguation.
Text books and Reference books	**Text Book(s):** **[1].** Daniel Jurafsky and James H.Martin,"Speech and Language Processing:An Introduction to Natural Language Processing, Computational Linguistics, and SpeechRecognition", (availbale at **https://web.stanford.edu/~jurafsky/slp3/ed3book.pdf**) **Reference Books:** **[1].** Jacob Perkins, Nitin Hardeniya, Deepti Chopra, ItiMathur, Nisheeth Josh Natural Language Processing: Python and NLTK, Packt Publishing,2016 **[2].** Hobson lane, Cole Howard, Hannes Hapke, "Natural language processing in action" MANNING Publications, 2019. **[3].** Rajesh Arumugam, RajalingappaShanmugamani "Hands-on natural language processing with python: A practical guide to applying deep learning architectures to your NLP application". PACKT publisher, 2018. **[4].** Michael Nielsen,"Neural Networks and Deep Learning", Determination Press 2015
E-resources and other digital material	**[1].** Dan Jurafsky and Christopher Manning, Natural Language Processig Course,Stanford,26th Jun2019,https://web.stanford.edu/~jurafsky/NLPCourseraSlides.html **[2].** Prof. DragomirRadev,Ph.D.,Lecture Series on Natural Language Processing,Department of School of Information,University of Michigan,Mar 2016 https://www.youtube.com/playlist?list=PLLssT5z_DsK8BdawOVCCaTCO99Ya58ryR **[3].** Prof. Pawan Goyal, IIT Kharagpur on Natural Language Processing https://onlinecourses.nptel.ac.in/noc23_cs45/preview **[4].** https://www.nltk.org/howto.html

24UC501 – RESEARCH METHODOLOGY AND IPR

Course Category:	Mandatory learning Course	**Credits:**	0
Course Type:	Theory	**Lecture-Tutorial-Practice:**	2-0-0
Prerequisites:	-	**Internal Assessment:**	100
		Semester end Evaluation:	-
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Demonstrate proficiency in formulating research problems, applying scientific methods, and understanding the significance of research methodology in academic and professional settings
	CO2	Achieve proficiency in critically reviewing literature, enhancing research methodologies, and designing effective research studies that contribute to knowledge broadening and contextual understanding
	CO3	Gain proficiency in designing reliable sampling strategies, applying measurement scales, and executing data collection methods to minimize errors and enhance research validity
	CO4	conduct hypothesis tests, interpret test statistics, and utilize data analysis methods to enhance research validity
	CO5	Interpret research results, write impactful reports, and apply knowledge of intellectual property rights to research practices.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3-High)		**PO1**	**PO 2**	**PO 3**	**PO4**	**PO5**
	CO1	2	2	2	2	2
	CO2	1	2	2	2	2
	CO3	2	2	2	2	2
	CO4	1	3	1	1	1
	CO5	1	3	1	1	1

Course Content

UNIT I: **7 hrs**

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Research Approaches, Significance of Research, Research and Scientific Methods, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Research Problem: Defining theResearch Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, an Illustration.

	UNIT II: **6 hrs** **Reviewing the literature**: Place of the literature review in research, improving research methodology, broadening knowledge base in research area, enabling contextual findings. **Research Design**: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Basic Principles of experimental Designs, Important Experimental Designs.
	UNIT III: **7 hrs** **Design of Sampling**: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, sources of error in measurement tools. **Data Collection**: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method **ICT Tools and Techniques in Research:** Software for Reference Management (Zotero/ Mendeley), detecting Plagiarism, Research search Engines
	UNIT IV: **7 hrs** **Testing of Hypotheses**: Concepts, Hypothesis Testing, Test Statistics, Critical Region, Value and Decision Rule, Procedure. **Data Analysis**: Techniques and Tools for Analyzing Collected Data
	UNIT V: **7 hrs** **Interpretation and Report Writing**: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, and Significance of Report Writing **Intellectual Property:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act, 1957, Trade Secrets, Utility Models WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement.

Text books and Reference books	**Text books:** **[1]** Research methodology: Methods and Techniques, C.R. Kothari, GauravGarg, New Age International, 4th Edition, 2018. **[2]** Research Methodology a step-by-step guide for beginners.Ranjit Kumar, SAGE Publications Ltd.,3rd Edition, 2011 **[3]** Study Material, Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body under an Act of Parliament, September 2013. **Reference Books:** **[1]** An introduction to Research Methodology, Garg B.L et al ,RBSA Publishers 2002 **[2]** An Introduction to Multivariate Statistical Analysis Anderson T.W,Wiley 3rd Edition **[3]** Research Methodology, Sinha, S.C, Dhiman,EssEss Publications2002 **[4]** Research Methods: the concise knowledge base ,Trochim ,Atomic Dog Publishing, 2005 **[5]** How to Write and Publish a Scientific Paper, Day R.A,Cambridge University Press, 1992 **[6]** Conducting Research Literature Reviews: From the Internet to Paper,Fink A,Sage Publications,2009 **[7]** Proposal Writing,Coley S.M. Scheinberg, C.A,Sage Publications,1990 **[8]** Intellectual Property Rights in the Global Economy, Keith Eugene Maskus,Institute for International Economics.
E-resources and other digital material	**[1]** Prabuddhaganguli, Intellectual property right (1stedition) [English]. http://www.slideshare.net/harshhanu/intellectual-property-rights-13551183 **[2]** U.S Government Printing office, 1986 http://www.e-booksdirectory.com/details.php?ebook=10758

24ITDS581-MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE LAB

Course Category:	Program Core	**Credits:**	1.5
Course Type:	Lab	**Lecture-Tutorial-Practice:**	0-0-3
Prerequisites:	Any Programming Language	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Summarize the fundamental concepts of linear algebra, including vectors, matrices, linear transformations.
	CO2	Identify the properties and applications of the normal distribution, including the standard normal distribution.
	CO3	Apply joint probability distributions to model and analyze real-world problems involving the relationships between multiple variables.
	CO4	Apply regression analysis to model and analyze the relationships between multiple variables in real-world scenarios.
	CO5	Implement the principles of statistical inference, including hypothesis testing and confidence intervals.
	CO6	Interpret the results of confidence intervals in the context of real-world problems and decision-making.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)

	PO1	PO2	PO3	PO 4	PO 5
CO1	1		1	2	
CO2	1		2	1	
CO3	2		2	1	
CO4	2		2	3	
CO5	2		2	3	

Course Content

Week1: Basic Datatypes and control Structures in R

- Write r-program to check whether a number is even or odd.
- Write a R program to concatenate a vector with other.
- Write r-program to check whether a number is palindrome or not.
- Write r-program to print Fibonacci series.
- Write r-program to check whether a number is Armstrong or not.

Write a program to reverse a number

Week2: Operations on Vectors and Lists

- Write a R program to reverse the order of given vector.
  Write a R program to concatenate a vector with other
  Write a R program to count number of values in a range in a given vector.
- Write a R program to combines two given vectors By row and By column

	Week3: Operations on Arrays and matrix • Write a R program to find row and column index of maximum and minimum value in a given matrix. • Write a R program to create an array of two 3x3 matrices each with 3 rows and 3 columns from two given two vectors. • Write a R program to create an 3 dimensional array of 24 elements using the dim() function. • Write a R program to perform Different Matrix operations in R • Write a R program to find the Reverse of the matrix, Eigen values and Eigen vectors • Write a R program to perform Singular value decomposition on the given matrix.
	Week4: Operations on DataFrames and Reading Files • Creating a DataFrame and Accessing Rows and Columns in the data frame • Editing DataFrames by adding and removing rows and columns also identifying Missing Values in a Dataframe • Merge DataFrames based on a common variable using merge() Perform inner, outer, left, right joins • Write the R code to read a Excel file • Write the R code to read a csv file Write the R code to read the data from MySql.
	Week5: Normal Distribution • Write a R program to perform Probability Density Function (PDF) and Cumulative Distribution Function . • Write a R program to calculate Mean and Variance of a Continuous Random Variable • Suppose the height of males at a certain school is normally distributed with a mean of $\mu=70$ inches and a standard deviation of $\sigma = 2$ inches. Approximately what percentage of males at this school are taller than 74 inches? • Suppose the weight of a certain species of otters is normally distributed with a mean of $\mu=30$ lbs and a standard deviation of $\sigma = 5$ lbs. Approximately what percentage of this species of otters weight less than 22 lbs? • **:** Suppose the height of plants in a certain region is normally distributed with a mean of $\mu=13$ inches and a standard deviation of $\sigma = 2$ inches. Approximately what percentage of plants in this region are between 10 and 14 inches tall?
	Week6: Binomial Distribution • Dravid scores a wicket on 20% of his attempts when he bowls. If he bowls 5 times, what would be the probability that he scores 4 or lesser wicket? The probability of success is 0.2 here and during 5 attempts we get • 4% of Americans are Black. Find the probability of 2 black students when

