AEC-02	One from Pool	241/CS/AE201	2	-	-	2	-	-	2	15	35	-	-	50
Skill Enhancement Course(s)														
SEC-01	One from Pool	241/CS/SE201	2	-	-	2	-	-	2	15	35	-	-	50
Total Credits									**22**					**550**

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A07	Artificial Intelligence	241/CS/CC301	3	0	2	3	0	1	4	25	50	5	20	100
CC-A08	Software Engineering & Testing	241/CS/CC302	3	0	2	3	0	1	4	25	50	5	20	100
CC-A09	R programming	241/CS/CC303	3	0	2	3	0	1	4	25	50	5	20	100
Discipline Specific Elective Courses														
DSE-03	Block Chain Technology Or Soft Computing Techniques using Neural Networks	241/CS/DS301 241/CS/DS302	2	1	0	2	1	0	3	25	50	-	-	75
Multidisciplinary Course(s)														
MDC-03	One from Pool	241/CS/MD301	2	1	-	2	1	-	3	25	50	-	-	75
Skill Enhancement Course(s)														
SEC-02	One from Pool	241/CS/SE301	2	-	-	2	-	-	2	15	35	-	-	50
Value-added Course(s)														
VAC-02	One from Pool	241/CS/VA301	2	-	-	2	-	-	2	15	35	-	-	50
Seminar														
Seminar	Seminar	241/CS/SM301	2	-	-	2	-	-	2	50	-	-	-	50
Internship/Field Activity#														
	Internship/Field Activity	241/CS/INT301	-	-	8	-	-	4	4	100	-	-	-	100
Total Credits									**28**					**700**

#Four credits of internship earned by a student during summer internship after 2nd semester will be counted in 3rd semester of a student who pursue 2 year PG Programme without taking exit option.

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A10	Machine Learning using Python	241/CS/CC401	3	0	2	3	0	1	4	25	50	5	20	100
CC-A11	Big Data Analytics	241/CS/CC402	3	0	2	3	0	1	4	25	50	5	20	100
Discipline Specific Elective Courses														
DSE-04	Optimization Techniques Or Cloud Computing and IoT	241/CS/DS401 241/CS/DS402	2	1	0	2	1	0	3	25	50	-	-	75
Multidisciplinary Course(s)														
MDC-04	One from Pool	241/CS/MD401	2	1	-	2	1	-	3	25	50	-	-	75
Ability Enhancement Course(s)														
AEC-03	One from Pool	241/CS/AE401	2	-	-	2	-	-	2	15	35	-	-	50

Community Engagement/Field Work/Survey/Seminar/Project/Training														
	Project/Training	241/CS/PR401	-	-	12	-	-	6	6	-	-	-	-	150
Total Credits									**22**					**550**

241/CS/CC401

MACHINE LEARNING USING PYTHON

Semester	4			
Course code	CC-A10			
Category	Core Course(s)			
Course title	Machine Learning Using Python			
Course ID	241/CS/CC401			
Scheme and Credits	L	T	P	Credits
	3	0	1	4
Theory Internal	25 marks			
Theory External	50 marks			
Practical Internal	5 marks			
Practical External	20 marks			
Total	100 marks			
Duration of Exam	3 hrs			

Note: *The examiner will set nine questions in total. Question one will have seven parts from all units and the marks of first question will be of 20% of total marks of Question Paper and the remaining eight questions to be set by taking two questions from each unit and the marks of each question from Question no.2 to 9 will be of 20% of total marks of Question paper. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.*

COURSE OUTCOMES:

At the end of this course, students will demonstrate the ability to

CO1: Define machine learning and its types, Compare machine learning approaches with traditional programming methods.

CO2: Demonstrate proficiency in Python syntax, including data types and control structures.

CO3: Apply NumPy and Pandas skills to preprocess and prepare data for machine learning models effectively.

CO4: Apply dimensionality reduction techniques (PCA, t-SNE) to reduce the complexity of high-dimensional data and visualize relationships.

CO5: Gain insights into advanced machine learning topics such as Support Vector Machines (SVM) for classification and regression tasks, and delve into neural networks and deep learning basics using TensorFlow/Keras for building and training models

UNIT I

Introduction to Machine Learning and Python Basics: Overview of machine learning:

definitions, types (supervised, unsupervised, reinforcement learning), and applications. Comparison of machine learning with traditional programming approaches.

