CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

Course Structure for M. Tech.
Artificial Intelligence & Data Science
(I – IV SEMESTERS)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE Model Curriculum (with effect from 2026-27)
M.Tech (Artificial Intelligence and Data Science)

SEMESTER– I

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per Week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	26ADC101	Data Engineering	3	-	3	40	60	3
2	26ADC102	Advanced Artificial Intelligence and Machine Learning	3	-	3	40	60	3
3		Program Elective-1	3	-	3	40	60	3
4		Program Elective-2	3	-	3	40	60	3
5	26MEM101	Research Methodology and IPR	2	-	3	40	60	2
6		Audit Course-1	2	-	2	-	50	Non-Credit
PRACTICALS								
7	26ADC103	Data Engineering Lab	-	2	-	50	-	1
8	26ADC104	Advanced Artificial Intelligence and Machine Learning Lab	-	2	-	50	-	1
9		Program Elective-2 Lab	-	2	-	50	-	1
TOTAL			**16**	**06**	**-**	**350**	**350**	**17**

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**
CIE - Continuous Internal Evaluation **SEE-Semester End Examination**

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE Model Curriculum (with effect from 2026-27)
M.Tech (Artificial Intelligence and Data Science)

SEMESTER-II

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per Week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1	26ADC105	Cloud Computing	3	-	3	40	60	3
2	26ADC106	Advanced Data Science Techniques	3	-	3	40	60	3
3	26ADC107	Advanced Deep Learning	3	-	3	40	60	3
4		Program Elective-3	3	-	3	40	60	3
5		Program Elective-4	3	-	3	40	60	3
PRACTICALS								
6	26ADC108	Advanced Data Science Techniques Lab	-	2	-	50	-	1
7	26ADC109	Advanced Deep Learning Lab	-	2	-	50	-	1
8		Program Elective-4 Lab	-	2	-	50	-	1
9	26ADC110	Mini Project	-	2	-	50	-	1
TOTAL			**15**	**8**	**-**	**400**	**300**	**19**

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**
CIE-Continuous Internal Evaluation **SEE-Semester End Examination**

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

AICTE Model Curriculum (with effect from 2026-27)
M.Tech (Artificial Intelligence and Data Science)

SEMESTER–III

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per Week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
THEORY								
1		Program Elective-5	3	-	3	40	60	3
2		Open Elective	3	-	3	40	60	3
3		Audit Course-2	2	-	2	-	50	Non-Credit
PRACTICALS								
4	26ADC111	Dissertation Phase-I	-	20	-	100	-	10
TOTAL			**8**	**20**	**-**	**180**	**170**	**16**

SEMESTER–IV

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per Week		Duration of SEE in Hours	Maximum Marks		
			L/T	P/D		CIE	SEE	
PRACTICALS								
1	26ADC112	Dissertation Phase-II	-	32	Viva Voce	100	100	16
TOTAL			**-**	**32**	**-**	**100**	**100**	**16**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE-Continuous Internal Evaluation SEE-Semester End Examination

Total No. of Credits: 68

LIST OF COURSES

S.No.	Code	Course	Credits
Mandatory Courses			
1	26MEM101	Research Methodology and IPR	2
Program Elective-1			
2	26ADE104	Social Network Analytics	3
3	26ADE105	Blockchain Technology	3
4	26ADE112	Ethics and AI	3
5	26ADE102	Information Retrieval Systems	3
6	26ADE103	Time Series Analysis and Forecasting	3
Program Elective-2 (with lab)			
7	26ADE118	Predictive Analytics with R	3
8	26ADE115	Cyber Security	3
9	26ADE116	Big Data Analytics	3
10	26ADE119	Robotic Process Automation	3
11	26ADE125	Natural Language Processing	3
Program Elective-3			
12	26ADE101	Nature Inspired Computing	3
13	26ADE106	Recommender Systems	3
14	26ADE107	Reinforcement Learning	3
15	26ADE113	Healthcare Analytics	3
16	26ADE117	Augmented and Virtual Reality	3
Program Elective-4 (with lab)			
17	26ADE120	Federated Machine Learning	3
18	26ADE121	Edge Computing	3
19	26ADE122	Advanced Data Structures and Algorithms	3
20	26ADE124	Generative and Agentic AI	3
21	26ADE126	High Performance Computing	3
Program Elective-5			
22	26ADE110	Explainable Artificial Intelligence (EAI)	3
23	26ADE108	Scalable Algorithms and Systems for Data Analysis	3
24	26ADE111	Quantum Computing	3
25	26ADE109	Cyber Physical Systems	3
26	26ADE123	Mining Massive Data Sets	3
Audit Course – 1 and 2			
27	26EGA101	English for Research Paper Writing	0
28	26CEA101	Disaster Mitigation and Management	0
29	26EEA101	Sanskrit for Computational Thinking & Engineering Applications	0
30	26ECA101	Value Education	0
31	26EGA102	Constitution OF India	0
32	26ADA101	Pedagogy Studies	0
33	26EGA103	Stress Management by Yoga	0
34	26EGA104	Personality Development Through Life's Enlightenment Skills	0
Open Elective Courses			
35	26CSO101	Business Analytics	3
36	26MEO102	Introduction to Optimization Techniques	3
37	26CEO101	Cost Management of Engineering Projects	3
38	26MEO101	Industrial Safety	3
39	26MEO103	Composite Materials	3
40	26EEO102	Electric Vehicles & Future Mobility	3
Program Elective-2 Lab			
41	26ADE131	Predictive Analytics in R Lab	1
42	26ADE128	Cyber Security Lab	1
43	26ADE129	Big Data Analytics Lab	1
44	26ADE132	Robotic Process Automation Lab	1

45	26ADE138	Natural Language Processing Lab	1
Program Elective-4 Lab			
46	26ADE133	Federated Machine Learning Lab	1
47	26ADE134	Edge Computing Lab	1
48	26ADE135	Advanced Data Structures and Algorithms Lab	1
49	26ADE137	Generative and Agentic AI Lab	1
50	26ADE139	High Performance Computing Lab	1
Seminar and Projects			
51	26ADC110	Mini Project	1
52	26ADC111	Dissertation Phase-I	10
53	26ADC112	Dissertation Phase-II	16

*** Lab courses for Laboratory-2 and Laboratory-4 must be in one-to-one correspondence with the Elective courses opted in Program Elective-2 and Program Elective-4, respectively.**

Course Structure:

The following table shows the course structure with the credit weightage distribution.

S.No	Description	Credits
1.	Program Core Courses	15
2.	Laboratory courses	06
3.	Program Elective Courses	15
4.	Mandatory Course	2
5.	Open Elective course	03
6.	Audit Courses	Non-Credit
7.	Mini Project with Seminar	01
8.	Dissertation: Phase -I and II	26
Total		68

26ADC101

DATA ENGINEERING

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to

1. Understand the basic concepts of data engineering and its lifecycle.
2. Learn how to design good data architectures using different technologies.
3. Explore various data sources and how data is generated in source systems.
4. Know about data storage types, data ingestion methods, and file format issues.
5. Understand modern data architecture and implement data pipelines using Delta Lake and Spark.

COURSE OUTCOMES:

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

1. Understand the concepts, skills, and lifecycle of data engineering.
2. Identify suitable data architecture types and technologies for different scenarios.
3. Recognize various data sources and how data is generated in systems.
4. Compare different storage systems and ingestion techniques.
5. Build ACID-compliant data pipelines using Medallion Architecture with Spark and Databricks.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	-	2	3	3
CO 2	2	-	2	3	3
CO 3	3	2	3	2	2
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

UNIT-I

Data Engineering: What is Data Engineering, Data Engineering Skills and Activities.

Data Engineering Lifecycle: What is Data Engineering Life Cycle, The Data life cycle vs Data Engineering Life cycle, Major undercurrents across the Data Engineering Life cycle.

UNIT-II

Designing Good Data Architecture: What is Data Architecture, Principles of Good Data Architecture, Majoy Architecture Concepts, Examples and Types of Data Architecture, who is involved with designing a Data Architecture.

Choosing Technologies: Team Size and capabilities, Speed to Market, Interoperability, Cost Optimization and Business value, today vs the Future, Location, build vs Buy, Monolith Vs Modular, Serverless Vs Servers, Optimization, Performance and the Benchmark Wars.

UNIT-III

Data Generation in Source Systems: Sources of Data, Source Systems, Source system Practical details. Whom you'll

work with, Undercurrents and their impacts on Source Systems.

UNIT-IV

Storage: Raw Ingredients of Data Storage, Data storage systems, Data Engineering Storage abstractions, Big Ideas and Trends in Storage.

Ingestion: What is Data Ingestion, Key Engineering Considerations for ingestion, Batch Ingestion considerations, Message and Stream Ingestion Considerations, Ways to Ingest Data. Practical Issues with common File Formats.

Queries, Data Modeling, Transformations: Queries, Data Modelling, Transformations.

UNIT-V

Serving Data for Analytics, Machine learning and Reverse ETL: General Considerations for serving Data, Analytics, Machine Learning, what a Data Engineer should know about ML, Ways to Serve Data for Analytics and ML, Reverse ETL.

Modern Data Architecture: Evolution from Data Warehouse to Data Lake and Lakehouse, Medallion Architecture: Bronze, Silver, Gold layers, Delta Lake: ACID transactions on data lakes, Real-world implementation with Spark & Databricks

TEXT BOOKS:

1. "Fundamentals of Data Engineering: Plan and Build Robust Data Systems" by Joe Reis and Matt Housley, O'Reilly Media, 2022.
2. Data Engineering with Apache Spark, Delta Lake, and Lakehouse by Manoj Kukreja, Packt Publishing, Birmingham–Mumbai, First Edition, October 2021.

SUGGESTED READING:

1. "Data Engineering with Google Cloud Platform" by Adi Wijaya, Packt Publishing, 2022.
2. "Data Engineering with Python: Work with massive datasets to design data models and automate data pipelines using Python" by Paul Crickard, Packt Publishing, 2020.
3. "Current Trends and Advances in Computer-Aided Intelligent Environmental Data Engineering" edited by Gonçalo Marques and Joshua O. Ighalo, Academic Press (Elsevier), 2022.