	randomly selecting 6 students from a class of 100 without replacement. • How many tails will have a probability of 0.2 when a coin is tossed 61 times. • Hospital database displays that the patients suffering from cancer, 65% die of it. What will be the probability that of 5 randomly chosen patients out of which 3 will recover?
	Week 7: Poission Distribution • Customers call us at a rate of 12 per minute. "The boss" wants us to deliver excellent service and stay very productive. Our service will suffer if we get more than twenty calls in a minute. We're going to look lazy if five or less calls arrive in a minute. What are the odds of getting in trouble with the boss? • If there are twelve cars crossing a bridge per minute on average, find the probability of having seventeen or more cars crossing the bridge in a particular minute. • Customers call us at a rate of 12 per minute. What is the probability of having exactly twenty customers call us within the span of a minute?
	Week 8: Multinomial Probability Distribution • A fair die is rolled 12 times. What is the probability of getting 2 ones, 3 twos, 4 threes, 2 fours, 1 five, and 0 sixes? • A bag contains 5 red, 3 blue, and 2 green marbles. If 4 marbles are drawn at random without replacement, what is the probability of getting 1 red, 2 blue, and 1 green marble? • In a manufacturing process, 10% of the products are defective. If 15 items are randomly selected, what is the probability that exactly 2 are defective?
	Week 9: Bivariate Normal Distribution • The heights (in cm) of a group of people are normally distributed with a mean of 170 and a standard deviation of 5. The weights (in kg) are also normally distributed with a mean of 70 and a standard deviation of 10. The correlation coefficient between height and weight is 0.6. Find the probability that a randomly selected person has a height greater than 175 cm and a weight less than 80 kg. • The lifetimes of two components in a system are jointly normally distributed with means 1000 hours and 1500 hours, variances 100^2 hours^2 and 200^2 hours^2, and correlation coefficient 0.4. Find the probability that both components last at least 900 hours. • The weights and heights of adult males are approximately bivariate normal with μ_weight = 180 lbs, μ_height = 70 in, σ_weight = 20 lbs, σ_height = 3 in, and ρ = 0.7. Find the probability that a randomly selected adult male weighs more than 200 lbs and is taller than 72 in.
	Week 10 :Hypothetical Testing • Input a dataset and perform one-way ANOVA test. • Input a dataset and Perform one sample t-test, two sample t-test and

	paired two sample t-test. • Input a dataset and Perform summary function and quantile function for given sample data.
	Week11: Confidence Interval • Use a dataset to fit a linear regression model. Plot residuals to check for patterns. • Calculate R^2: Coefficient of Determination (R^2) for the given Dataset. • Calculate the correlation between two variables.
	Week 12: Case Study 1: Determining House Selling Price Problem: Develop a multiple linear regression model to predict the selling price of houses based on various features like floor area, number of rooms, age of the house, number of bedrooms, and number of bathrooms. Case Study 2: Estimating Elasticities for U.S. Sugar Price and Demand Problem: Develop a multiple linear regression model to estimate the elasticities of U.S. sugar price with respect to various factors like production, consumption, and imports.
Text books and Reference books	**Text Book(s):** [1]. Jared P. Lander, "R for Everyone, Addison Wesley Data &Analytics Series, Pearson", 2014. [2]. Norman Matloff, "The Art of R Programming, No Strach Press", San Francisco, 2011**.** **Reference Books:** [1]. Jeffrey Stanton, "An Introduction To Data Science", 2012 [1]. G. Jay Kerns, Introduction to Probability and Statistics using R, First Edition, 2010
E-resources and other digital material	[1]. Rafael Irizarry, Michael Love, Statistics with R, Harvard University (18, May, 2021). Available: https://www.edx.org/course/statistics-r-harvardx-ph525-1x-1 [2]. Mine Çetinkaya-Rundel, David Banks, Colin Rundel, Merlise A Clyde, Duke University, (18, May, 2021). Statistics with R Specialization. Available: https://www.coursera.org/specializations/statistics

24ITDS582-ADVANCED DATA STRUCTURES AND ALGORITHMS LAB

Course Category:	Program Core	**Credits:**	1.5
Course Type:	Lab	**Lecture-Tutorial-Practice:**	0-0-3
Prerequisites:	Any Programming Language	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Compute time complexity of a given algorithm
	CO2	Demonstrate the divide and conquer technique with time complexity analysis
	CO3	Design the algorithms for optimization problems using greedy or dynamic programming
	CO4	Demonstrate backtracking technique
	CO5	Perform operations on balanced data structures - AVL and B-trees
	CO6	Solve scenario based problemsusing appropriate data structure and design technique

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	1		1	2	
	CO2	1		2	1	
	CO3	2		2	1	
	CO4	2		2	3	
	CO5	2		2	3	

Course Content	**Week 1: Programs on Time complexity Analysis techniques** a. Design an algorithm for the given problem and analyze the time complexity of the algorithm. b. Design an algorithm for the given problem and analyze the time complexity of the algorithm. **Week 2&3: Programs on Divide And Conquer Technique** a. Sorting techniques: Merge Sort and Quick Sort b. Find the minimum and maximum in a given array of elements c. Design experiment using Divide and Conquer Technique **Week 4&5: Programs on Greedy Method** a. Implement fractional Knapsack problem b. Find minimum cost spanning tree using Prims and Kruskals Algorithms c. Implement Single Source Shortest Path problem d. Implement job sequencing with deadlines problem **Week 6: Programs on Dynamic Programming** a. Implementation of all Pairs shortest path problem. b. Implementation of travelling salesperson Problem. c. Implementation of 0/1 Knapsack Problem **Week 7&8: Programs on Backtracking** a. Implement N-Queens Problem b. Implement sum of subsets problem c. Implement Graph coloring problem d. Implement Hamiltonian cycle problem **Week 9: AVL tree and applications** a. Implementation of AVL tree operations. b. Design experiment using AVL-Tree **Week 10:B- tree and applications** a. Insert and delete operations on B-tree b. Design experiment using B-Tree **Week 11: Design experiments/scenario based problem solving usingAdvanced Data structures** **Week 12: Design experiments/scenario based problem solving usingAlgorithm Design Strategies**
Text books and Reference books	**Text Book(s):** [1]. Horowitz Sahni and Anderson-Freed, "Fundamentals of Data Structures in C", 2nd edition, Universities Press, 2011. [2]. Mark Allen Weiss, "Data structure and Algorithm Analysis in C", 2nd edition, Addison Wesley Publication, 2010. **Reference Books:** [2]. YedidyahLangsam, Moshe J. Augenstein and Aaron M. Tenenbaum, "Data

	Structures using C and C++", 2nd edition, Pearson Education, 1999. [3]. Data Structures: A Pseudocode Approach with C, 2nd Edition, R. F. Gilberg and B. A. Forouzan, Cengage Learning
E-resources and other digital material	[1]. Erik Demaine, Advanced Data Structures, [MIT- OpenCourseWare]. (26, May, 2021). Available: http://ocw.mit.edu/ [2]. Dr. Naveen Garg, Department of Computer Science & Engineering ,IIT Delhi, Lecture Series on Data Structures and Algorithms [NPTEL], (26,May,2021) Available: https://nptel.ac.in/courses/106/102/106102064/ [3]. Data Structures and applications on, [Geeksforgeeks], (25, May, 2021) Available: https://www.geeksforgeeks.org/data-structures/ [4]. Data Structures and challenges [Hacker rank], (25,May,2021) Available: https://www.hackerrank.com/domains/data-structures

24ITDS591 – Capstone Project 1

Course Category:	Project	**Credits:**	1
Course Type:	Practical	**Lecture-Tutorial-Practice:**	0-0-2
Prerequisites:	Concepts of AI and Datascience	**Continuous Evaluation:**	60
		Semester end Evaluation:	40
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Apply Data Science and AI principles to address complex engineering problems within their chosen project theme
	CO2	Showcase advanced proficiency in utilizing specialized software tools for analysis, design, and simulation relevant to the chosen project theme
	CO3	Develop the ability to propose innovative and creative solutions to societal problems within the field of Datascience, integrating advanced knowledge and skills.
	CO4	Enhance their professional communication skills by preparing comprehensive technical reports and delivering effective presentations that document project work and findings

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H- High)		**PO1**	**PO2**	**PO3**	**PO 4**	**PO 5**
	CO1	2	1	2	2	2
	CO2	2	2	1	2	2
	CO3	3	2	3	3	2
	CO4	1	3	2	1	1

Course Content	The project shall be carried out in the major areas pertaining to the program approved by Project Review Committee and may address the societal problems/issues related to the program

SEMESTER II

24ITDS506–SCALABLE SYSTEMS FOR DATA SCIENCE

Course Category:	Program Core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Handle large data sets for finding similar items.
	CO2	Apply the techniques of solving large scale data science problems, link analysis mining data streams.
	CO3	Implement the techniques if finding frequent item sets and clusters on large scale datasets.
	CO4	Design the solution for real-world problems which need scalable systems for large scale data science such as web advertising and recommendation systems.
	CO5	Implement large scale machine learning models to solve large scale data science projects.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)

	PO1	PO2	PO3	PO 4	PO 5
CO1	2		1	1	
CO2	3		1	1	
CO3	3		2	1	
CO4	3	1	2		2
CO5	3	2	2		2

Course Content

UNIT I: **9 hrs**

Data Mining: What is Data Mining, Statistical Limits on Data Mining

Finding Similar Items: Applications of Near-Neighbor Search, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures, Applications of Locality-Sensitive Hashing

UNIT II: **9 hrs**

Mining Data Streams: The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Counting Ones in a Window.

Link-Analysis: Page Rank, Efficient Computation of PageRank, Link spam, Hubs and authorities.