Python Basics for Machine Learning: Introduction to Python programming language: syntax, data types (numeric, string, list, tuple, dictionary), and control structures (loops, conditionals), Basic input/output operations and functions in Python.

NumPy and Pandas for Data Manipulation: Introduction to NumPy: arrays, array operations, and mathematical functions, Data manipulation and analysis with Pandas: Series, DataFrames, indexing, and basic data operations.

UNIT II

Supervised Learning Algorithms: Linear Regression: Understanding the linear regression model and its applications, Implementing linear regression using scikit-learn in Python, model evaluation, and interpretation of results.

Classification Algorithms: Introduction to classification: logistic regression, k-nearest neighbors (KNN), decision trees, and ensemble methods (random forests), Implementing classification algorithms using scikit-learn, evaluating classification models, and handling performance metrics.

UNIT III

Unsupervised Learning Algorithms: Clustering Algorithms: Introduction to clustering: k-means clustering, hierarchical clustering, and density-based clustering (DBSCAN), Implementing clustering algorithms using scikit-learn, evaluating clustering results, and applications in data segmentation.

Dimensionality Reduction: Techniques for dimensionality reduction: principal component analysis (PCA) and t-distributed stochastic neighbor embedding (t-SNE), Implementing dimensionality reduction techniques in Python and visualizing high-dimensional data.

UNIT IV

Advanced Topics in Machine Learning: Support Vector Machines (SVM), Understanding the SVM algorithm for both classification and regression tasks, Implementing SVM using scikit-learn, tuning hyperparameters, and handling non-linear data.

Neural Networks and Deep Learning Basics: Introduction to artificial neural networks (ANNs), deep learning, and deep neural networks (DNNs). Building and training simple neural networks using TensorFlow/Keras in Python for classification and regression tasks.

BOOKS:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien

Géron

2. Python Machine Learning by Sebastian Raschka and Vahid Mirjalili

3. Introduction to Machine Learning with Python: A Guide for Data Scientists by Andreas C. Müller and Sarah Guido

MACHINE LEARNING USING PYTHON LAB

Note: At least 8 experiments are to be performed by the students.

List of Subject related Experiments

1. Perform data preprocessing tasks such as handling missing values, encoding categorical variables, and scaling numerical features. Visualize data distributions, correlations, and relationships using Pandas and Matplotlib libraries.
2. Implement a simple linear regression model using scikit-learn to predict a continuous target variable. Visualize the regression line and residuals to assess model performance.
3. Implement and compare different classification algorithms (e.g., logistic regression, KNN, decision trees) using scikit-learn.
4. Apply the K-Means clustering algorithm to group data points into clusters based on similarity. Visualize clusters and centroids to interpret clustering results.
5. Perform dimensionality reduction using Principal Component Analysis (PCA) to reduce the number of features in a dataset.
6. Implement a Support Vector Machine (SVM) classifier for both linear and non-linear datasets.
7. Build and train a simple artificial neural network (ANN) using Keras and TensorFlow backend.
8. Implement a Convolutional Neural Network (CNN) architecture using Keras for image classification tasks (e.g., MNIST, CIFAR-10).
9. Evaluate CNN performance on test data and visualize feature maps and filters.

BIG DATA ANALYTICS

Semester	4			
Course code	CC-A11			
Category	Core Course(s)			
Course title	Big Data Analytics			
Course ID	241/CS/CC402			
Scheme and Credits	L	T	P	Credits
	3	0	1	4
Theory Internal	25 marks			
Theory External	50 marks			
Practical Internal	5 marks			
Practical External	20 marks			
Total	100 marks			
Duration of Exam	3 hrs			

Note: *The examiner will set nine questions in total. Question one will have seven parts from all units and the marks of first question will be of 20% of total marks of Question Paper and the remaining eight questions to be set by taking two questions from each unit and the marks of each question from Question no.2 to 9 will be of 20% of total marks of Question paper. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.*

COURSE OUTCOMES:

At the end of this course, students will demonstrate the ability to

CO1: Identify the characteristics and challenges of big data analytics.

CO2: Implement the Hadoop and MapReduce framework for processing massive volume of data.