26ADC102

ADVANCED ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Any programming, Basics of Probability

COURSE OBJECTIVES:
This course aims to:

1. Understand core concepts of AI including agents, search, and reasoning.
2. Analyze knowledge representation and decision-making under uncertainty.
3. Learn probabilistic foundations of machine learning.
4. Apply advanced supervised learning and optimization techniques.
5. Explore unsupervised learning, graphical models, and inference methods.

COURSE OUTCOMES:
Upon completion of this course, students will be able to:

1. Apply AI search and reasoning techniques to solve problems.
2. Represent knowledge and perform logical and probabilistic inference.
3. Use probabilistic models for machine learning tasks.
4. Implement advanced supervised learning methods.
5. Apply unsupervised learning, graphical models, and inference techniques.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	1	2	2	3
CO 2	3	2	2	2	3
CO 3	3	1	3	3	3
CO 4	3	1	3	3	3
CO 5	3	2	3	3	3

UNIT - I

Problem Solving and Advanced Search: Intelligent agents and rational decision-making, problem-solving as state-space search, uninformed and informed search strategies with complexity analysis, advanced heuristic design and evaluation, admissibility and consistency of heuristics, memory-bounded search algorithms (IDA*, RBFS, SMA*), local search and optimization techniques including hill climbing, simulated annealing, and genetic algorithms, search in complex environments with nondeterministic actions and partial observability, AND-OR graph search, online search and learning in unknown environments, Constraint Satisfaction Problems including advanced techniques such as forward checking, arc consistency (AC-3), constraint propagation, backtracking with heuristics, and local search methods, adversarial search including minimax, alpha-beta pruning.

UNIT - II

Knowledge Representation and Advanced Reasoning: Logical agents and knowledge-based systems, including the Wumpus World as a model environment, foundations of logic with propositional logic, advanced propositional inference techniques, theorem proving, and efficient model checking, agents based on logical reasoning, First-Order Logic including syntax, semantics, and knowledge engineering, advanced inference mechanisms with unification and lifting, forward and backward chaining, and resolution-based reasoning, planning as logical inference including classical planning, planning graphs, hierarchical planning, and multi-agent planning, knowledge representation using ontological engineering with

categories, objects, events, and mental states, reasoning with structured knowledge including inheritance, default reasoning, and non-monotonic reasoning.

UNIT – III

Probabilistic Foundations of Machine Learning:A brief review of probability theory, common discrete and continuous distributions, joint probability distributions, transformations of random variables, information theory, Bayesian Concept Learning, Empirical bayes, Dirichlet-multinomial model, Naive Bayes classifiers, Gaussian discriminant analysis, inference in jointly Gaussian distributions, Bayesian model selection.

UNIT – IV

Advanced Supervised Learning and Model Design: Linear regression and logistic regression, exponential family and generalized linear models (GLMs), probit regression and multi-task learning, regularization techniques including L1 regularization (Lasso), its algorithms and extensions, non-convex regularizers, kernel methods including kernel functions and the kernel trick, support vector machines (SVMs) and comparison of discriminative kernel methods, Gaussian processes for regression including GP latent variable models and approximation methods for large datasets, and advanced model design techniques including decision trees (CART), boosting methods, and ensemble learning approaches.

UNIT – V

Unsupervised Learning, Graphical Models and Inference: Latent variable models including mixture models and the EM algorithm, dimensionality reduction techniques such as Principal Component Analysis (PCA), clustering methods including K-means, hierarchical and spectral clustering, Graphical Models - hidden Markov models (HMMs), Markov random fields, and introduction to inference techniques including variational inference and sampling-based methods.

TEXT BOOKS:

1. Stuart Russell, Peter Norving, “Artificial Intelligence: A Modern Approach”, Third Edition, Pearson Education I Prentice hall of India, 2010.
2. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, First Edition, MIT Press, 2012.
3. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Third Edition, Tata McGraw-Hill, 2010.

SUGGESTED READING:

1. Patrick H. Winston. "Artificial Intelligence", Third edition, Pearson Edition, 2006.
2. Dan W.Patterson, “Introduction to Artificial Intelligence and Expert Systems”, PHI, 2006.
3. Nils J. Nilsson, “Artificial Intelligence: A new Synthesis”, Harcourt Asia Pvt. Ltd., 2000

26ADC103

DATA ENGINEERING LAB

Instruction	2 P Hours per
week CIE	50
Marks Credits	1

COURSE OBJECTIVES:

This course aims to:

1. To provide an in-depth understanding of data engineering concepts and lifecycle.
2. To design and evaluate scalable data architectures for real-world applications.
3. To analyze data generation mechanisms and integration of heterogeneous data sources.
4. To implement and optimize data storage, ingestion, and transformation techniques.
5. To develop and evaluate scalable data pipelines using modern data engineering tools.

COURSE OUTCOMES:

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

1. Analyze and implement data engineering lifecycle stages in real-world scenarios.
2. Design and evaluate data architectures based on scalability and performance requirements.
3. Integrate and process data from multiple heterogeneous sources.
4. Apply and optimize storage, ingestion, and transformation techniques for large-scale data.
5. Develop and evaluate efficient data pipelines for analytics and machine learning applications.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	2	3	2
CO 2	2	3	2	3	2
CO 3	3	2	3	2	2
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

LIST OF PROGRAMS:

1. Design and implement a complete Data Engineering pipeline for a real-world dataset and analyze each stage of the data engineering lifecycle.
2. Design and compare multiple data architectures (centralized and distributed) for a given use case and evaluate their scalability, cost, and performance.
3. Simulate high-volume data generation in source systems and analyze system behavior with respect to volume, velocity, and variety.
4. Integrate heterogeneous data sources such as CSV, JSON, and log files and resolve schema mismatches and data inconsistencies.
5. Benchmark different storage formats such as CSV, JSON, and Parquet by measuring storage efficiency and read/write performance.
6. Design and optimize a batch data ingestion pipeline and analyze performance bottlenecks and improvements.
7. Implement stream data processing using PySpark and evaluate latency, throughput, and fault tolerance.
8. Perform large-scale data transformations using PySpark and compare execution performance with traditional approaches.
9. Implement Medallion Architecture using layered data processing and analyze improvements in data quality and query performance across layers.
10. Develop a scalable end-to-end data pipeline project and evaluate its performance, reliability, and suitability for analytics applications.

TEXT BOOKS:

1. Fundamentals of Data Engineering: Plan and Build Robust Data Systems by Joe Reis and Matt Housley, O'Reilly Media, 2022.
2. Data Engineering with Apache Spark, Delta Lake, and Lakehouse by Manoj Kukreja, Packt Publishing, 2021.

SUGGESTED READING:

1. "Data Engineering with Google Cloud Platform" by Adi Wijaya, Packt Publishing, 2022.
2. "Data Engineering with Python: Work with massive datasets to design data models and automate data pipelines using Python" by Paul Crickard, Packt Publishing, 2020.
3. "Current Trends and Advances in Computer-Aided Intelligent Environmental Data Engineering" edited by Gonçalo Marques and Joshua O. Ighalo, Academic Press (Elsevier), 2022.

WEB RESOURCES:

1. https://spark.apache.org/
2. https://pandas.pydata.org/
3. https://docs.delta.io/

26ADC104

ADVANCED ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. Implement advanced AI search and optimization algorithms.
2. Develop logical reasoning systems using propositional and first-order logic.
3. Apply probabilistic models and statistical learning techniques.
4. Implement advanced supervised learning algorithms with optimization methods.
5. Design and evaluate unsupervised learning and probabilistic models.

COURSE OUTCOMES:

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

1. Implement and analyze heuristic search and optimization algorithms.
2. Develop logic-based inference systems using resolution and unification.
3. Apply probabilistic models such as Naive Bayes, GDA, and Bayesian networks.
4. Implement supervised learning models including logistic regression, SVM, and ensemble methods.
5. Apply clustering and probabilistic models such as K-means and GMM for data analysis.

CO-PO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	2	2	3
CO2	3	2	2	2	3
CO3	3	1	3	3	3
CO4	3	1	3	3	3
CO5	3	1	3	3	3

LIST OF PROGRAMS

1. Implementation of A* Search with heuristic evaluation.
2. Implementation of Hill Climbing and Simulated Annealing.
3. Implementation of Constraint Satisfaction Problem (CSP) using backtracking, forward checking, and AC-3
4. Implementation of Propositional Logic using Resolution.
5. Implementation of First-Order Logic inference.
6. Implementation of Bayesian Network inference.
7. Implementation of Naive Bayes classifier, Gaussian, Multinomial.
8. Implementation of Gaussian Discriminant Analysis (GDA)
9. Implementation of MLE and MAP estimation
10. Implementation of Logistic Regression with regularization (L1/L2).
11. Implementation of Support Vector Machine (SVM) with kernel trick.
12. Implementation of Ensemble Learning.
13. Implementation of Hierarchical clustering (Agglomerative) and comparison with K-means
14. Implementation of Gaussian Mixture Model (GMM) using EM algorithm.

TEXT BOOKS:

1. Sebastian Raschka and Vahid Mirjalili, *"Python Machine Learning"*, Third Edition, Packt Publishing, 2019.
2. Prateek Joshi, *"Artificial Intelligence with Python"*, First Edition, Packt Publishing, 2017.

SUGGESTED READING:

1. Aurélien Géron, *"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow"*, Third Edition, O'Reilly Media, 2022.
2. Andreas C. Müller and Sarah Guido, *"Introduction to Machine Learning with Python: A Guide for Data Scientists"*, First Edition, O'Reilly Media, 2016.
3. Christopher M. Bishop, *"Pattern Recognition and Machine Learning"*, First Edition, Springer, 2006.