UNIT III: **9 hrs**

Frequent Item sets: Market-Basket model, Market Baskets and the A-Priori Algorithm, Handling larger data sets in memory, Limited-pass algorithms. **Clustering:** Introduction to Clustering Techniques, Hierarchical clustering, K-Means Basics, Initializing Clusters for K-Means, Picking the Right Value of k,

	CURE, Clustering for Streams and Parallelism.
	UNIT IV: **9 hrs** **Advertising on the web**: Matching problem, ad-words problem, **Recommendation systems**: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction
	UNIT V: **9 hrs** **Dimensionality Reduction**: Singular-Value Decomposition, CUR Decomposition **Large-Scale Machine Learning:** Parallel Implementation of Perceptrons, Parallel implementation of SVM, Dealing with High-Dimensional Euclidean Data in nearest neighbors, Distributed machine learning.
Text books and Reference books	**Text Book(s):** **[1].** Jure Leskovec, AnandRajaraman, Jerey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2014. **Reference (Book)s:** **[1].** Jimmy Lin and Chris Dyer, "Data-Intensive Text Processing with MapReduce", 1st Edition, Morgan and Claypool Publishers, 2010. **[2].** Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, "Advanced Analytics with Spark: Patterns for Learning from Data at Scale", Oreilly, 2015. **[3].** Ankit Jain, "Mastering Apache Storm: Processing big data streaming in real time", Packt Publishing, 2017.
E-resources and other digital material	**[1].** Prof. Sourangshu Bhattacharya, Indian Institute of Technology, Kharagpur HTTPS://ARCHIVE.NPTEL.AC.IN/COURSES/106/105/106105186/ **[2].** Bill Howe, University of Washington HTTPS://WWW.COURSERA.ORG/SPECIALIZATIONS/DATA-SCIENCE **[3].** Prof. AnirbanDasgupta, Indian Institute of Technology, Kharagpur Https://www.Classcentral.Com/Course/Swayam-Scalable-Data-Science-14279

24ITDS507- BIGDATA FRAMEWORKS

Course Category:	ProgrammeCore	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	• Basic programming knowledge (preferably Python or Java). • Familiarity with fundamental data science concepts. • Understanding of databases and SQL.	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Summarize Big Data Characteristics, Hadoop, Hive, Hdfs And Map Reduce Architectures.
	CO2	Experiment With Nosql Databases To Process Unstructured And Semi Structured Data.
	CO3	Apply Pig Latin, Hive Scripts And Map Reduce Programming On Real Time Applications.
	CO4	Perform In-Memory Data Analytics With Spark And Spark Streaming.
	CO5	Apply The Principles Of Nosql Databaseson Real Time Applications

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	2		1		3
	CO2	2		1		3
	CO3	2		1		3
	CO4	2		1		3
	CO5	2		1		3

Course Content

UNIT I: **9 hrs**

INTRODUCTION TO BIG DATA:

Big Data-Definition, Characteristics of Big Data, Data in the Warehouse and Data in Hadoop, Importance of Big Data and Patterns for Big Data Development.

INTRODUCTION TO HADOOP:

Introduction to Hadoop and HDFS,MapReduce programming model, YARN and resource management, Hadoop ecosystem tools (Pig, Hive, HBase).

Data ingestion tools: Apache Flume, Apache Sqoop, Kafka.

UNIT II: **9 hrs**

Hadoop Distributed File System: The Design of HDFS, HDFS Concepts, Blocks, Namenodes and Datanodes, Basic Filesystem Operations, Hadoop Filesystems, Reading Data from a HadoopURL, Data Flow, Anatomy of a File Read and Anatomy of a File Write.

UNIT III: **9 hrs**

	Map Reduce–A Weather Dataset, Data Format, Analyzing the Data with Unix Tools, Analyzing the Data with Hadoop, Map and Reduce, Java Map Reduce, Scaling Out, Hadoop Streaming, Hadoop Pipes. **Pig-**Installation and Running of Pig, Execution Types, Running Pig Programs, Pig Latin Editors, Comparison with databases, Pig Latin, Functions, Data Processing Operators.
	UNIT IV: 9 hrs **Hive**-Installing Hive, An Example, Running Hive, Comparison With Traditional Databases, Hiveql, Tables, Querying Data. **Spark-**Introduction To Data Analytics With Spark, Spark Stack, Programming With Rdds, Working With Key/Value Pairs And Spark Sql.
	UNIT V: 9 hrs **NoSQL:** Introduction to NOSQL, Types of NoSQL Databases, Advantages of NoSQL databases, SQL versus NoSql. **NoSQL databases:** Introduction to MongoDB, Data types in MongoDB, MongoDB query language, HBase, Cassandra
Text books and Reference books	**Text Book(s):** **[1].** Dirk deRoos, Chris Eaton, George Lapis, Paul Zikopoulos, Tom Deutsch, "Understanding Big Data Analytics for Enterprise Class Hadoop and Streaming Data" 1st Edition, TMH,2012. [2]. Tom White, Hadoop, "The Definitive Guide", 3rd Edition, O'Reilly Publications, 2012. [3]. Seema Acharya, Subhashini Chellappan, Big Data and Analytics, Wiley Publishers. **Reference Books:** **[1].**Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, "Learning Spark: Lightning-Fast Big Data Analysis", O'Reilly Media, Inc. **[2]. "**NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence" by Pramod J. Sadalage and Martin Fowler
E-resources and other digital material	**[1].** Big Data Use cases for Beginners | Real Life Case Studies | Success Stories https://www.youtube.com/watch?v=HHR0-iJp2sM **[2].** Alexey Grishchenko, Hadoop Vs Mpp, Https://0x0fff.Com/Hadoop-Vs-Mpp/ **[3].** Random Notes On Bigdata- Slideshare: Available www.Slideshare.Net/Yiranpang/Random-Notes-On-Big-Data-26439474 **[4].** Introduction To Big Data, Ilkay Altintas,Amarnath Gupta, Https://Www.Coursera.Org/Learn/Big-Data-Introduction?Specialization=Big-Data

24ITDS508–DEEP LEARNING

Course Category:	Program Core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	2-0-2
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Analyze the performance of afeed forward neural network with different hyper parameters
	CO2	Apply CNN, Attention mechanisms and GANs on image processing applications
	CO3	Implement An Autoenoder Architecture for Dimensionality Reduction and Denoising Applications
	CO4	Build an RNN model for time series applications
	CO5	Create a suitable intelligent model for the given application

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)						
		PO1	PO2	PO3	PO 4	PO 5
	CO1	1			1	
	CO2	1		2	2	1
	CO3	2		2	2	2
	CO4	2		2	2	2
	CO5			3	3	

Course Content	**UNIT I: 7 hrs** **The Neural Network**: Building Intelligent Machines, The Limits of Traditional Computer Programs, The Mechanics of Machine Learning, The Neuron, Expressing Linear Perceptrons as Neuron, Feed-Forward Neural Networks, Linear Neurons and Their Limitations, Sigmoid, Tanh, and ReLU,Softmax Output Layers **Training Feed-Forward Neural Network**: Gradient Descent, The Delta Rule and Learning Rates, Gradient Descent with Sigmoidal Neurons, The Backpropagation Algorithm, Stochastic and Minibatch Gradient Descent, Test Sets, Validation Sets, and Overfitting, Preventing Overfitting in Deep Neural Networks
	UNIT II: 9 hrs **Convolutional Neural Networks**: Neurons in Human Vision, The Shortcomings of Feature Selection, Filters and Feature Maps, Convolutional Layer, Max Pooling, Full Architectural Description of Convolution Networks, Image Preprocessing pipelines, Accelerating training with batch normalization CaseStudies ofConvolutionalArchitectures :Alexnet, VGG, Googlenet, Resnet, pretrained models

	UNIT III: **8 hrs** **Embedding and Representation Learning**: Learning Lower-Dimensional Representations, Principal Component Analysis Autoencoder: Motivating the Autoencoder Architecture, Denoising to Force Robust Representations, Sparsity in Autoencoders
	UNIT IV: **9 hrs** **Sequence Modeling**: **Recurrent and Recursive nets:** Unfolding Computational Graphs, Recurrent neural networks, Bidirectional RNNS,Encoder-Decoder sequence-to –sequence architectures, Deep Recurrent networks, Recursive neural networks. **The Challenge of Long-Term Dependencies:** Echo State Networks, Leaky Units &Other strategies for multiple timescales, Gated Networks,The Long Short-Term memory
	UNIT V: **7 hrs** **Advanced Topics in Deep Learning:** Introduction, Attention Mechanisms, Recurrent Models of Visual Attention, Attention Mechanisms for Machine Translation, Neural Networks with External Memory-Neural Turing Machine, **Generative Adversarial Networks:**Training a Generative Adversarial Network, Using GANs for Generating Image Data, Conditional Generative Adversarial Networks, Competitive Learning, Limitations of Neural Networks
Text books and Reference books	**Text Book(s):** **[4].** Nikhil Buduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms", O'Reilly Media, 2017 **[5].** Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning(Adaptive Computation and Machine Learning series",MIT Press, 2017 **[6].** Charu C. Aggarwal, Neural Networks and Deep Learning, c Springer International Publishing AG, part of Springer Nature 2018, ISBN 978-3-319-94462-3 ISBN 978-3-319-94463-0 (eBook) **Reference (Book)s:** **[1].** Li Deng and Dong Yu, "Deep learning Methods and Applications", Now publishers, 2013 **[2].** Michael Nielsen,"Neural Networks and Deep Learning", Determination Press 2015 Vaswani A, Shazeer N, Parmar N, Uszkoreit J, Jones L, Gomez AN, Kaiser Ł, Polosukhin I. Attention is all you need. Advances in neural information processing systems. 2017; 30.
E-resources and other digital material	**[4].** MiteshKhapra, "Deep Learning", Sep 20, 2018, https://www.youtube.com/watch?v=4TC5s_xNKSs&list=PLH- xYrxjfO2VsvyQXfBvsQsufAzvlqdg9 **[5].** AfshineAmidi and ShervineAmidi ,"Deep Learning cheat sheets for Stanford's CS 230", 2018, https://github.com/afshinea/stanford-cs-230-deep-learning **[6].** YoshuaBengio, Deep learning: "Theoretical Motivations, Canadian Institute for Advanced Research", 2015 http://videolectures.net/deeplearning2015_bengio_theoretical_motivations/