CO3: Analyze data by utilizing various statistical and data mining approaches.

CO4: Implement CRUD operations effectively using MongoDB and Report generation using Jaspersoft studio.

CO5: Explore the usage of Hadoop and its integration tools to manage Big Data and use Visualization Techniques.

CO6: Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

UNIT-I

Introduction to Big Data: Types of Digital Data-Characteristics of Data, Evolution of Big Data, Definition of Big Data, Characteristics, Applications & Challenges with Big Data, 3Vs of Big Data, Non-Definitional traits of Big Data, Big Data workflow Management, Business Intelligence vs. Big Data, Distributed file systems.

UNIT-II

Big Data Analytics: Classification of analytics, Data Science, Terminologies in Big Data, CAP Theorem.

Introduction to Hadoop: Features, Advantages, Overview of Hadoop Eco systems, Hadoop distributions, SQL vs. Hadoop, Hadoop Components, Architecture, HDFS.

UNIT-III

Map Reduce: Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression.

NoSQL: Types of Databases, Advantages, SQL vs. NoSQL, NewSQL

Mongo DB: Introduction, Features, Data types, Mongo DB Query language, CRUD operations. Arrays. Functions: Count, Sort, t – Limit, Skip, Aggregate, Map Reduce. Cursors: Indexes, Mongo Import, Mongo Export.

UNIT-IV

Cassandra: Introduction, Features, CQLData types, CQLSH, Key spaces, CRUD operations, Collections, Counter, TTL, alter commands, Import and Export, Querying System tables.

BOOKS:

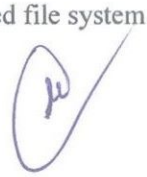
1. T. Erl , W.Khattak and P. Buhler., *Big Data Fundamentals, Concepts, Drivers & Techniques* (1e), The Prentice Hall Service Technology Series, 2016.
2. S. Acharya, *Big Data and Analytics*, Wiley India Pvt. Ltd., 2015
3. V. Prajapati, *Big Data Analytics with R and Hadoop*, Packt Publishing Ltd., 2013.
4. A. Holmes, *Hadoop in Practice*, (2e), Manning Publications, 2015
5. S. Ryza, *Advanced Analytics with Spark: Patterns for Learning from Data at Scale*, (2e), O'Reilly, 2017.

BIG DATA ANALYTICS LAB

Note: At least 8 experiments are to be performed by the students.

List of Subject related Experiments:

1. Identify and classify various types of digital data (structured, semi-structured, unstructured). Compare traditional data management approaches with big data management challenges.
2. Install and set up a Hadoop distribution (e.g., Apache Hadoop, Cloudera, Hortonworks). Explore Hadoop components: HDFS (Hadoop Distributed File System), YARN (Yet Another Resource Negotiator), MapReduce.
3. Develop and execute a MapReduce program using Hadoop framework.
4. Implement basic MapReduce tasks such as word count, searching, sorting, and data aggregation.
5. Install and configure MongoDB database management system
6. Implement MongoDB functions: count, sort, limit, skip, aggregate, and map-reduce operations.
7. Setup and configure Apache Cassandra database. Create keyspaces and tables using Cassandra Query Language (CQL).
8. Apply Hadoop and MapReduce for analyzing large datasets. Perform analytics tasks such as data aggregation, statistical analysis, and trend identification.
9. Design and implement a distributed file system using Hadoop HDFS or similar technologies.



241/CS/DS401

OPTIMISATION TECHNIQUES

Semester	4			
Course code	DSE-04			
Category	Discipline Specific Elective Courses			
Course title	Optimisation Techniques			
Scheme and Credits	L	T	P	Credits
	2	1	0	3
Theory Internal	25 marks			
Theory External	50 marks			
Total	75 Marks			
Duration of Exam	3 hours			

Note: *The examiner will set nine questions in total. Question one will have seven parts from all units and the marks of first question will be of 20% of total marks of Question Paper and the remaining eight questions to be set by taking two questions from each unit and the marks of each question from Question no.2 to 9 will be of 20% of total marks of Question paper. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.*

UNIT – I

Introduction to Optimization: Definition and scope of optimization techniques, Classification of optimization problems: linear vs. nonlinear, discrete vs. continuous, single-objective vs. multi-objective, Applications of optimization in various domains: engineering, economics, operations research, machine learning, etc.