26ADC105

CLOUD COMPUTING

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Familiarize basic concepts of cloud computing and enabling technologies.
2. Introduce Auto-Scaling, capacity planning and load balancing in cloud.
3. Impart knowledge on issues related to security, privacy and compliance.
4. Introduce cloud management standards and programming models.
5. Deal with the concepts of Service-oriented architecture and cloud database technology.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Understand different types of cloud computing concepts and the techniques.
2. Determine the issues related to scaling, capacity planning and load balancing.
3. Assess the cloud infrastructure, information security and compliance issues.
4. Analyse the Portability and Interoperability issues of cloud virtualization.
5. Evaluate the importance of SOA and cloud database technology.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	2	2	2
CO 2	2	2	2	2	2
CO 3	3	2	3	3	3
CO 4	3	2	3	3	3
CO 5	3	2	3	3	3

UNIT-I

Introduction-Limitations of the Traditional Computing Approaches, Three Layers of Computing, Three Layers in Traditional Computing, The End of Traditional Computing, Influences behind Cloud Service Adoption. Benefits and challenges: Origin of the Term 'Cloud Computing', Early Initiatives, Utility Computing, Metering and Billing in Cloud, Separation of Data Center Operation, Benefits of Cloud Computing, Challenges of Cloud Computing, How Cloud Computing Addresses Business Challenges, Ethical Issues in Cloud Computing, Cloud Computing: Network as Computer, Role of Web Service, Role of API, Ubiquitous Cloud, Confusion Between Cloud and Internet. Cloud computing services, Resource Virtualization, Resource pooling, sharing and provisioning.

UNIT-II

Scaling in cloud- Introduction to Scaling, Scaling in Traditional Computing, Scaling in Cloud Computing, Foundation of Cloud Scaling, Scalable Application, Scaling Strategies in Cloud, Auto-Scaling in Cloud, Types of Scaling, Performance and Scalability, the Resource Contention Problem, Cloud Bursting: A Scenario of Flexible Scaling, Scalability is a Business Concern

Capacity Planning- Capacity Planning, Capacity Planning in Computing, Capacity Planning in Cloud Computing, Approaches for Maintaining Sufficient Capacity, Steps for Capacity Planning

Load Balancing- Load Balancing, Importance of Load Balancing in Cloud Computing, Load Balancing in Cloud, Goals of Load Balancing, Categories of Load Balancing, Load Balancing Algorithms, Case study on Google cloud and Amazon Elastic Compute Cloud (EC2), File System and Storage. IOT suite.

UNIT-III

Content Delivery Network: CDN Service Operations, Evolution of CDN, Advantages of CDN, Disadvantages of CDN, CDN Service Provider, Security Reference Model

Security Issues- Cloud security, threats to Cloud Security, Infrastructure Security, Information Security, Identity Management and Access Control, Cloud Security Design Principles, Cloud Security Management Frameworks, Security-as-a-Service, Privacy and Compliance Issues.

UNIT-IV

Portability and Interoperability Issues- Challenges in the Cloud, The Issues in Traditional Computing, Addressing Portability and Interoperability in Cloud, Portability and Interoperability Scenarios, Machine Imaging or Virtual Machine Image, Virtual Appliance, Difference between Virtual Machine Image and Virtual Appliance, Open Virtualization Format (OVF), Cloud Management and a Programming Model Case Study, Popular Cloud Services.

UNIT-V

Service-Oriented Architecture: The Pre-SOA Era, Role of SOA in Cloud Computing, Service-Oriented Architecture, Goal of System Designing, Service Represents Business Functionality, Open Standard Implementation, Benefits of SOA, SOA and Cloud Computing.

Database Technology: Database in Cloud, Data Models, Database-as-a-Service, Relational DBMS in Cloud, Non-relational DBMS in Cloud.

TEXT BOOK:

1. Sandeep Bhowmik, “Cloud Computing”, Cambridge University Press, 2017.

SUGGESTED READING:

1. Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra, “Distributed and Cloud Computing from Parallel Processing to the Internet of Things”, Elsevier, 2012.
2. Barrie Sosinsky” Cloud Computing Bible”, Wiley-India, 2010
3. Ronald L. Krutz, Russell Dean Vines “Cloud Security: A Comprehensive Guide to Secure Cloud Computing”, Wiley- India,2010
4. John W. Rittenhouse, James F. Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2009.
5. Enterprise Cloud Computing - Technology, Architecture, Applications by Gautam Shroff, Cambridge University Press, 2016. 3 Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra,

WEB RESOURCES:

1. https://nptel.ac.in/courses/106105167/1
2. https://www.manning.com/books/exploring-cloud-computing
3. https://www.coursera.org/specializations/cloud-computing

26ADC106

ADVANCED DATA SCIENCE TECHNIQUES

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aims to:

1. To introduce the fundamentals of Data Science.
2. To understand the role of statistical analysis.
3. To facilitate different optimization techniques in the field of Data Science.
4. To handle heterogeneous data and visualize them for better understanding.
5. To understand the process of applications to solve various industrial problems.

Course Outcomes:
Upon completion of this course, students will be able to:

1. Comprehend fundamental knowledge on data science.
2. Demonstrate proficiency in statistical analysis of data.
3. Develop mathematical knowledge and study various optimization techniques to perform data science operations.
4. Handle various types of data and visualize them using through programming for knowledge representation.
5. Demonstrate numerous open-source data science tools to solve real-world problems through industrial case studies.

CO-PO Articulation Matrix

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	1	-	1	2
CO 2	2	2	-	2	2
CO 3	2	2	1	2	2
CO 4	1	2	-	2	2
CO 5	2	2	1	3	2

UNIT - I

Data science in a big data world: Benefits and uses of data science and big data, Facets of data. **The data science process:** Overview of the data science process, defining research goals and creating a project charter, Retrieving data, Cleansing, integrating, and transforming data, Exploratory data analysis, Build the models, Presenting findings and building applications

UNIT - II

Handling large data on a single computer: The problems you face when handling large data, General techniques for handling large volumes of data: Choosing the right algorithm, Choosing the right data structure, Selecting the right tools, General programming tips for dealing with large data sets, Case study: Predicting malicious URLs, Building a recommender system inside a database. **Reading Text Files in Pieces**, Writing Data to Text Format, Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Web APIs, Interacting with Databases

UNIT - III

Data Cleaning and Preparation: Handling missing data, Data transformation, **Data Wrangling: Join, Combine, and Reshape:** Hierarchical Indexing, Reordering and Sorting Levels, Summary Statistics by Level, Indexing with a DataFrame's columns, Combining and Merging Datasets, Database-Style Data Frame Joins, Merging on Index,

Concatenating Along an Axis, Combining Data with Overlap, Reshaping and Pivoting, Reshaping with Hierarchical Indexing, Pivoting "Long" to "Wide" Format, Pivoting "Wide" to "Long" Format

UNIT - IV

Plotting and Visualization: A Brief matplotlib API Primer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File, matplotlib Configuration, Plotting with pandas and seaborn, Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots, Facet Grids and Categorical Data, Other Python Visualization Tools

UNIT – V

Time Series: Date and Time Data Types and Tools, Time Series Basics, Date Ranges, Frequencies, and Shifting, Time Zone Handling, Periods and Period Arithmetic, Resampling and Frequency Conversion, Moving Window Functions

Text mining and Text Analysis: Text mining in the real world, Text mining techniques, Case study: Classifying Reddit posts

TEXTBOOKS:

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, "Introducing Data Science: Big Data, Machine Learning, and more, using Python Tools", Manning Publications, 2016
2. McKinney, W. “Python for data analysis: Data wrangling with pandas, NumPy, and IPython” O'Reilly Media, 2018.

SUGGESTED READING:

1. Joel Grus, "Data Science from Scratch-First Principles with Python", O'Reilly Media, 2015
2. John V. Guttag, "Introduction to Computation and Programming Using Python— with Application to Understanding Data", Second Edition, The MIT Press, 2016.
3. Alberto Boschetti, Luca Massaron, "Python Data Science Essentials: A Practitioner's Guide Covering Essential Data Science Principles, Tools, and Techniques", Third Edition, 2018.
4. Allen B. Downey, "Think Python How to Think Like a Computer Scientist", Second Edition, O'Reilly, 2016.
5. Jake VanderPlas, "Python Data Science Handbook", Second Edition, O’Reilly Media, 2016.

WEB RESOURCES:

1. https://www.kaggle.com
2. https://www.dataschool.io/
3. https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-proj ects-to-boost-your-knowledge-and-skills/
4. https://www.linkedin.com/in/randylaosat

26ADC107

ADVANCED DEEP LEARNING

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Understand fundamentals of neural networks and deep learning.
2. Learn training methods, optimization, and regularization techniques.
3. Study convolutional neural networks and advanced architectures.
4. Understand recurrent neural networks and attention mechanisms.
5. Apply advanced models like autoencoders to real-world problems

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Apply deep learning concepts and optimization techniques to neural network models.
2. Implement training strategies, regularization, and optimization methods for deep learning models.
3. Analyze and implement convolutional neural networks and advanced architectures for image-based tasks.
4. Analyze recurrent neural networks and attention mechanisms for sequential data processing.
5. Design and evaluate deep learning models for real-world applications.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	3	2	2
CO 2	3	2	3	3	2
CO 3	3	2	3	3	3
CO 4	2	2	3	3	3
CO 5	3	2	3	3	3

UNIT-I:

Advanced Deep Learning Foundations & Optimization: Fully Connected Layers, Backward and Forward Propagation. Activation Functions: Sigmoid, Tanh, Rectified Linear Unit(ReLU), Leaky ReLU, Exponential Linear Unit(ELU), Softmax. Error Functions: Mean Square Error and Cross-Entropy Loss. Optimization and Gradient Descent Variants: Stochastic, Mini-batch, Momentum, Root Mean Square Propagation(RMSProp), Adaptive Moment Estimation(Adam), Nesterov-accelerated Adaptive Moment Estimation, Learning Rate- Step decay, cosine annealing, warm restar, Weight Initialization Strategies: Xavier and He Initialization. Backpropagation using Chain Rule and Computation Graphs. Gradient Stability, Vanishing and Exploding Gradients, Saddle Points, and Local Minima.

UNIT-II :

Regularization and Basic Deep Learning Architectures: Model Capacity: Overfitting and Underfitting, Validation Sets and Hyperparameter Tuning. Regularization Techniques: Weight Decay using L1 and L2 Regularization, Early Stopping, Dropout, and Data Augmentation, Label Smoothing, Normalization Strategies: Batch Normalization and Layer Normalization. Introduction to Convolutional Neural Networks: Limitations of Fully Connected Networks, Local Correlation, Weight Sharing, Convolution Operation, Filters, Stride, Padding, Pooling Layers, Feature Maps. Classic CNN Architecture: LeNet-5.