	[7]. Geoffrey Hinton's GoogleTech Talk,"Recent developments on Deep Learning" March 2010, https://www.youtube.com/watch?v=VdIURAu1-aU

Lab Tasks:

Task No	Task Description
1	**Data Preprocessing** o Load and preprocess a dataset (e.g., CIFAR-10). o Perform data augmentation techniques such as rotation, flipping, and scaling. o Normalize the dataset and split it into training and validation sets
2	**Building and Training Neural Networks** o Implement a simple feedforward neural network for a classification task. o Experiment with different activation functions and observe their impact on model performance.
3	**Convolutional Neural Networks (CNNs)** o Build a CNN for image classification (e.g., using MNIST , CIFAR-10 datasets).
4	**Transfer Learning** o Load a pre-trained model (e.g., VGG16 or ResNet) and fine-tune it on a new dataset. o Implement feature extraction using a pre-trained model. o Compare the performance of the fine-tuned model with a basic CNN
5	**Autoencoders** o Build and train an autoencoder for dimensionality reduction using MNIST dataset o Build a denoisy autoencoder
6	**Recurrent Neural Networks (RNNs) and LSTMs** o Build and train an RNN for a text classification task. o Implement an LSTM for time series prediction.
7	**Generative Adversarial Networks (GANs)** Build and train a simple GAN to generate synthetic images.
8	**Advanced Architectures** Build and train a transformer model for natural language processing tasks (use a training dataset for this purpose, which contains short English and German sentence pairs)
9	**Case Study1:** Malaria Cell Image dataset. This dataset consists of 27,558 images of microscopic blood samples. The dataset consists of 2 folders – folders-Parasitized and Uninfected. Sample Images-a) parasitized blood sample, b) Uninfected blood sample Build CNN classification model using the dataset. Compare the performance of Basic CNN with any 2 transfer learning models Data source: https://www.kaggle.com/datasets/iarunava/cell-images-for-detecting-malaria
10	**Case Study2:** implementation of a Transformer network for language translation, focusing on translating English sentences to French.

24ITDS509A –COMPUTER VISION AND ROBOTICS

Course Category:	Program Elective	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand basic knowledge, theories and methods in computer vision
	CO2	Understand various feature extraction methods and its significance.
	CO3	Analyze various clustering and classification techniques.
	CO4	Analyze various Video Processing methods.
	CO5	Understand the basics of robotics in vision.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	2			1	
	CO2	2			1	
	CO3	1			3	
	CO4	1			2	
	CO5	2			1	

Course Content

UNIT I: **9 hrs**

Introduction: Computer vision, A brief history.

Image formation: Geometric primitives and transformations**,** Photometric image formation

Image processing: Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets.

UNIT II: **9 hrs**

Feature detection and matching:

Points and patches, Application: Performance-driven animation Edges, Application: Edge editing and enhancement, Lines, Application: Rectangle detection.

UNIT III: **9 hrs**

Image Segmentation

Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods, Application: Medical image segmentation.

Feature-based alignment:

Pose estimation, Application: Augmented reality

UNIT IV: **9 hrs**

Dense motion estimation:

Parametric motion, Application: Video stabilization, Optical flow, Application:

	Video de-noising, Layered motion, Application: Frame interpolation.
	UNIT V: 9 hrs **Representing Position and Orientation** Representing Pose in 2-Dimensions, Representing Pose in 3-Dimensions ,Representing Orientation in 3-Dimensions,Combining Translation and Orientation **Time and Motion** Trajectories,Smooth One-Dimensional Trajectories ,Multi-Dimensional Case, Multi-Segment Trajectories **Mobile Robot Vehicles** Mobility ,Car-like Mobile Robots
Text books and Reference books	**Text Book(s):** **[1].** Richard Szeliski, Computer Vision: Algorithms and Applications, Second edition Springer-Verlag London Limited 2022. **[2].** Peter Corke, Robotics, Vision and Control: Fundamental Algorithms, Springer Tracts in Advanced Robotics, Volume 118, Second Edition, 2016 **Reference (Book)s:** **[1].** Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003. **[2].** K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990. **[3].** R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison-Wesley, 1992.
E-resources and other digital material	**[1].** Dr. Mubarak Shah, (13, 07, 2024). UCF Computer Vision Video Lectures,https://www.youtube.com/watch?v=715uLCHt4jE&list=PLd3hlSJsX_ImKP68wfKZJVIPTd8Ie5u-9 **[2].** Prof. M.K. Bhuyan (13, 07, 2024). Computer Vision and Image Processing – Fundamentals and Applications, https://onlinecourses.nptel.ac.in/noc21_ee23/preview

24ITDS509B–SPATIO-TEMPORAL DATA ANALYTICS

Course Category:	Program Elective	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	• Basic understanding of statistics and probability concepts • Familiarity with a statistical software package	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand spatial data & visualize point data distributions.
	CO2	Preprocess spatial data & evaluate quality for analysis.
	CO3	Apply spatial analysis & analyze time series patterns
	CO4	Decompose time series & interpret visualizations for trends/seasonality.
	CO5	Evaluate spatiotemporal models & present interactive visualizations.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3-High)

	PO 1	PO2	PO3	PO 4	PO 5
CO1	**2**		**2**	**2**	**1**
CO2				**2**	
CO3	**2**		**1**		**2**
CO4			**1**	**1**	**1**
CO5	**2**		**2**		**2**

Course Content

UNIT I: **9 hrs**

Introduction to spatio-temporal data, Importance of spatio-temporal data, Data acquisition and preprocessing: sources, challenges (missing values, inconsistencies), basic functionalities of GIS, Spatial Operations and Analysis, spatial statistics-Moran's I, Getis Orids

UNIT II: **9 hrs**

Spatial Interpolation techniques:Kriging, Inverse Distance Weighting (IDW), Spatial Clustering:K-Means, DBSCAN (Density-Based Spatial Clustering of Applications with Noise), Spatial Autoregressive Models (SAR), Space-Time Krigging, Spatio-temporal classification.

UNIT – III: **9 hrs**

Statistical foundations for spatio-temporal analysis: probability distributions, hypothesis testing, Exploring spatial autocorrelation and spatial heterogeneity. Spatial statistics: Moran's I, Getis-Ord G statistics, Case studies.

UNIT – IV: **9 hrs**

Time series analysis concepts: stationarity, trend, seasonality, Techniques for analyzing time series data: autocorrelation function (ACF), partial

	autocorrelation function (PACF) , Time series decomposition techniques, Forecasting with time series models: introduction to common models (ARIMA, SARIMA)
	UNIT – V: 9 hrs **Spatio-temporal models:** Integration of spatial and temporal components, Common types of spatio-temporal models: autoregressive models, agent-based models (ABM), Applications of spatio-temporal modeling: case studies in various disciplines.
Text books and Reference books	**Text Book(s):** **[1] Applied Spatial Data Analysis with R (Second Edition)** by Roger S. Bivand, Edzer J. Pebesma, and Virgilio Gómez-Rubio (**ASDAR**) **[2] Spatiotemporal Statistics with R** by Christopher K. Wikle, Andrew Zammit-Mangion, and Noel Cressie (**STSR**) **[3] Geostatistics for Natural Resources Evaluation**,Pierre Goovaerts **Reference (Book)s:** **[1].** Spatiotemporal Data Analytics and Modeling: Techniques and Applications, John A , Satheesh Abimannan, El-Sayed M. El-Alfy, Yue-Shan Chang. **[2].** Longley P. and Batty M. (eds.) (1996) Spatial Analysis: Modelling in a GIS Environment, Geoinformation International, Cambridge, 392pp **[3].** Statistics for Spatio-Temporal Data *by Noel Cressie* and Christopher K. Wikle.
E-resources and other digital material	**[1].** "Analyzing Space, Time and Place: GIS for the Social Sciences" by John Paul Densham (https://www.amazon.com/Geographic-Information-Systems-Social-Sciences/dp/0761928731) **[2].** "Introduction to Geographic Information Systems" by Kang-Tsung Chang (https://www.amazon.com/Best-Sellers-Geographic-Information-Systems/zgbs/books/15959291) **[3].** "Spatio-Temporal Statistics with R" by Wikle et al. (https://www.amazon.com/Spatio-Temporal-Statistics-Chapman-Hall-CRC/dp/1138711136) **[4].** https://www.publichealth.columbia.edu/research/population-health-methods/spatiotemporal-analysis. **[5].** "An Introduction to Agent-Based Modeling" by Uri Wilensky and William F. Dietrich (https://mitpress.mit.edu/9780262731898/an-introduction-to-agent-based-modeling/)

24ITDS509C– BIG DATA SECURITY

Course Category:	Program Core	**Credits:**	3
Course Type:	Programme Elective - III	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand the fundamental concepts of Big Data and its security challenges and Hadoop security.
	CO2	Understand the concepts of securing distributed systems and Hadoop roles and separation strategies.
	CO3	Building security in Hadoop environment and its ecosystem.
	CO4	Understand mechanisms to protect data in a Hadoop cluster, both in transit and at rest.
	CO5	Analyzing data security and event logging.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)

	PO1	PO2	PO3	PO 4	PO 5
CO1		2			2
CO2	1	3			2
CO3	3		3	3	2
CO4	3			2	2
CO5	2		2		2

Course Content

UNIT I: **9 hrs**

Computer and Network Security concepts: Computer Security concepts, challenges of computer security.

OSI security architecture, security attacks, security services, security mechanisms, fundamental security design principles, attack surfaces and attack trees, model for network security.

UNIT II: **9 hrs**

Symmetric Ciphers: Symmetric cipher model, substitution techniques, transposition techniques.