Linear Programming: Formulation of linear programming (LP) problems: constraints, objective function, decision variables, Simplex method for solving LP problems: initialization, pivoting, optimality conditions, Duality in linear programming and economic interpretation.

Integer Programming and Combinatorial Optimization: Introduction to integer programming (IP) and mixed-integer programming (MIP) problems, Branch and bound method for solving IP problems, Applications of combinatorial optimization: traveling salesman problem (TSP), knapsack problem, scheduling problems.

UNIT – II

Nonlinear Optimization: Unconstrained Optimization: Optimization without constraints: gradient-based methods (gradient descent, Newton's method), Line search methods and convergence criteria, Applications in machine learning: parameter estimation, neural network training.

Constrained Optimization: Constrained optimization problems: equality and inequality constraints, Lagrange multipliers and KKT conditions for constrained optimization, Interior point methods and penalty methods for solving constrained optimization problems.

UNIT – III

Metaheuristic Optimization Techniques:

Evolutionary Algorithms: Introduction to evolutionary algorithms: genetic algorithms (GA), differential evolution (DE), Genetic operators: selection, crossover, mutation, Applications of evolutionary algorithms in optimization and search problems.

Swarm Intelligence: Basics of swarm intelligence: particle swarm optimization (PSO), ant colony optimization (ACO), Algorithmic principles, convergence properties, and parameter tuning, Real-world applications of swarm intelligence techniques.

UNIT – IV

Multi-objective Optimization: Pareto optimality and the concept of Pareto front, Multi-objective evolutionary algorithms (MOEA): NSGA-II, SPEA2, Decision-making in multi-objective optimization: weighted sum approach, epsilon-constraint method.

Applications of Optimization Techniques: Optimization techniques in data science: feature selection, model parameter tuning, Optimization in machine learning pipelines: hyperparameter optimization using grid search, random search, and Bayesian optimization

BOOKS:

1. Optimization for Machine Learning by Suvrit Sra, Sebastian Nowozin, and Stephen J. Wright

2. Introduction to Linear Optimization by Dimitris Bertsimas and John N. Tsitsiklis

3. Metaheuristics: From Design to Implementation by El-Ghazali Talbi

241/CS/DS402

CLOUD COMPUTING & IOT

Semester	4			
Course code	DSE-04			
Category	Discipline Specific Elective Courses			
Course title	Cloud Computing & IoT			
Scheme and Credits	L	T	P	Credits
	2	1	0	3
Theory Internal	25 Marks			
Theory External	50 Marks			
Total	75 Marks			
Duration of Exam	3 hours			

Note: *The examiner will set nine questions in total. Question one will have seven parts from all units and the marks of first question will be of 20% of total marks of Question Paper and the remaining eight questions to be set by taking two questions from each unit and the marks of each question from Question no.2 to 9 will be of 20% of total marks of Question paper. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.*

COURSE OUTCOMES:

At the end of this course, students will demonstrate the ability to

CO1: Understand the concepts of Internet of Things

CO2: Analyze basic protocols network

CO3: Understand the concepts of Web of Things

CO4: Basic Understanding of Cloud Computing.

UNIT - I

INTRODUCTION TO CLOUD COMPUTING: Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing.

UNIT - II

CLOUD COMPUTING ARCHITECTURE: Requirements, Introduction Cloud computing architecture, On Demand Computing Virtualization at the infrastructure level, Security in Cloud computing environments, CPU Virtualization, A discussion on Hypervisors Storage Virtualization Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model Cloud Deployment Models Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise .

UNIT – III

INTRODUCTION TO IOT: Introduction to IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs

NETWORK AND COMMUNICATION ASPECTS: Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.

UNIT – IV

WEB OF THINGS: Web of Things vs Internet of things, two pillars of web, Architecture and standardization of IoT, Unified multitier-WoT architecture, WoT portals and Business intelligence, Cloud of things: Grid/SOA and cloud computing, Cloud middleware, cloud standards

BOOKS:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory
and Practice"
3. Cuno Pfister, “Getting Started with the Internet of Things”, Shroff Publisher/Maker Media.
4. Internet of Things, RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan, John Wiley and Sons