UNIT-III:

Advanced Convolutional Neural Networks: Representation Learning in Deep Networks. Forward and Backward

Propagation in Convolutional Neural Networks. Pooling Layers: Max Pooling and Average Pooling. Normalization Techniques: Batch Normalization and their role in stable training. Deep CNN Architectures: AlexNet, VGGNet, GoogLeNet (Inception), Residual Networks (ResNet), DenseNet, Mobile Net,Convolutional Layer Variants: Dilated Convolution, Transposed Convolution, and Depthwise Separable Convolution. Transfer Learning and Fine-Tuning of Pretrained CNN Models, domain adaption, self-supervised feature learning.

UNIT-IV:

Recurrent Neural Networks and Attention Mechanisms: Limitations of Fully Connected Layers for Sequential Data. Recurrent Neural Networks: Principle, Shared Weights, Global Semantics, Gradient Propagation, and Simple RNN Cell. Applications of RNNs in Sentiment Classification. Challenges in RNN Training: Vanishing and Exploding Gradients, Gradient Clipping, and Short-Term Memory Limitation. Long Short-Term Memory Networks: Principle, Forget Gate, Input Gate, Memory Update, and Output Gate. Gated Recurrent Units: Introduction and Reset Gate. Attention Mechanism: Self-Attention and Multi-Head Attention, Bahdanau attention, Luong Attention

UNIT-V:

Advanced Autoencoders and Generative Models: Principles of Autoencoders: Encoder, Decoder, Latent Representation, and Bottleneck Layer. Image Reconstruction and Loss Functions. Regularized Autoencoders: Denoising Autoencoders and Sparse Autoencoders. Adversarial Autoencoders. Graph Autoencoders for Non-Euclidean Data. Deep Embedded Representations using Autoencoders. Applications of Autoencoders in Anomaly Detection, Feature Learning, and Dimensionality Reduction, multimodal deep learning, Generative Adversarial Networks(GAN's): Introduction, Discriminator, Generator, Models: Deep Convolution GAN(DCGAN), Conditional GAN(CGAN), Wasertein GAN(WGAN)

TEXT BOOKS:

1. Liangqu Long & Xiangming Zeng, "Beginning Deep Learning with TensorFlow", 1st Edition, Apress, 2022.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "Dive into Deep Learning", Release 0.16.6, 2018.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016

SUGGESTED READING:

1. Levitin A, "Introduction to the Design And Analysis of Algorithms", Pearson Education, 2008.
2. Ian Goodfellow,Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016
3. Indra den Bakker, "Python Deep Learning Cookbook", Packt publisher, 2017
4. Wei Di, Anurag Bhardwaj, Jianing Wei, "Deep Learning Essentials" , Packt publishers, 2018

26ADC108

ADVANCED DATA SCIENCE TECHNIQUES LAB

Instruction	2P Hours per Week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. To introduce data structures in Python.
2. To familiarize with data types and file formats.
3. To gain knowledge on data preprocessing and data visualization.
4. To acquaint with supervised and unsupervised learning algorithms.
5. To explore various case studies.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Identify appropriate data structures for storing and processing the data.
2. Choose suitable data type to handle real time data and explain file formats.
3. Apply preprocessing techniques on raw data.
4. Interpret the data from visualizations.
5. Build supervised and unsupervised models to solve real world problems.

CO-PO Articulation Matrix

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	3	2	3	2
CO 2	3	3	2	3	2
CO 3	3	3	2	3	3
CO 4	3	3	2	3	3
CO 5	3	3	3	3	3

LIST OF PROGRAMS

1. Using Numpy implement Array Indexing, slicing and array basic operations
2. Perform different arithmetic, logical, and filtering operations on dataframes
3. Build program to demonstrate Indexing and Reindexing
4. Perform group by, pivot and crosstab aggregation on the dataframes
5. Implementation of preprocessing techniques on any two datasets and demonstrate Data Transformation and Summarizing, encoding for categorical data
6. Implement a program to demonstrate Binning, Classing and Standardization
7. Building programs to visualize the dataframe in matplotlib and seaborn
8. Building programs to visualize the univariate, bivariate and multivariate relation
9. Case study with all the appropriate graphs to visualize the relationship in the data
10. Implement program to demonstrate Time Series Data, Text analysis

TEXT BOOKS:

1. Allen B. Downey, ―Think Python How to Think Like a Computer Scientist‖, Second Edition, O'Reilly,2016.
2. William McKinney, ―Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython‖, Second Edition, O‘Reilly Media, 2017.
3. Samir Madhavan, ―Mastering Python for Data Science‖, Packt Publishing, 2015.

SUGGESTED READING:

1. Joel Grus, ―Data Science from Scratch-First Principles with Python‖, O‘Reilly Media, 2015.
2. Rachel Schutt, Cathy O‘Neil, ―Doing Data Science, Straight Talk from the Frontline‖, O‘Reilly, 2014.

DATASETS:

1. https://www.kaggle.com/datasets
2. https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/multilabel.html#siam-competition2007
3. https://archive.ics.uci.edu/ml/index.php

WEB RESOURCES:

1. https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-projects-to-boost-your-knowledge-and-skills/
2. https://www.learndatasci.com/tutorials/data-science-statistics-using-python/
3. https://www.kaggle.com/getting-started
4. https://www.datacamp.com/community/tutorials

26ADC109

ADVANCED DEEP LEARNING LAB

Instruction	2P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. Implement fundamental neural network models for classification tasks.
2. Apply optimization and regularization techniques to improve model performance.
3. Develop convolutional neural networks for image-based applications.
4. Design recurrent neural network models for sequential data analysis.
5. Implement advanced deep learning models for real-world applications.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Implement basic neural network models for classification problems.
2. Apply optimization and regularization techniques to improve model performance.
3. Develop and evaluate convolutional neural network models for image classification tasks.
4. Develop and analyze recurrent neural network models for sequential data applications.
5. Design and implement advanced deep learning models for real-world applications.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	1	3	2	2
CO 2	3	1	3	3	2
CO 3	3	1	3	3	3
CO 4	3	1	3	3	3
CO 5	3	2	3	3	3

LIST OF PROGRAMS:

1. Feedforward neural network for handwritten digit classification (MNIST)
2. Activation function comparison on classification task
3. Optimizer comparison for model training
4. Regularization techniques to reduce overfitting (MNIST/CIFAR)
5. CNN for image classification (CIFAR-10/cats vs dogs)
6. CNN with data augmentation for improved image classification
7. Transfer learning using pretrained CNN for custom image classification
8. RNN for time series prediction (stock/temperature data)
9. LSTM/GRU for sentiment analysis (text classification)
10. Attention-based model for text classification
11. Autoencoder for image denoising and reconstruction
12. Implementation of GANs for generating Synthetic datasets.

TEXT BOOKS:

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 3rd Edition, O'Reilly Media.
2. Tom Hope, Yehezkel S. Resheff, Itay Lieder, *Learning TensorFlow: A Guide to Building Deep Learning Systems*, O'Reilly Media.
3. Liangqu Long & Xiangming Zeng, "Beginning Deep Learning with TensorFlow", 1st Edition, Apress, 2022.

26MEM101

RESEARCH METHODOLOGY AND IPR

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aims to

1. Motivate to choose research as career
2. Formulate the research problem, prepare the research design
3. Identify various sources for literature review and data collection report writing
4. Equip with good methods to analyze the collected data
5. Know about IPR copyrights

Course Outcomes:

Upon completion of this course, students will be able to:

1. Define research problem, review and asses the quality of literature from various sources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs.
3. Collect the data by various methods: observation, interview, questionnaires.
4. Analyze problem by statistical techniques: ANOVA, F-test, and Chi-square.
5. Understand apply for patent and copyrights.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	2	1	2	2	3
CO2	3	3	3	2	2	2
CO3	3	2	2	1	2	1
CO4	3	1	2	2	3	2
CO5	3	3	3	3	3	3

UNIT - I

Research Methodology: Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

UNIT - II

Literature Survey Report writing: Literature Survey: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanics of writing a report. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.
Introduction to latex ,Basic rules, LaTeX templates — Reports

UNIT- III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

UNIT - IV

Data Collection and Analysis: Data Collection: Methods of data collection, importance of Parametric, non-parametric test, testing of variance of two normal population, use of Chi-square, ANOVA, Ftest, z-test.

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UNIT - V

Patents and Copyright: Patent: Macro economic impact of the patent system, Patent document, Patent Filling Procedures,. Granting of patent, Rights of a patent, patent protection. Copyright: Meaning.Copyrights protection, steps involved for applying copyrights registrations process ,Enforcement of Intellectual Property Rights: Infringement of intellectual property rights, Case studies of patents and IP Protection. IP as a Global Indicator of Innovation, Major Amendments In IP laws And Acts in India.

Text Books:

1. C.R Kothari, "Research Methodology, Methods & Technique"; New Age International Publishers, 2004
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers , 2011
3. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publs., Pvt., Ltd., New Delhi, 2004.

Suggested Reading:

1. Ajit Parulekar and Sarita D' Souza, "Indian Patents Law – Legal & Business Implications"; Macmillan India ltd , 2006
2. B. L.Wadehra; "Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications"; Universal law Publishing Pvt. Ltd., India2000.
3. P. Narayanan; "Law of Copyright and Industrial Designs"; Eastern law House, Delhi 2010.

26ADE104

SOCIAL NETWORK ANALYTICS

(Program Elective-1)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Design modelling, aggregating and knowledge representation of semantic web
2. Describe Association rule mining algorithms
3. To know the applications in real time systems.