Block ciphers and data encryption standard: traditional block cipher structure, the data encryption standard, a DES example.

Asymmetric ciphers: Public key cryptography and RSA, principles of public key cryptosystems, the RSA algorithm.

UNIT III: **9 hrs**

Introduction to Big Data and Security Challenges: Definition and characteristics of Big Data, Big Data vs. traditional data, Security challenges in Big Data, Importance of Big Data security, Big Data Security, Organizational Security.

Hadoop Security: Histroy of Hadoop Security, Hadoop Security design, Security architecture.

	UNIT IV: **9 hrs** **Securing Distributed Systems:** Threat categories, threat and risk management, vulnerabilities. **System Architecture:** operating environment, Network Security, Hadoop Roles and Separation Strategies, operating system security, Kerberos, Default Hadoop Model without security, Hadoop Kerberos Security Implementation & Configuration.
	UNIT V: **9 hrs** **Identity and Authentication:**Identity: Mapping Kerberos Principals to Usernames, Hadoop User to Group Mapping, Provisioning of Hadoop Users. **Authentication**: Kerberos, Username and Password Authentication, Tokens, ImpersonationConfiguration. Configuring Kerberos for Hadoop ecosystem components with Pig, Hive, Oozie, Flume, HBase, Sqoop.
Text books and Reference books	Text Book(s): **[1]** William Stallings, "Cryptography and Network Security Principles and Practice", 7th Ed,Pearson publications **[2]** Ben Spivey, Joey Echeverria, "Hadoop Security" Released June 2015, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491901342 Reference Books: 1. Gupta, S., Banerjee, I. and Bhattacharyya, S. eds., 2019. Big Data Security (Vol. 3). Walter de Gruyter GmbH & Co KG. **2.** Sudheesh Narayan, Securing Hadoop: Implement robust end-to-end security for your Hadoop ecosystem, packt publisher
E-resources and other digital material	**[1].** Big Data Security https://www.turing.com/resources/big-data-security **[2].** Big Data security and Privacy https://www.youtube.com/watch?v=w5gcoYq_3Cw **[3].** Spark security, https://spark.apache.org/docs/latest/security.html

24ITDS510A– WEB AND SOCIAL MEDIA ANALYTICS

Course Category:	Program Core	**Credits:**	3
Course Type:	Programme Elective - IV	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand web analytics, log file analysis and google analytics
	CO2	Analyse web site traffic, users, content usage and click path analysis using Google Analytics.
	CO3	Derive the similarities of people in the society and find the communities in the society.
	CO4	Apply graph basics to analyze the social media data and measure the network measures
	CO5	Generate recommendations, social recommendations and evaluate recommendations.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)	PO1	PO2	PO3	PO 4	PO 5
CO1	2	1	3	2	2
CO2	3	1	3	2	2
CO3	3	1	3	2	2
CO4	2	1	3	2	2
CO5	2	1	3	2	2

Course Content

UNIT I: **9 hrs**

Web Analytics: Introduction to Web Analytics, User Experience and web analytics, Google Analytics, Web Analytics approach, Know the website, model of analysis.

How Web analytics works: log file analysis, page tagging, metrics and dimensions, interacting with data in Google Analytics.

Goals: Goals and conversions, Conversion Rate, Goal reports in Google Analytics.

UNIT II: **9 hrs**

Learning about Users through web analytics: visitor analysis

Tr**affic analysis:** source and medium, organic search, search query analysis, referral traffic, direct traffic. **Analyzing How People Use Your Content:** web site

	content reports, **Click path-analysis:** focus on relationships between pages, navigation summary, visitors flow report, analyzing how users move from one page to another.
	UNIT III: 9 hrs **Social media mining and its challenges. Graph Essentials:** Graph basics: nodes, edges, degree, degree distribution. Graph representation, types of graphs. Connectivity in graphs. Special graphs **Network Centrality Measures**: Degree centrality, eigenvector centrality, katz centrality, page rank, betweenness centrality
	UNIT IV: 9 hrs **Community analysis**: Community Detection, Node degree, Node Reachability, Social Communities, Community Detection Algorithms, Member Based Community Detection **Group Based Community Detection Algorithms:** Balanced Communities, Robust Communities, Modular Communities, Dense Communities and Hierarchical communities.
	UNIT V: 9 hrs **Recommendation in Social Media:** Recommendation System challenges, classical recommendation algorithms, Content-based methods, collaborative filtering, User-based collaborative filtering, item-based collaborative filtering. **Recommendation using social context:** Recommendation using social context alone, recommendation constrained by social context, Evaluating Recommendations.
Text books and Reference books	TextBooks: 1. Reza Zafarani, Mohammad Ali Abbasi , Huan Liu Social Media Mining: An Introduction, Cambridge University Press 2. Michael Beasley,Practical Web Analytics for User Experience, Publishers: Morgan Kaufmann, ISBN: 9780124046948 Reference books: 1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc. (2010), 2nd ed 2. Actionable Web Analytics: Using Data To Make Smart Business Decisions by Jason Burby and Shane Atchison,2007, Publisher(s): Sybex
E-resources and other digital material	**[1]** Web Mining https://medium.com/image-processing-with-python/web-mining-196e47decb6a **[2]** How to use Google Analytics to measure web site performance https://www.youtube.com/watch?v=90-Ru6EnF1k **[3]** Web analytics tools https://www.youtube.com/watch?v=E801FMdbu88

24ITDS510B–AI AND ML TECHNIQUES FOR CYBER SECURITY

Course Category:	ProgrammeElective	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	2-0-2
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Understand concepts of machine learning, artificial intelligence to address issues in cybersecurity
	CO2	Apply machine learning solutions to detect various cybersecurity problems
	CO3	Use TensorFlow in the cybersecurity domain and implement in real-world applications
	CO4	Analyze and predict security threats using artificial intelligence
	CO5	Demonstrate successful AI approaches and models adaptable to detect potential attacks and protect corporate systems

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3-High)

	PO1	PO2	PO3	PO 4	PO 5
CO1	1				
CO2			2	2	
CO3			2	2	
CO4			2	2	
CO5	1		1		1

Course Content

UNIT I: 10 hrs

Basics of Machine Learning in Cyber Security : Machine Learning, Time Series Analysis and Ensemble Modeling-Time series, Classes of time series models, Time series decomposition, Use cases for Time series, Time series analysis in cyber security, Time series trends and seasonal spikes, Predicting DDoS Attacks, Ensemble Learning methods, Voting ensemble method to detect cyber attacks

Segregating Legitimate and Lousy URLs-Types of abnormalities in URLs, Using heuristics to detect malicious pages, Using ML to detect malicious URLs, Logistic Regression to detect malicious URLs, Logistic Regression to detect malicious URLs, SVM to detect malicious URLs, Multi class classification for URL classification.

UNIT II: 9 hrs

Basics of Machine Learning in Cyber Security : Machine Learning, Time Knocking Down CAPTCHAs- Characteristics of CAPTCHAs, Using AI to crack CAPTCHA

Using Data Science to Catch Email Fraud and Spam : Email spoofing, Spam detection, Efficient Network Anomaly Detection Using k-means- Stages of a network attack, Dealing with lateral movement in networks, Using Windows event logs to detect network anomalies, Ingesting active directory data, Data parsing,

	Modeling,Detecting anomalies in a network with k-means **Decision Tree and Context-Based Malicious Event Detection**- Adware, Bots, Bugs, Ransomware, Rootkit, Spyware, Trojan horses, Viruses, Worms, Malicious data injection within databases, Malicious injections in wireless sensors, Use case, Revisiting malicious URL detection with decision trees
	UNIT III: 10 hrs **Catching Impersonators and Hackers Red Handed**- Understanding impersonation, Different types of impersonation fraud **Levenshtein distanceChanging the Game with TensorFlow**- Introduction to TensorFlow, Installation of TensorFlow, TensorFlow for Windows users, Hello world in TensorFlow, Importing the MNIST dataset, Computation graphs, Tensor processing unit, Using TensorFlow for intrusion detection **Financial Fraud and How Deep Learning Can Mitigate It**- Machine learning to detect financial fraud, Logistic regression classifier – under-sampled data, Deep learning time. Case Studies-Introduction to our password dataset
	UNIT IV: 8 hrs **Introduction to AI for Cybersecurity Professionals :**Applying AI in cybersecurity, Evolution in AI: from expert systems to data mining, Types of machine learning, Algorithm training and optimization, AI in the context of cybersecurity, **Detecting Email Cybersecurity Threats with AI** - Detecting spam with Perceptron's,Spam detection with SVMs, Phishing detection with logistic regression and decision trees, Spam detection with Naive Bayes
	UNIT V: 8 hrs **Malware Threat Detection-**Malware analysis at a glance, Decision tree malware detectors, Detecting metamorphic malware with HMMs, Advanced malware detection with deep learning **Fraud Prevention with Cloud AI Solutions** - Introducing fraud detection algorithms, Predictive analytics for credit card fraud detection, Getting to know IBM Watson Cloud solutions, Importing sample data and running Jupyter Notebook in the cloud, Evaluating the quality of our predictions
Text books and Reference books	**Text Book(s):** **[1].** Soma Halder,SinanOzdemir, "Hands-On Machine Learning for Cybersecurity ",Packt publishing, 1st Edition, Dec 2018. **[2].** Alessandro Parisi, "Hands-On AI for Cybersecurity", Packt Publishing, 1st Edition, August 2019. **Reference (Book)s:** **[1].** Sam Grubb, "How cybersecurity really works: a hands-on guide for total beginners", William Pollock publisher, 2021
E-resources and other digital material	**[1].** Professor Saji k Matthew IIT Madras, "Cyber Security and Privacy", https://onlinecourses.nptel.ac.in/noc23_cs127/ **[2].** Professor Deepak k "Introduction to AI", http://www.digimat.in/nptel/courses/video/106106126/L01.html Professor S. Sarkar IIT Kharagpur "Introduction to machine learning" , https://www.youtube.com/playlist?list=PLYihddLFCgYuWNL55Wg8ALkm6u8U7