COURSE OUTCOMES:

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

1. Understand the basics of social network analysis.
2. Analyse ontology representation of social network data.
4. Apply supervised and unsupervised algorithms on social networks.
5. Interpret the semantic content of social media data.
6. Build social network model for real time applications

CO-PO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	1	1	1
CO2	2	1	-	2	2
CO3	3	2	2	3	2
CO4	2	2	1	2	2
CO5	3	3	3	3	3

UNIT – I

INTRODUCTION: Introduction to Web, Limitations of current Web, Development of Semantic Web, Emergence of the Social Web, Statistical Properties of Social Networks, Social Network analysis, Development of Social Network Analysis, Key concepts and measures in network analysis, Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities, Web-based networks.

UNIT – II

MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation, Ontology languages for the Semantic Web: Resource Description Framework, Web Ontology Language, Modeling and aggregating social network data: State-of-the-art in network data representation, Ontological representation of social individuals, Ontological representation of social relationships, Aggregating and reasoning with social network data, Advanced representations.

UNIT – III

ALGORITHMS AND TECHNIQUES: Association Rule Mining, Supervised Learning, Unsupervised Learning, Semi-supervised Learning, Markov models, K-Nearest Neighboring, Content-based Recommendation, Collaborative Filtering Recommendation, Social Network Analysis, Detecting Community Structure in Networks, the Evolution of Social Networks.

UNIT – IV

EXTRACTING AND ANALYZING WEB SOCIAL NETWORKS: Extracting Evolution of Web Community from a Series of Web Archive, Temporal Analysis on Semantic Graph using Three-Way Tensor, Decomposition, Analysis of Communities and their Evolutions in Dynamic Networks, Socio-Sense: A System for Analyzing the Societal Behavior from Web Archive

UNIT – V

APPLICATIONS: A Learning Based Approach for Real Time Emotion Classification of Tweets, A New Linguistic Approach to Assess the Opinion of Users in Social Network Environments, Explaining Scientific and Technical Emergence Forecasting, Social Network Analysis for Biometric Template Protection

TEXTBOOKS:

1. Peter Mika, "Social Networks and the Semantic Web", Springer, 1st edition, 2007.
2. Guandong Xu , Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", Springer, 1st edition, 2012.
3. Przemyslaw Kazienko, Nitesh Chawla, "Applications of Social Media and Social Network Analysis", Springer,2015.

SUGGESTED READING:

1. Ajith Abraham, Aboul Ella Hassanien, Václav Snášel, "Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2012
2. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1 st edition, 2011
3. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2014
4. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.

WEB RESOURCE:

1. https://swayam.gov.in/nd1_noc19_cs66/preview

23ADE105

BLOCKCHAIN TECHNOLOGY

(Program Elective-1)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Facilitate understanding of Bitcoin and working with consensus in Bitcoin.
2. Impart knowledge about designing and building Permissioned blockchains.
3. Introduce the concepts of Cryptocurrency, Ethereum virtual machine, cryptocurrency regulation, and Hyperledger Fabric.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Demonstrate the concepts of blockchain technology.
2. Understand Bitcoin, working with consensus in Bitcoin.
3. Design Permissioned Blockchains.
4. Illustrate the concepts of Cryptocurrency, Ethereum virtual machine, and cryptocurrency regulations.
5. Design smart contracts using Hyperledger Fabric frameworks.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	1	2	2	2
CO 2	3	2	3	2	2
CO 3	3	3	3	3	2
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

UNIT-I

Introduction: Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Blockchain, Transactions, Distributed Consensus, Public vs Private Blockchain, Understanding Cryptocurrency to Blockchain, Permissioned Model of Blockchain, Overview of Security aspects of Blockchain Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Asymmetric Cryptography

UNIT-II

Bitcoin and Blockchain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.

Working with Consensus in Bitcoin: Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) — basic introduction, HashcashPoW, BitcoinPoW.

UNIT-III

Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned block chains, Overview of Consensus models for Permissioned block chain Distributed consensus in a closed environment. Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Block chain-enabled Trade, We Trade — Trade Finance Network, Supply Chain Financing, Identity on Block chain.

UNIT-IV

Cryptocurrency: History, Distributed Ledger, Mining strategy and rewards, Ethereum Runtime Environment, Ethereum Virtual Machine (EVM)-Wallets for Ethereum, Decentralized Autonomous Organization, Smart Contract, Vulnerability Attacks. Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects-Crypto currency Exchange, Black Market, and Global Economy.

UNIT- V

Hyperledger Fabric- Architecture, organizations, Peers, Ordering Service (Orderers), Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contracts using Hyperledger Fabric, Writing smart contracts using Ethereum, Overview of Ripple and Corda. Applications: Internet of Things, Payments in Automotive Suppliers, Tracing the Food/Meat, Monitoring Cold Chain, Health Industry, Medical Record Management System, Supply chain management, and Future of Block Chain.

TEXT BOOKS:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten,Andrew Miller and Steven Gold feder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press(July19,2016).
2. Melanie Swan, "Block Chain: Blueprint for a New Economy", 1st Edition O'Reilly, 2015.

SUGGESTED READING:

1. Iran Bashir “Mastering Blockchain” 2nd Edition Paperback 2018.
2. Daniel Drescher, “Block Chain Basics”, 1st Edition, Apress, 2017.
3. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing.

WEB RESOURCE:

1. www.blockchain.com
2. https://www.blockchain.com/btc/blocks?page=1

https://andersbrownworth.com/blockchain/hash26ADC101

26ADE112

ETHICS AND AI

(Program Elective-1)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Study the morality and ethics in AI
2. Learn about the Ethical initiatives in the field of artificial intelligence
3. Study about AI standards and Regulations
4. Study about social and ethical issues of Robot Ethics
5. Study about AI and Ethics- challenges and opportunities

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Learn about morality and ethics in AI.
2. Understand the ethical harms and ethical initiatives in AI.
3. Learn about AI standards and Regulations like AI Agent, Safe Design of Autonomous and Semi- Autonomous Systems.
4. Understand the concepts of Roboethics and Morality with professional responsibilities.
5. Learn about the societal issues in AI with National and International Strategies on AI.

CO-PO Articulation Matrix:

	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	-	1	-
CO2	2	2	-	1	1
CO3	2	2	1	1	1
CO4	1	2	-	2	1
CO5	2	2	1	1	2

UNIT – I

INTRODUCTION

Definition of Ethics, Morality and Applied Ethics , Introduction to AI Ethics and Responsible AI, Impact of AI on: Society (employment, inequality), Human psychology (trust, dependency), Legal systems (accountability, liability), Environment (energy consumption of AI systems), Principles of Trustworthy AI: fairness, accountability, transparency

UNIT – II

ETHICAL INITIATIVES IN AI

Ethical principles in artificial intelligence including fairness, accountability, transparency, and explainability. Overview of global ethical initiatives such as OECD AI Principles, UNESCO AI Ethics Guidelines, and European Commission guidelines. Ethical harms and concerns in AI including bias and discrimination, privacy violations, and misinformation. Case studies involving ethical issues in AI applications such as healthcare systems with diagnostic bias, autonomous vehicles and decision-making dilemmas, and warfare involving autonomous weapons.

UNIT – III

AI GOVERNANCE, STANDARDS AND REGULATION:

Introduction to the need for AI governance and regulation. Ethical considerations in the AI system design lifecycle. Data governance including data privacy, responsible data usage and protection principles. Algorithmic bias including sources of bias, discrimination in AI systems, and the importance of fairness. Transparency and explainability in AI systems. Overview of ethical frameworks and general approaches to AI regulation and governance as discussed in international initiatives.

UNIT – IV

ROBOETHICS: SOCIAL AND ETHICAL IMPLICATION OF ROBOTICS:

Introduction to robotics and roboethics. Ethical issues in robotics including human-robot interaction, safety, and autonomy. Moral responsibility in autonomous systems. Ethics in science and technology and ethical issues in an ICT society. Professional ethics and responsibilities of AI engineers. Overview of roboethics taxonomy.

UNIT – V

AI AND ETHICS- CHALLENGES AND OPPORTUNITIES:

Ethical challenges in artificial intelligence including bias, privacy concerns, and accountability issues. Societal implications of AI such as inequality, employment impact, and digital divide. Applications of artificial intelligence in critical domains including healthcare and industry with focus on ethical decision-making. Role of AI in influencing society and public trust. National and international strategies and policy approaches to artificial intelligence. Opportunities for developing responsible and ethical AI systems.

TEXT BOOKS:

1. Y. Eleanor Bird, Jasmin Fox-Skelly, Nicola Jenner, Ruth Larbey, Emma Weitkamp, Alan Winfield, *The Ethics of Artificial Intelligence: Issues and Initiatives*, First Edition, European Parliamentary Research Service (STOA), 2020.
2. Patrick Lin, Keith Abney, George A. Bekey, *Robot Ethics: The Ethical and Social Implications of Robotics*, First Edition, MIT Press, 2014.

SUGGESTED READING:

1. Paula Boddington, *Towards a Code of Ethics for Artificial Intelligence*, 2017
2. Mark Coeckelbergh, *AI Ethics*, MIT Press, 2020

WEB RESOURCES:

1. https://www.oecd.org/ai/
2. https://unesdoc.unesco.org/ark:/48223/pf0000381137
3. https://www.weforum.org/agenda/archive/artificial-intelligence/

26ADE102

INFORMATION RETRIEVAL SYSTEMS
(Program Elective-1)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:
This course aims to:
1. To introduce the foundations of information retrieval and its applications in AI & Data Science.
2. To understand retrieval models, evaluation techniques, and query languages.
3. To apply indexing, searching, and query operations for large-scale text and multimedia data.
4. To analyze distributed IR and web search systems.
5. To evaluate user interfaces, digital libraries, and multimedia IR systems for modern applications.

COURSE OUTCOMES:
Upon successful completion of this course, students will be able to:
1. Remember & understand the fundamentals of IR systems.
2. Apply retrieval models, query languages, and indexing methods.
3. Analyze performance measures, architectures, and multimedia IR.
4. Evaluate distributed, web-based, and digital library systems.
5. Create innovative IR solutions integrating AI & Data Science.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/ PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	-	2	2	2
CO 2	3	-	2	3	3
CO 3	2	-	2	2	2
CO 4	3	1	3	3	2
CO 5	3	1	3	3	3

UNIT-I
Fundamentals of Information Retrieval Models
Introduction: Basic concepts, Past, Present and Future of IR, The Retrieval Process. **Modeling:** Introduction, A Taxonomy of IR Models, Retrieval: Adhoc and Filtering, A formal characterization of IR Models, Classic Information Retrieval, Alternative Set Theoretic Models, Alternative Algebraic Models, Alternative Probabilistic Models, Structured Text Retrieval Models, Models for Browsing.

UNIT-II
Retrieval Evaluation, Query Languages & Operations
Retrieval Evaluation: Retrieval Evaluation, Retrieval Performance Evaluation, Reference Collections. **Query Languages:** Introduction, Keyword-Based Querying, Pattern Matching, Structural Queries, and Query Protocols **Query Operations:** Introduction, User Relevance Feedback, Automatic Local Analysis, Automatic Global Analysis

UNIT-III
Indexing, Searching & Text/Multimedia Processing
Indexing and Searching: Introduction, Inverted Files, Other Indices for Text, Boolean Queries, Sequential Searching, Pattern Matching, Structural Queries and Compression. **Text and Multimedia Languages and Properties:** Introduction, Metadata, Text, Markup Languages and Multimedia.**Text Operations:** Introduction, Document Pre-processing, Document Clustering, Text Compression and Comparing Text Compression Techniques.

UNIT-IV

Web, Distributed & User Interfaces

Searching the Web : Introduction, Challenges, Characterizing the Web, Search Engines, Browsing, Meta searchers, Searching using Hyperlinks **Parallel and Distributed IR :** Introduction, Parallel IR, Distributed IR. **User Interfaces and Visualization:** Introduction, Human-Computer Interaction, the Information Access Process, Starting Points, Query Specification, Context, Using Relevance Judgements, Interface Support for the Search Process

UNIT- V

Multimedia, Libraries & Digital Systems

Multimedia IR-Models and Languages: Introduction, Data Modeling, Query Languages. **Indexing and Searching**: Introduction, Background - Spatial Access Methods, Generic Multimedia Indexing Approach, One-dimensional Time Series, Two-dimensional Color Images Automatic Feature Extraction. **Libraries and Bibliographical Systems**: Introduction, Online IR Systems and Document Databases, Online Public Access Catalogs (OPACs). **Digital Libraries**: Introduction, Definitions, Architectural Issues, Document Models, Representations, and Access, Prototypes, Projects, and Interfaces, Standards.

TEXT BOOK:

1. Ricardo, Baeza-yates, BerthierRibeiro-Neto, “Modern Information Retrieval” Pearson Education**.**2008.

SUGGESTED READING:

1. Christopher D. Manning, Prabhakar Raghavan, HinrichSchütze, “Introduction to Information Retrieval”, Cambridge University Press, 2009.
2. David A. Grossman, OphirFrieder, "Information Retrieval - Algorithms and Heuristics",Springer, 2nd Edition, 2004.
3. Gerald Kowalski, “Information Retrieval Systems: Theory and Implementation”, Springer.
4. William B. Frakes, Ricardo Baeza- Yates, “Information Retrieval – Data Structures & Algorithms”, Pearson Education, 2008.

WEB RESOURCES:

1. http://www.dcs.gla.ac.uk/Keith/Preface.html

26ADE103

TIME SERIES ANALYSIS AND FORECASTING
(Program Elective-1)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Introduce time series analysis, trend analytics and forecasting based on past data.
2. Give an overview of the basic concepts and techniques that would be applicable for commonly-found analytics use cases in the industry.
3. Familiarize students with the tools and techniques required to process, model, and visualize time series data.
4. Enable students to confidently think through a problem and come up with its solution in time series forecasting.
5. Develop an expertise in generating data-driven business insights.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Understand the time series and non-time series data and choose the right approach to solve a given problem.
2. Apply advanced Preprocessing and visualization techniques on time series data.
3. Analyze the various smoothing methods such as first, second and higher-ordered exponentials.
4. Understand the auto-regressive models.
5. Develop forecasting models for time series data using different RNNs such as Vanilla RNN, Gated Recurrent Units, and Long Short-Term Memory units.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	-	3	2	3
CO 2	3	1	2	2	3
CO 3	1	2	1	-	3
CO 4	3	-	2	2	3
CO 5	3	-	2	-	3

UNIT-I

Introduction to Time Series: Different types of data- Cross-sectional data, Time series data, Panel data, Internal structures of time series- General trend, Seasonality, Run sequence plot, Seasonal sub series plot, Multiple box plots, Cyclical changes, unexpected variations, Models for time series analysis- Zero mean models, Random Walk, Trend models, Seasonality models, Autocorrelation and Partial autocorrelation.

UNIT-II

Understanding Time Series Data: Advanced processing and visualization of time series data, Resampling time series data- Group wise aggregation, Moving statistics, Stationary processes- Differencing, First-order differencing, Second-order differencing, Seasonal differencing, Augmented Dickey-Fuller test, Time series decomposition- Moving averages, Moving averages and their smoothing effect, Seasonal adjustment using Moving Average, Weighted Moving Average, Time series decomposition using Moving Averages, Time series decomposition using statsmodels.tsa.

UNIT-III

Exponential Smoothing based Methods: Introduction to time series smoothing, First order exponential smoothing, Second order exponential smoothing, and Modeling higher-order exponential smoothing.

UNIT-IV

Auto-Regressive Models: Auto-regressive models, Moving average models, Building datasets with ARMA, ARIMA, Confidence interval.

UNIT- V

Deep Learning for Time Series Forecasting: Multi-layer perceptrons-Training MLPs, MLPs for time series forecasting, Recurrent neural networks- Bi-directional recurrent neural networks, Deep recurrent neural networks, Training recurrent neural networks, Solving the long-range dependency problem, Long Short Term Memory, Gated Recurrent Units, Choosing between LSTM and GRU, Recurrent neural networks for time series forecasting, Convolutional neural networks- 2D convolutions, 1D convolution, 1D convolution for time series forecasting.

TEXT BOOKS:

1. Dr. Avishek Pal, Dr. PKS Prakash, "Practical Time Series Analysis:Master Time Series Data Processing, Visualization, and Modeling Using Python", PacktPublishing, First Edition, 2017.

SUGGESTED READING:

1. Douglas C. Montgomery, Cheryl L. Jen,"Introduction To Time Series Analysis And Forecasting", 2nd Edition, Wiley Series, 2015.
2. Soren Bisgaard Murat Kulahci , "Time Series Analysis And Forecasting By Example", Technical University Of Denmark by John Wiley & Sons, Inc., 2011.

WEB RESOURCES:

1. https://nptel.ac.in/courses/103106123

26ADE118

PREDICTIVE ANALYTICS WITH R

(Program Elective-2)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Understand predictive analytics and its challenges.
2. Learn the descriptive modelling algorithms used for predictive software.
3. Identify relationships that associate inputs with one or more target variables in supervised learning models.
4. To make students gain knowledge on predictive modelling approaches to textual data.
5. To learn and familiarise with various deployment models.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Analyze key characteristics of data for modeling.
2. Apply clustering techniques and interpret the meaning of the resulting clusters.
3. Assess model accuracy to select and deploy the best model.
4. Extract features from textual data and build predictive models for textual data.
5. Understand various deployment models.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	2	2	3
CO 2	3	2	3	2	3
CO 3	3	2	3	2	3
CO 4	3	2	3	3	3
CO 5	3	2	3	3	3

UNIT I

Overview of Predictive Analytics: Introduction to Analytics – Predictive Analytics – Parametric vs. Non-Parametric Models -Business Intelligence – Predictive Analytics vs. Business Intelligence – Predictive Analytics vs. Statistics – Predictive Analytics vs. Data Mining – Challenges in using Predictive Analytics - Obstacles with Data - Obstacles with Modeling.

UNIT II

Problem Setting, Data understanding and Preparation: Defining Data for Predictive Modeling – Defining Target Variable – Defining Measures of Success for Predictive Models - Single Variable and Multiple Variable Summaries – Data Visualization – Variable Cleaning – Feature Creation - Case study: Fraud Detection.

UNIT III

Predictive Modeling : Parameter Settings – Measures of Interesting Rules – Deploying Association Rules – Building Classification Rules from Association Rules – Neural Networks - Decision Trees – Linear Regression - Logistic Regression – K-Nearest Neighbor Classifier

Descriptive Modeling : Data Preparation Issues with Descriptive Modeling - Principal Component Analysis (PCA) Algorithm - Applying PCA to New Data - PCA for Data Interpretation - Clustering Algorithms - The K-Means Algorithm - The Kohonen SOM Algorithm - Visualizing Kohonen Maps

UNIT – IV

Model Ensembles and Assessing Predictive Models: Model Ensembles - The Wisdom of Crowds - Bias Variance Tradeoff - Bagging - Boosting - Random Forests - Stochastic Gradient Boosting .- Heterogeneous Ensembles - Interpreting Model Ensembles - Batch Approach to Model Assessment -Percent Correct Classification - Rank-Ordered Approach to Model Assessment Assessing Regression Models.

UNIT – V

Healthcare Analytics: Introduction - Healthcare Data Sources and Basic Analytics - Electronic Records - Clinical Prediction Models - Privacy-Preserving Data Publishing - Temporal Data Mining for Healthcare Data - Association Analysis - Classical Methods - Temporal Methods - Temporal Pattern Mining - Sequential Pattern Mining - Time-Interval Pattern Mining - Medical Applications - Sensor Data Analysis - Convolutional Event Pattern Discovery - Patient Prognostic via Case-Based Reasoning - Disease Progression Modeling

TEXT BOOKS:

1. Dean Abbott, Applied Predictive Analytics: Principles and Techniques for the professional Data Analyst, John Wiley & Sons Inc. Publishers, First edition, 2014.
2. Chandan K. Reddy, Charu C. Aggarwal, Healthcare Data Analytics, Chapman & Hall/CRC, Data Mining and Knowledge Discovery Series, 2015.

REFERENCE BOOKS:

1. Klimberg, Ron and B.D. McCullough, Fundamentals of Predictive Analytics with JMP®, Cary, NC: SAS Institute Inc., Second Edition, 2016.
2. Eric Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, John Wiley & Sons Inc. Publishers, Second edition, 2016.
3. Hui Yang, Eva K. Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, John Wiley & Sons Inc. Publishers, 2016.