24ITDS510C–CONVERSATIONAL AI

Course Category:	ProgrammeElective	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Describe the fundamentals of Conversational AI and its applications
	CO2	Apply basic NLP techniques for Conversational AI development
	CO3	Design engaging conversational flows for effective user interaction
	CO4	Develop a functional Conversational Agent using a chosen platform
	CO5	Analyze and propose strategies for deploying Conversational Agents

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)

	PO1	PO2	PO3	PO4	PO5
CO1	1		2	1	1
CO2	2	1	2	3	2
CO3	1	2	2	2	3
CO4	1	2	2	3	3
CO5	3	3	3	3	2

Course Content

UNIT I: **9 hrs**

Introduction to Conversational AI: Overview and History, Evolution and historical milestones in AI and NLP, Components of Conversational AI.
Types of Conversational Agents: Rule-based chatbots, AI-driven chatbots,Applications and Use Cases- Customer service, Healthcare, Entertainment, E-commerce, Conversational AI Architectures**.**

UNIT II: **9 hrs**

Introduction to Natural Language Processing (NLP): Basics,Machine Learningand Deep Learning for NLP,Advanced Models- Recurrent Neural Networks, LSTM, Bi-LSTM, Encoder-Decoder, Attention.

UNIT III: **9 hrs**

Conversational Design Process: Introduction to Virtual Assistants and Chatbots, Application of chatbots, motivations for chatbots, relevance of chatbot with industry, Conversational design process-Designing conversational flows, writing the scripts.

UNIT IV: **9 hrs**

Building Conversational Agents:Introduction to Dialogflow, Setting up Dialogflow, Agents, types of Intents, creating Intents, training phrases, Entities, configuring rich responses, Small talk and salutations, Configuring and testing Intents on Google Assistant, Working on Connected Flows.

UNITV: **9 hrs**

	Deploying Conversational Agents:Development Frameworks and Tools-Introduction to Popular platforms: Google Dialogflow, Microsoft Bot Framework, RASA, LUIS, QnA Maker. Introduction to Multimodal Conversational AI-Gemini Framework,Microsoft Cortana, Integration with Third party APIs, Connecting to an Enterprise Data Store, Deployment to Cloud.
Text books and Reference books	**Text Book(s):** **[1].** DanielJurafsky&James Martin,"Speech and Language Processing", 3rd Edition, Prentice Hall. **[2].** Michael McTear, Conversational Ai: Dialogue Systems, Conversational Agents, and chat bots (Synthesis Lectures on Human Language Technologies), Morgan & Claypool (2021) **Reference (Book)s:** **[1].** Singh, Abhishek, Karthik Ramasubramanian, and Shrey Shivam. "Building an Enterprise Chatbot.", Springer, Apress, 2019 **[2].** Kelly III, John E., and Steve Hamm. Smart machines: IBM's Watson and the era of cognitive computing, Columbia University Press, 2013.
E-resources and other digital material	**[1].** Amropali Shetty, "What is conversation AI – Benefits and Examples",https://yellow.ai/conversational-ai/ **[2].** Hans van Dam, Co-founder/Dean CDI,"The Conversation Design Workflow AI Training", https://www.youtube.com/watch?v=smkpfY8zjEE **[3].** Dr. Rachael Tatman, "Conversational AI with Rasa: Introduction to Rasa",https://www.youtube.com/watch?v=Ap62n_YAVZ8&list=PL75e0qA87dlEjGAc9j9v3a5h1mxI2Z9fi **[4].** Dr.Jana Bergant, Web Developer,Udemy, "Chatbots: Messenger ChatBot – DialogFlow and nodejs", https://www.udemy.com/course/chatbots/?audience=Keyword&campaigntype=Search&gad_source=2&gclid=EAIaIQobChMIprXZuteuhwMVFatmAh1aBgQ-EAAYASAAEgJULvD_BwE&language=EN&matchtype=b&portfolio=India&priority=&product=Course&test=&topic=&utm_campaign=LongTail_la.EN_cc.INDIA&utm_content=deal4584&utm_medium=udemyads&utm_source=adwords&utm_term=_._ag_82876605567_._ad_670210173503_._kw_dialogflow+tutorial_._de_c_._dm__._pl__._ti_kwd-483727528556_._li_9040200_._pd__._&couponCode=IND21PM **[5].** Bhanu Teja P, Indie Maker and Founder @ SiteGPT & Feather,"Examples of conversational artificial intelligence across diverse industries",https://www.mccormick.northwestern.edu/computer-science/academics/courses/descriptions/347-447.html

24ITDS583-BIGDATA FRAMEWORKS LAB

Course Category:	Program Core	**Credits:**	1.5
Course Type:	Lab	**Lecture-Tutorial-Practice:**	0-0-3
Prerequisites:	• Knowledge of VirtualBox • Familiarity withUnix/Linux Commands • Familiarity with Java/Python Programming	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Configure Hadoop and perform File Management Tasks
	CO2	Apply MapReduce programs to real time issues like word count, weather dataset andsales of a company
	CO3	Critically analyze huge data set using Hadoop distributed file systems and MapReduce
	CO4	Apply different data processing tools like Pig, Hive and Spark.
	CO5	Apply unstructured data by using NoSQL commands

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	1		1	2	
	CO2	1		2	1	
	CO3	2		2	1	
	CO4	2		2	3	
	CO5	2		2	3	

Course Content

Week 1, 2:

1. (i)Perform setting up and Installing Hadoop in its three operating modes:
- Standalone,
- Pseudo distributed,
- Fully distributed.

(ii)Use web-based tools to monitor your Hadoop setup.

Week 3:

2. Implement the following file management tasks in Hadoop:
- Adding files and directories
- Retrieving files
- Deleting files

Hint: A typical Hadoopworkflow creates data files (such as log files) elsewhere and copies them into HDFS using one of the above command line utilities.

	Week 4: 3. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. **Week 5:** 4. Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather a large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record oriented. **Week 6:** 5. Implement Matrix Multiplication with Hadoop Map Reduce **Week 7 , 8:** 6. Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data. **Week 9,10:** 7. Install and Run Hive then use Hive to create, alter, and drop databases, tables, views,functions, and indexes **Week 11** 8.Implement and Perform Streaming Data Analysis using flume for data capture, PYSpark / HIVE for data analysis of twitter data, chat data, weblog analysis etc. 9. Install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL Commands. 10.Develop a Java application to find the maximum temperature using Spark.
Text books and Reference books	**Text Book(s):** 1. Tom White, "Hadoop: The Definitive Guide" Fourth Edition, O'reilly Media, 2015. **Reference Books:** [1]. Glenn J. Myatt, Making Sense of Data , John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O'Reilly, 2011. [2]. 2 Michael Berthold, David J.Hand, Intelligent Data Analysis, Spingers, 2007. [3]. 3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, Uderstanding Big Data : Analytics for Enterprise Class Hadoop and Streaming Data, McGrawHill Publishing, 2012. [4]. 4. AnandRajaraman and Jeffrey David UIIman, Mining of Massive Datasets Cambridge University Press, 2012.
E-resources and other digital material	**[1].** Big Data Use cases for Beginners | Real Life Case Studies | Success Stories https://www.youtube.com/watch?v=HHR0-iJp2sM **[2].** Alexey Grishchenko, Hadoop Vs Mpp, Https://0x0fff.Com/Hadoop-Vs-Mpp/ **[3].** Random Notes On Bigdata- Slideshare: Available www.Slideshare.Net/Yiranpang/Random-Notes-On-Big-Data-26439474 Introduction To Big Data, Ilkay Altintas,Amarnath Gupta,

	Https://Www.Coursera.Org/Learn/Big-Data-Introduction?Specialization=Big-Data

24ITDS584A –COMPUTER VISION AND ROBOTICS LAB

Course Category:	Program Elective	**Credits:**	1.5
Course Type:	Laboratory	**Lecture-Tutorial-Practice:**	0-0-3
Prerequisites:	---	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Implement basic image preprocessing techniques to enhance image quality.
	CO2	Utilize feature detection algorithms for different computer vision applications..
	CO3	Apply object detection methods for real-time tracking of moving objects.
	CO4	Simulate and implement trajectory planning for robotic movements.
	CO5	Develop systems to enhance human-robot communication.

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)	PO1	PO2	PO3	PO 4	PO 5
CO1	2			1	
CO2	2				
CO3	1			3	
CO4				2	
CO5	2			1	

Course Content

Week-1Image Processing Techniques

a. Implement basic image filtering (Gaussian, median).
b. Perform histogram equalization.
c. Apply edge detection (Canny, Sobel).

Week-2. Feature Detection and Matching

a. Detect features using SIFT/SURF.
b. Match features between two images.
c. Implement a basic panorama stitching algorithm.

Week-3. Object Detection

a. Implement a Haar Cascade classifier for face detection.
b. Use a pre-trained YOLO or SSD model for real-time object detection.
c. Create a simple application to track a moving object in a video.