WEB RESOURCES:

1. https://nptel.ac.in/courses/111106164
2. http://coursera.org/learn/hands-on-introduction-to-linux-commands-and-shellscripting?utm_medium=sem&utm_source=gg&utm_campaign=b2c_india_courseraplus_coursera_ftc
3. https://www.coursera.org/learn/predictive-modeling-analytics

26ADE115

CYBER SECURITY

(Program Elective-2)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Understand cybercrime concepts, legal frameworks, and investigation basics
2. Analyze cyber-attack techniques and tools
3. Apply vulnerability assessment and network scanning methods
4. Demonstrate usage of security and defense tools
5. Evaluate web application security mechanisms

COURSE OUTCOMES:

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

1. Explain legal frameworks and cybercrime classifications
2. Analyze attack methods and tools
3. Perform vulnerability scanning and reconnaissance
4. Apply network defense mechanisms.
5. Assess web application vulnerabilities using tools

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	2	3	2
CO 2	3	2	3	3	2
CO 3	3	3	3	3	2
CO 4	3	2	3	3	3
CO 5	3	3	3	3	3

UNIT-I

Introduction to Cybercrime: Definition and origins of the word, Cybercrime and Information security, who are cyber criminals, Classification of Cybercrimes, Legal Perspectives, Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes, Cybercrime Era.

Cyber offenses: Introduction, How Criminals plan the attacks, Social Engineering, Cyberstalking, Cybercafe and Cybercrimes, Botnets, Attack vector, Cloud computing.

UNIT-II

Tools and Methods Used in Cybercrime: Introduction, Proxy servers and Anonymizers, Password Cracking, Keyloggers and Spywares, Viruses and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks.

Identity-based Attacks: Introduction, Phishing, Identity Theft.

UNIT-III

Systems Vulnerability Scanning Overview of vulnerability scanning, Open Port / Service Identification, Banner/Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, Open VAS, Metasploit, Networks- Netcat, Socat, understanding Port and Services tools - Datapipe, Fpipe, WinRelay, Network Reconnaissance – Nmap, THC-Amap and System tools, Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping, Kismet

UNIT-IV

Network Defense tools Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Intrusion Detection System.

UNIT-V

Web Application Tools: Scanning for web vulnerabilities tools: Nikto, HTTP utilities - Curl, Open SSL and Stunnel, Application Inspection tools – Zed Attack Proxy, Sqlmap, Password Cracking and Brute-Force Tools – John the Ripper, L0phtcrack, Pwdump, THC-Hydra

Text Books:

1. Nina,Godbole,Sunit Belapure, ”Cyber Security understanding Cyber Crimes,Computer forensics and Legal Perspectives”,Wiley India Pvt.Ltd., 2013
2. Anti-Hacker Tool Kit (Indian Edition) by Mike Shema,Fourth Edition, Publication McGraw Hill,2014.

Suggested Reading:

1. William Stallings “Cryptography and Network Security Principles and Practice, 6th Edition, Pearson 2014.
2. Dr.V.K.Jain, ”Cryptography and Network Security”, First Edition ,Khanna Book publishing New Delhi 2013.
3. Nina Godbole, “Information Systems Security Management, Metrics, Frameworks and Best Practices”, Wiley,2nd Edition,2012

Web Resource:

1. https://www.udemy.com/the-complete-cyber-security-course-end-point-protection

26ADE116

BIG DATA ANALYTICS

(Program Elective-2)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. To Introduce to some of the most common frameworks such as Hadoop, MapReduce.
2. To provide knowledge of modern data lake house technologies through open table formats (Delta Lake, Apache Iceberg, and Apache Hudi) and orchestration in big data pipelines.
3. To Provide Large scale data storage technologies such as NoSQL distributed databases with MongoDB
4. To investigate the integration of Kafka with other streaming frameworks like Apache Spark and Apache Flink.

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Design of Hadoop Distributed Files system and build applications using MapReduce
2. Perform analysis on large datasets using Hive and open table formats (Delta Lake, Iceberg, and Hudi).
3. Model the data using NoSQL and MongoDB
4. Develop applications of Parallel programming with Spark and Spark SQL
5. Gain familiarity with streaming technologies and apply Kafka with Spark and Flink for real-time data ingestion and processing.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	2	3	3
CO 2	3	2	2	3	2
CO 3	3	1	1	2	2
CO 4	3	2	3	3	2
CO 5	3	2	3	3	2

UNIT-I

Introduction to Big Data: Introduction, Big Data Enabling Technologies, Hadoop Stack for Big Data. **The Hadoop Distributed Files system:** Overview, The Design of HDFS, HDFS Concepts, The Command-Line Interface, Hadoop File systems. **MapReduce:** Overview, developing a MapReduce Application, How MapReduce works, MapReduce Types and Formats, MapReduce Features, MapReduce Examples.

UNIT-II

Open Table Formats in Big Data Analytics: Introduction to Open Table Formats**,** Delta Lake: ACID transactions, schema enforcement, time travel, use cases **Apache Iceberg:** Table architecture, hidden partitioning, schema evolution, snapshot isolation. **Apache Hudi:** Incremental data processing, streaming ingestion, use cases, Comparison of Delta, Iceberg, Strengths, limitations, Need for orchestration in modern data pipelines. **Hive:** Comparison with Traditional Databases, HiveQL, Tables, Querying Data, User-Defined Functions, Writing a User Defined Functions, Writing a User Defined Aggregate Function.

UNIT-III

No SQL Databases: Review of traditional Databases, Need for NoSQL Databases, Columnar Databases, Failover and reliability principles, CAP Theorem, Differences between SQL and NoSQL databases. **Working Mechanisms of Mongo DB**: Overview, Advantages, Environment, Data Modelling, Create Database, Drop Database, Create collection, Drop collection, Data types, Insert, Query, Update and Delete operations, Limiting and Sorting records, Indexing, Aggregation.

UNIT-IV

Parallel programming with Spark: Overview of Spark, Fundamentals of Scala and functional programming, Spark concepts - Resilient Distributed Datasets (RDD), creating RDDs, Basic Transformations, Basic Actions, Word Count Example; Spark operations, Job execution, Spark Applications – Cluster computing with working sets. **Spark SQL:** What is SQL, Big Data and SQL – Spark SQL, How to Run Spark SQL Queries, Tables, iews, Databases, Select Statements.

UNIT-V

Apache Kafka Fundamentals: Architecture, Brokers, Topics, Partitions, Producers, Consumers, Kafka Connect and Kafka Streams **Advanced Kafka Features:** Exactly-Once Semantics, Kafka Transactions, Tiered Storage, Integrating Kafka with Apache Spark and Apache Flink, Integrating Kafka with Spark Streaming, Real-time Analytics Use Cases with Kafka - such as Fraud Detection, Clickstream Analysis, Real-time Monitoring,

TEXT BOOKS:

1. Tom White, "Hadoop: The Definitive Guide", Fourth Edition, O'Reilly Media Inc, 2015.
2. Bill Chambers & Matei Zaharia, “Spark: The Definitive Guide”, O’Reilly Media Inc, 2018.
3. Nick Pentreath, “Machine Learning with Spark”, First Edition, Packt Publishing, 2015.
4. Neha Narkhede, Gwen Shapira, Todd Palino, "Kafka: The Definitive Guide", 2nd Edition, O'Reilly Media, 2017
5. Viktor Gamov, "Kafka Streams in Action", 1st Edition, Manning Publications, 2018
6. Dipankar Mazumdar & Vinoth Govindarajan, "Engineering Lakehouses with Open Table Formats", First Edition, Packt Publishing, 2025.
7. Kyle Weller, "Apache Iceberg vs Delta Lake vs Apache Hudi: Feature Comparison Deep Dive", Onehouse Publications, 2025.

SUGGESTED READING:

1. Thilinagunarathne, “Hadoop MapReduce v2 Cookbook”, Second Edition, Packet Publishing, 2015.
2. Chuck Lam, Mark Davis, Ajit Gaddam, “Hadoop in Action”, Manning Publications Company, 2016.
3. Alex Holmes, “Hadoop in Practice”, Manning Publications Company, 2012.
4. Alan Gates, "Programming Pig", O'Reilly Media Inc, 2011.
5. Edward Capriolo, Dean Wampler, Jason Rutherglen, "Programming Hive", O'Reilly Media Inc, 2012.

WEB RESOURCES:

1. https://nptel.ac.in/courses/106104189
2. https://stanford.edu/~rezab/sparkworkshop/slides/xiangrui.pdf

26ADE119

ROBOTIC PROCESS AUTOMATION

(Program Elective-2)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

1. To provide insights on robotic process automation (RPA) technology and its value proposition.
2. To introduce different platforms for RPA.
3. To learn different types of variables, control flow and data manipulation techniques.
4. To familiarize with Image, Text and data Tables Automation
5. To describe various types of Exceptions and strategies to handle them.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Gain insights into Robotic Process Automation Technology
2. Acquire knowledge of RPA Platforms and components
3. Identify and understand Image, Text and Data Tables Automation
4. Understand various control techniques and OCR in RPA
5. Describe Exception Handling and Debugging techniques

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	3	2	2
CO2	2	2	3	2	2
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	2	2

UNIT-I

What is Robotic Process Automation?, Scope and techniques of automation, What should be automated? , What can be automated? , Techniques of automation, Robotic process automation, What can RPA do?, Benefits of RPA, Components of RPA, Recorder, Development studio, Extensions and plugins, Bot runner, Control center, RPA platforms , Automation Anywhere, UiPath 18 Blue Prism, WorkFusion , Thoughtonomy, KOFAX, About UiPath, UiPath Studio, UiPath Robot, UiPath Orchestrator.