Week-4. Robotic Kinematics and Control

a. Simulate forward and inverse kinematics for a robotic arm.
b. Implement trajectory planning for a robot to follow a predefined

	path. c. Control a robotic simulation using ROS (Robot Operating System). **Week-5. Simultaneous Localization and Mapping** a. Implement a basic 2D SLAM algorithm using laser data. b. Use visual SLAM techniques to map an environment using a camera. c. Visualize SLAM results using RViz (ROS visualization tool). **Week-6. Human-Robot Interaction** a. Develop a gesture recognition system using computer vision. b. Create a simple application where a robot responds to user commands detected via video. c. Implement face recognition for user identification. **Week-7. Case Study:** Demonstration of algorithms related to Visualization Transformers **Week-8. Case Study:** Gestures and Human Pose Recognition for medical applications **Week-9. Case Study:** Facial and Emotion Recognition for Surveillance **Week-10. Case Study:** Agricultural and Military Robotics
Text books and Reference books	**Text Book(s):** **[1].** Richard Szeliski, Computer Vision: Algorithms and Applications, Second edition Springer-Verlag London Limited 2022. **[2].** Bruno Siciliano • Lorenzo Sciavicco,Luigi Villani • Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer-Verlag London Limited. **Reference (Book)s:** **[1].** Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003. **[2].** K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990. **[3].** R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison-Wesley, 1992.
E-resources and other digital material	**[1].** Dr. Mubarak Shah, (13, 07, 2024). UCF Computer Vision Video Lectures,https://www.youtube.com/watch?v=715uLCHt4jE&list=PLd3hlSJsX_ImKP68wfKZJVIPTd8Ie5u-9 **[2].** Prof. M.K. Bhuyan (13, 07, 2024). Computer Vision and Image Processing – Fundamentals and Applications, https://onlinecourses.nptel.ac.in/noc21_ee23/preview **[3].** eNCORD, (13, 07, 2024), Top 8 Applications of Computer Vision in Robotics, https://encord.com/blog/computer-vision-robotics-applications/ **[4].** Santosh Dahal, (13, 07, 2024), Computer Vision For Robotics, https://www.suntos.com.np/computer-vision-for-robotics/

24ITDS584B- SPATIO-TEMPORAL DATA ANALYTICS LAB

Course Category:	Program Elective	**Credits:**	1.5
Course Type:	Lab	**Lecture-Tutorial-Practice:**	0-0-3
Prerequisites:	R &QGIS	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Explore spatial data structure & visualize point distribution.
	CO2	Preprocess spatial data & analyze trends/seasonality.
	CO3	Identify spatial clusters & create maps across time periods.
	CO4	Assess stationarity & identify patterns in time series.
	CO5	Decompose time series & explore spatiotemporal relationships.

Contribution of Course Outcomes towards achievement of ProgramOutcomes (1-Low, 2-Medium, 3-High)

	PO 1	PO2	PO3	PO 4	PO 5
CO1	3		2	1	
CO2					2
CO3			2		
CO4	2		1	3	
CO5					1

Course Content

WEEK – 1: Exploring the Data (Week 1):

a. Download the Spatial dataset for any area.Examine the data structure (columns, data types).
b. Visualize the spatial distribution of point data on a map.

WEEK -2: Data Preprocessing (Week 2):

a. Identify and handle missing values in the data (e.g., interpolation, removal).
b. Check for outliers and inconsistencies in the data.Plot time series graphs of the spatial data to identify trends and seasonality.

WEEK – 3&4 : Spatial Analysis (Week 3& 4):

a. Calculate spatial autocorrelation of data using Moran's I statistic to identify spatial clusters of high/low hotspots.
b. Create maps for different time periods (e.g., monthly, seasonal).

WEEK – 5: Time Series Analysis (Week 5):

a. Assess stationarity of the time series data.
b. Calculate the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) to identify patterns in the data over time.

WEEK – 6&7: Time Series Decomposition (Week 6&7):

a. Decompose the time series data into trend, seasonal, and cyclical components to understand underlying patterns.
b. Visualize the decomposed components to identify long-term trends and seasonal variations.

	WEEK – 8: Combining Spatial and Temporal Analysis (Week 8): a. Explore spatiotemporal relationships by correlating spatial data with weather data (e.g., temperature, wind speed) at different stations over time. WEEK – 9&10: Case Study Exploration &Interactive Visualization (Week 9& 10): a. Implementation of spatiotemporal modeling in air quality analysis (e.g., identifying pollution sources).Analyze a relevant case study data and discuss its findings. b. Create an interactive map or dashboard to visualize air quality data across space and time.
Text books and Reference books	[1] Applied Spatial Data Analysis with R (Second Edition) by Roger S. Bivand, Edzer J. Pebesma, and Virgilio Gómez-Rubio (ASDAR) [2] Spatiotemporal Statistics with R by Christopher K. Wikle, Andrew Zammit-Mangion, and Noel Cressie (STSR) Reference (Book)s: **[1].** Spatiotemporal Data Analytics and Modeling: Techniques and Applications, John A , SatheeshAbimannan, El-Sayed M. El-Alfy, Yue-Shan Chang. **[2].** Longley P. and Batty M. (eds.) (1996) Spatial Analysis: Modelling in a GIS Environment, Geoinformation International, Cambridge, 392pp **[3].** *Statistics for Spatio-Temporal Data* by Noel Cressie and Christopher K. Wikle
E-resources and other digital material	[1] QGIS Tutorial by Ujwal Gandhi, Spatial Thoughts, Link: https://www.qgistutorials.com/en/docs/3/animating_time_series.html [2]SantoshGhanshu, "A spatiotemporal analysis of Land surface temperature day and night using Modis data" Accessible athttps://in.video.search.yahoo.com/video/play;_ylt=AwrKArSD_phmSP0XVDzmHAx.;_ylu=c2VjA3NyBHNsawN2aWQEZ3BvcwMxMg--?p=spatiotemporal+data+analysis+in+QGIS

24ITDS584C: BIG DATA SECURITY LAB

Course Category:	Program Elective	**Credits:**	1.5
Course Type:	Lab	**Lecture-Tutorial-Practice:**	0-0-3
Prerequisites:	Operating System, Computer Networks	**Continuous Evaluation:**	40
		Semester end Evaluation:	60
		Total Marks:	100

Course Outcomes	Upon successful completion of the course, the student will be able to:	
	CO1	Implement data security using symmetric and asymmetric algorithms.
	CO2	Scanning the target systems in the Network using nmap.
	CO3	Analyze the Network traffic using Wireshark.
	CO4	Configure Hadoop environment using Hadoop Kerbos for authentication.
	CO5	Practice Authorization and auditing in Hadoop using Apache Ranger.
	CO6	Design solutions for complex real world problems using Big Data security .

Contribution of Course Outcomes towards achievement of Program Outcomes (1-Low, 2-Medium, 3- High)		PO1	PO2	PO3	PO 4	PO 5
	CO1	1		1	2	2
	CO2	1		2	1	2
	CO3	2		2	1	2
	CO4	2		2	2	2
	CO5	2		2	2	2

Course Content

Week 1 & 2 : Programs on data security and privacy algorithms

A. Implementing Symmetric Key Encryption using PyCrypto library

B. Implementing Asymmetric Key Encryption using Python (PyCryptodome library)

Week 3 & 4: Scanning the target using Network mapper - Nmap .

A. Use nmap to scan the target and find the software version of the OS and the running services (list at least 3 of the running services).

B. Use OpenVAS to find two vulnerabilities of the target, and briefly describe them.

Week 5 & 6 : Network traffic analysis using wireshark.

A. Install Wireshark on your home computer.

B. Launch Wireshark in the mode of capturing traffic passing through an interface connected to the local network (usually eth0).

C. Analyze the captured traffic and generate reports.

Week 7: Hadoop installation and security features using SSL.

A. Download Hadoop (latest stable version) and install multinode cluster.

	Week 8 & 9 : Setting Up Kerberos Authentication and Configure Hadoop for Kerbos A. Configure Kerberos: and Configure the KDC. B. Create the KDC database. C. Create principals for Hadoop services and users. **Week 10 & 11: Download and Install Apache Ranger:** A. Install Apache ranger with plugins. B. Setting Up Apache Ranger for Authorization C. Start ranger Admin D. Install ranger plugins for HDFS, HIVE and Yarn. **Week 12: Setting up audit log and Design solutions for big data analysis problems using Hadoop security.**
Text books and Reference books	**Text Book(s):** [1] Ben Spivey, Joey Echeverria, "Hadoop Security" Released June 2015, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491901342 [2] Gupta, S., Banerjee, I. and Bhattacharyya, S. eds., 2019. Big Data Security (Vol. 3). Walter de Gruyter GmbH & Co KG. **Reference Books:** [1] Ben Spivey, Joey Echeverria, "Hadoop Security Protecting Your Big Data Problem", O'Reilly Media, 2015.
E-resources and other digital material	[1] Top Tips for Securing Big Data Environments: e-book (http://www.ibmbigdatahub.com/whitepaper/top-tips-securing-big-data-environments-ebook) [2] http://www.dataguise.com/?q=securing-hadoop-discovering-and-securing-sensitive-datahadoop-data-stores [3]. Gazzang for Hadoop http:// www.cloudera.com/ content/ cloudera/ n/solutions/ enterprisesolutions/ security-for-hadoop.html [4]. eCryptfs for Hadoop https://launchpad.net/ecryptfs. [5]. Project Rhino - https://github.com/intel-hadoop/project-rhino/

24MTUC502 - TECHNICAL REPORT WRITING

Course Category:	Audit Course	**Credits:**	0
Course Type:	Theory	**Lecture-Tutorial-Practice:**	2 - 0 - 0
Prerequisites:	Nil	**Total Marks:**	Nil

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Develop proficiency in scientific writing by effectively structuring and composing scientific and engineering papers, including titles, abstracts, introductions, methods, results, discussions, conclusions, and managing references.
	CO2	Enhance visual communication skills through the selection and creation of appropriate charts, graphs, tables, and diagrams to effectively present data and information in technical reports.
	CO3	Master LaTeX for document preparation by utilizing its tools for document structure, formatting, integrating special characters, and managing bibliographies to enhance document clarity and professionalism.
	CO4	Apply advanced LaTeX techniques for inserting and formatting equations, managing BibTeX files, citing references, and using styles to maintain consistency and accuracy in technical documents.
	CO5	Integrate tables, figures, and equations effectively using LaTeX to enhance document organization, visual appeal, and overall quality in scientific and engineering papers.

Contribution of Course Outcomes towards achievement of program outcomes (1-Low, 2-Medium, 3- High)		**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO5**
	CO1	1	3	1		
	CO2	1	3	1		
	CO3	1	3	1		
	CO4	1	3	1		
	CO5	1	3	1		

Course Content	**UNIT I: 6 hrs** **Writing scientific and engineering papers-**Title, Abstract, Introduction, Materials And Methods, Result, Discussion, Conclusion, Reference Books, Acknowledgements, Appendices, Hedging and Criticizing, Paraphrasing and Plagiarism.
	UNIT II: 9 hrs 7 hrs **Effective use of charts, graphs and tables-**Bar Chart, Line Chart, Pie Chart, Area Chart, Cylindrical Chart, Column Bars, Bubble Chart, Flow Diagram,

	Screen Capture, Tables **Writing Technical Reports-**Objectives Of Technical Report, Types Of Reports, Steps In Writing A Technical Report, Guidelines For Writing A Technical Report.
	UNIT III: 6 hrs LATEX- Introduction, Document Structure- Creating a Title, Sections, Labeling, Table of Contents **Typesetting Text-** Font Effects, Colored Text, Font Sizes, Lists, Comments & Spacing, Special Characters, symbols
	UNIT IV: 7 hrs **Tables, Figures, Equations-** Inserting Equations, Mathematical Symbols, Practical Applications. **Inserting Reference Books-** Introduction, The BibTeX file, Inserting the bibliography, Citing Reference Books, Styles, Practical Applications, • LaTeX Exercises and Projects
	UNIT V: 7 hrs **Integrating Tables, Figures, and Equations-**Practical Applications of Tables, Figures, and Equations,Advanced LaTeX Features for Technical Documents **Using LaTeX for Complex Document Structures-**Enhancing Document Quality with LaTeX**,** Applying LaTeX in Scientific and Engineering Papers
Text books and Reference books	**Text Book(s):** **[1]** Barun K Mitra, Effective Technical Communication-A Guide for Scientists and Engineers, Oxford University Press, 2006, ISBN: 978019568291. **[2]** LATEX for Beginners, Workbook Edition 5, March 2014 Document Reference: 3722-2014. **Reference Books:** **[1]** Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) **[2]** Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
E-resources and other digital material	**[1].** LaTeX Basics - https://www.overleaf.com/learn/latex/sections_and_chapters **[2].** Citation & Style Guide - https://libguides.cu-portland.edu/citationstyles **[3].** Advanced LaTeX Techniques for Scientific Writing in Journal of Technical Writing and Communication, Volume 45, Issue 4, pp. 321-335 **[4].** Enhancing Technical Documentation with LaTeX in IEEE Transactions on Professional Communication, Volume 59, Issue 2, pp. 123-137

24ITDS593 - TERM PAPER

Course Category:	**Term paper**	**Credits:**	**1**
Course Type:	Term paper	**Lecture-Tutorial-Practice:**	0-0-2
Prerequisites:	NIL	**Continuous Evaluation:**	60
		Semester end Evaluation:	40
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Identify real world problems related to Data Science area
	CO2	Analyse the problems from its state of the art for arriving at feasible solutions
	CO3	Prepare an organized report employing elements of technical writing & critical thinking
	CO4	Summarize and communicate the content to audience in an effective manner

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H- High)		**PO1**	**PO2**	**PO3**	**PO 4**	**PO 5**
	CO1	1	1	1	1	1
	CO2	3	1	2	2	2
	CO3	1	3	1	1	1
	CO4	1	3	1	1	1

Course Content	Student shall collect the literature on the advanced topic in relevant fields and critically review the literature and submit it to the department in a form of report and shall make an oral presentation before the Academic Committee

24ITDS592 – Capstone Project 2

Course Category:	Project	**Credits:**	1
Course Type:	Practical	**Lecture-Tutorial-Practice:**	0-0-2
Prerequisites:	Concepts of AI and Datascience	**Continuous Evaluation:**	60
		Semester end Evaluation:	40
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**					
	CO1	Apply Data Science and AI principles to address complex engineering problems within their chosen project theme				
	CO2	Showcase advanced proficiency in utilizing specialized software tools for analysis, design, and simulation relevant to the chosen project theme				
	CO3	Develop the ability to propose innovative and creative solutions to societal problems within the field of Datascience, integrating advanced knowledge and skills.				
	CO4	Enhance their professional communication skills by preparing comprehensive technical reports and delivering effective presentations that document project work and findings				
Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H- High)		**PO1**	**PO2**	**PO3**	**PO 4**	**PO 5**
	CO1	2	1	2	2	2
	CO2	2	2	1	2	2
	CO3	3	2	3	3	2
	CO4	1	3	2	1	1
Course Content	The project shall be carried out in the major areas pertaining to the program approved by Project Review Committee and may address the societal problems/issues related to the program					

SEMESTER III

24ITDS601 – SELF LEARNING (MOOCS COURSE)

Course Category:	Program Elective-V	**Credits:**	3
Course Type:	theory	**Lecture-Tutorial-Practice:**	3-0-0
Prerequisites:	-	**Continuous Evaluation:**	-
		Semester end Evaluation:	-
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Select appropriate MOOCs that align with their academic and career objectives
	CO2	Apply the knowledge and skills acquired from MOOCs to their academic projects and professional practice
	CO3	Evaluate the impact of self-learning on their personal and professional growth.
	CO4	Develop a habit of continuous learning and staying updated with the latest advancements in Artificial Intelligence and Data Science

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H- High)		**PO1**	**PO2**	**PO3**	**PO 4**	**PO 5**
	CO1				1	
	CO2	1		1	2	2
	CO3	1		2	2	2
	CO4				1	1

Course Content	The department will recommend the self-learning courses from the available open courseware. The self-learning courses shall be taken from the list of approved MOOCs providers (SWAYAM / NPTEL/ EDX / Others).They must be approved/ratified in the respective Board of Studies and must have a minimum duration of 12 weeks.

24ITDS681 – INTERNSHIP

Course Category:	Internship	**Credits:**	2
Course Type:	Project	**Lecture-Tutorial-Practice:**	0-0-4
Prerequisites:	-	**Continuous Evaluation:**	60
		Semester end Evaluation:	40
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Demonstrate the ability to apply theoretical concepts and engineering principles to solve practical problems encountered during their internship.
	CO2	Exhibit improved professional skills, including teamwork, communication, project management, and adherence to industry standards and ethics.
	CO3	Gain hands-on experience with industry-specific tools, software, and methodologies, enhancing their technical proficiency and readiness for the workforce
	CO4	Prepare a comprehensive report of the internship work and communicate the outcome of the work effectively through oral presentation

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H- High)		**PO1**	**PO2**	**PO3**	**PO 4**	**PO 5**
	CO1	2	1	2	1	2
	CO2	1	1	1	2	3
	CO3	3	2	3	3	3
	CO4	1	1	2	1	1

Course Content	The students shall undergo Internship for a period of six weeks in Industry/ Research organizations/ institute of higher learning approved by the Head of the Department during any time after the second semester

24ITDS682 - PROJECT PART-A

Course Category:	Project	**Credits:**	10
Course Type:	Practical	**Lecture-Tutorial-Practice:**	0-0-20
Prerequisites:	Term Paper	**Continuous Evaluation:**	60
		Semester end Evaluation:	40
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Identify a topic in relevant areas of Data Science
	CO2	Review literature to identify gaps and define objectives & scope of the project
	CO3	Apply appropriate research methodology to provide a solution to the chosen problem
	CO4	Prepare a technical report effectively using modern tools

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H- High)		**PO1**	**PO2**	**PO3**	**PO 4**	**PO 5**
	CO1	2	1	2	2	2
	CO2	2	2	1	2	2
	CO3	3	2	3	3	2
	CO4	1	3	2	1	1

Course Content	The project shall be carried out in the major areas pertaining to the program approved by Project Review Committee and may address the societal problems/issues related to the program

SEMESTER IV

24ITDS683 - PROJECT PART-B

Course Category:	Project Part-B	**Credits:**	16
Course Type:	Project	**Lecture-Tutorial-Practice:**	0-0-32
Prerequisites:	Project Part-A	**Continuous Evaluation:**	60
		Semester end Evaluation:	40
		Total Marks:	100

Course Outcomes	**Upon successful completion of the course, the student will be able to:**	
	CO1	Identify methods and resources to carry out analysis and experiments
	CO2	Reorganize the procedures with a concern for society, environment and ethics
	CO3	Generate possible alternative solutions to chosen problem, compare, analyze them and derive performance metrics of the result
	CO4	Prepare a comprehensive report of the project work and also explore the possibility of publishing the work.

Contribution of Course Outcomes towards achievement of Program Outcomes (L-Low, M-Medium, H- High)		**PO1**	**PO2**	**PO3**	**PO 4**	**PO 5**
	CO1	2	1	2	1	2
	CO2	1	1	1	2	3
	CO3	3	2	3	3	3
	CO4	1	3	2	1	1

Course Content	Project Part B shall be the extension of project Part A.