UNIT-II

Record and Play UiPath stack**:** UiPath Studio, UiPath Robot, Types of Robots, UiPath Orchestrator, Downloading and installing UiPath Studio, Learning UiPath Studio, Projects, The user interface, The Ribbon, The Quick Access Toolbar, Designer panel , Properties panel, Activities panel, Project panel , Outline panel, Output panel, Library panel, Variable panel, Argument, Task recorder : Advanced UI interactions , Input methods, Output methods, Step-by-step examples using the recorder, Emptying trash in Gmail , Emptying Recycle Bin

UNIT-III

Sequence, Flowchart, and Control Flow, Sequencing the workflow, Activities: Using activities with workflows, What Flowcharts are and when to use them, Control flow, various types of loops, and decision making, The Assign activity, The Delay activity, Example, The Break activity, Example, The While activity, Example, The Do while activity, Example, The For each activity, Example, The If activity, The Switch activity Step-by-step example using Sequence and Flowchart, How to use a Sequence, How to use a Flowchart, Step-by-step example using Sequence and Control flow

UNIT-IV

Data Manipulation:

Variables and scope, Collections, Arguments – Purpose and use, Data table usage with examples, Building a data table, Building a data table using data scraping (dynamically), Clipboard management, File operation with step-by-step example, Read cell, Write cell, Read range , Write range, Append range , CSV/Excel to data table and vice versa (with a step-by-step example), Reading an Excel file and creating a data table by using data from the Excel file, Creating a data table and then writing all its data to an Excel file.

UNIT-V

Taking Control of the Controls: Finding and attaching windows, Implementing the Attach Window activity, Finding the control, Anchor base, Element Exists, Element scope, Find children, Find element, Find relative element, Get ancestor, Indicate on screen, Techniques for waiting for a control, Wait Element Vanish, Wait Image Vanish, Wait attribute, Act on controls – mouse and keyboard activities, Mouse activities, The Click activity, The Double-click activity, The Hover activity, Keyboard activities, Send hotkey, Type into activity , Type secure text.

TEXT BOOKS:

1. Alok Mani Tripathi, Learning Robotic Process Automation, 2018, PACKT publishing
2. Tom Taulli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress Publishing, 2020

SUGGESTED READING:

1. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant, Independently Published, 1st Edition 2018.
2. Frank Casale , Rebecca Dilla, Heidi Jaynes , Lauren Livingston, "Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation,1st Edition 2015.
3. Srikanth Merianda,"Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation", Consulting Opportunity Holdings LLC, 1st Edition 2018

WEB RESOURCES:

1. https://www.uipath.com/rpa/robotic-process-automation,
2. https://www.academy.uipath.com,

26ADE125

NATURAL LANGUAGE PROCESSING

(Program Elective-2)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. To introduce the concepts, architecture and limitations of neural networks
2. To provide foundational concepts of deep learning
3. To learn the concepts convolution neural networks
2. To familiarize with architectures of recurrent neural networks
3. To impart the knowledge of advanced applications of deep neural networks.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Understand NLP concepts and preprocessing techniques
2. Apply text representation and feature extraction methods
3. Use embeddings for semantic analysis
4. Build ML/DL models for NLP tasks
5. Develop real-world NLP applications using Python

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO1	PO2	PO3	PSO1	PSO2
CO1	**2**	**1**	**2**	**1**	**2**
CO2	**2**	**2**	**3**	**2**	**3**
CO3	**2**	**2**	**3**	**2**	**3**
CO4	**3**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**

UNIT-I

Introduction to NLP and Python Ecosystem: Overview of Natural Language Processing (NLP), NLP vs Programming Languages, Applications: Chatbots, Sentiment Analysis, Machine Translation, NER, NLP Pipeline and Challenges, Python for NLP: Libraries: NLTK, TextBlob, SpaCy, Text Preprocessing: Tokenization, Stopword Removal, Stemming, Lemmatization.

UNIT-II

Text Representation and Feature Engineering: Natural Language Representation, Bag of Words (BoW), One-hot Encoding, TF-IDF and Frequency Analysis, N-grams and Language Modeling, Text Normalization Techniques, Transforming Text into Data Structures, Distance Metrics for Text Similarity,

UNIT-III

Word Embeddings and Semantic Analysis: Limitations of Traditional Representations, Word Embeddings; Word2Vec (CBOW, Skip-gram), GloVe , Semantic Similarity and Vector Spaces, Cosine Similarity and Distance Measures, Handling Out-of-Vocabulary Words, Applications of Embeddings.

UNIT-IV

Machine Learning and Deep Learning for NLP: NLP with Machine Learning: Classification (Naïve Bayes, SVM), Clustering, Feature Engineering for ML Models, Neural Networks for NLP: Basics of Artificial Neurons, Feedforward Networks, Deep Learning Models: CNN for Text, RNN, LSTM basics, Model Evaluation Techniques.

UNIT-V

Advanced NLP Applications and Projects: Sentiment Analysis (Rule-based & ML-based), Named Entity Recognition (NER), Chatbot Development, Machine Translation Basics, Text Summarization, Real-world NLP Applications: Recommendation Systems, Document Classification, Introduction to Modern NLP Trends (Transformers, BERT – overview).

TEXT BOOKS:

1. Aman Kedia Mayank Rasu, Hands-On Python Natural Language Processing ,First Edition,2020, PACKT publishers
2. Thushan Ganegedara, Natural Language Processing with TensorFlow.,2018, Packt Publishing Ltd

SUGGESTED READING:

1. Steven Bird, Evan Klein and Edward Loper, "Natural Language Processing with Python", O'Reilly Media, Inc., 2009.
2. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2nd Edition, Pearson Education, 2009.
3. Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, 2ndEdition, Chapman and Hall/CRC Press, 2010
4. Nitin Hardaniya, Jacob Perkins, "Natural Language Processing: Python and NLTK", Packt Publishers, 2016

DATASETS:

1. https://www.kaggle.com/datasets
2. https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/multilabel.html#siam-competition2007
3. https://archive.ics.uci.edu/ml/index.php

WEB RESOURCES:

1. https://pythonprogramming.net/tokenizing-words-sentences-nltk-tutorial/
2. http://www.nptelvideos.in/2012/11/natural-language-processing.html
3. https://github.com/keon/awesome-nlp

26ADE101

NATURE INSPIRED COMPUTING

(Program Elective-3)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. To establish basic knowledge in NP hard problems and understand the need for approximation algorithms.
2. Design algorithms that include operators, representations, fitness functions and potential hybridizations for non-trivial problems.
3. Design algorithms that utilize the collective intelligence of simple organisms to solve problems.
4. Design and implement an artificial neural network that employs learning to solve nontrivial problems.

COURSE OUTCOMES:

1. Understand fundamental concepts of NP-hardness and computational complexity
2. Understand the strengths, weaknesses and appropriateness of nature-inspired algorithms.
3. Apply nature-inspired algorithms to optimization, design and learning problems.
4. Analyze the Behavior systems of nature inspired algorithm applied in real world problems.
5. Understand the theory behind the design of immune networks and DNA computing and their potential applications.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	1	2	1
CO 2	3	3	2	2	2
CO 3	3	3	3	2	2
CO 4	3	3	3	2	3
CO 5	3	3	3	3	3

UNIT-I

INTRODUCTION: Computational Problems, Decision Problem, Optimization Problem, Hardness in Optimization Problems, NP class, NP-Hard, examples for NP-Hard problems, tackling NP-Hard problems, Rationale for seeking inspiration from nature, Pillars of Evolutionary Theory, The Genotype, Artificial Evolution, Genetic.

UNIT-II

COMPUTING INSPIRED BY NATURE: Evolutionary Computing, Hill Climbing and Simulated Annealing, Darwin's Dangerous Idea, Genetics Principles, Standard Evolutionary Algorithm -Genetic Algorithms , Reproduction-Crossover, Mutation, Evolutionary Programming, Genetic Programming, Particle Swarm Optimization Algorithm, Hybrid PSO algorithms, Ant Colony Optimization, Artificial Bee Colony, Firefly Algorithm

UNIT-III

SWARM INTELLIGENCE: Introduction - Ant Colonies, Ant Foraging Behavior, Ant Colony Optimization, SACO and scope of ACO algorithms, Ant Colony Algorithm (ACA), Swarm Robotics, Foraging for food, Social Adaptation of Knowledge, Particle Swarm Optimization (PSO).

UNIT-IV

Introduction- Immune System, Physiology and main components, Pattern Recognition and Binding, Immune Network Theory- Danger Theory, Evaluation Interaction- Immune Algorithms, Introduction – Genetic algorithms, Bone Marrow Models, Forest's Algorithm, Artificial Immune Networks, Bone Marrow Models, Forest's Algorithm, Artificial Immune Networks.

UNIT- V

COMPUTING WITH NEW NATURAL MATERIALS: DNA Computing: Motivation, DNA Molecule, Adleman's experiment, Test tube programming language, Universal DNA Computers, PAM Model, Splicing Systems, Lipton's Solution to SAT Problem, Scope of DNA Computing, From Classical to DNA Computing

TEXT BOOKS:

1. Handbook of Nature-Inspired and Innovative Computing – Covers a wide range of nature-inspired techniques and innovative computing paradigms.
2. Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies – Provides theoretical foundations and practical approaches to bio-inspired AI systems.

SUGGESTED READING:

1. Iran Bashir “Mastering Blockchain” 2nd Edition Paperback 2018.
2. Daniel Drescher, “Block Chain Basics”, 1st Edition, Apress, 2017.
3. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing.
4. Xin-She Yang, “Nature-Inspired Computation and Swarm Intelligence Algorithms, Theory and Applications”, Elsevier, Academic Press, 2020.

WEB RESOURCE:

1. https://link.springer.com3W
2. https://pmc.ncbi.nlm.nih.gov
3. https://www.ijert.org

26ADE106

RECOMMENDER SYSTEMS

(Program Elective-3)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. To understand the foundations of the recommender system
2. To learn the significance of machine learning and data mining algorithms for Recommender systems
3. To learn about collaborative filtering.
4. To make students design and implement a recommender system.
5. To learn collaborative filtering.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Understand the basic concepts of recommender systems.
2. Implement machine-learning and data-mining algorithms in recommender systems data sets.
3. Implementation of Collaborative Filtering in carrying out performance evaluation of recommender systems based on various metrics.
4. Design and implement a simple recommender system.
5. Learn about advanced topics of recommender systems applications

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	2	2	3
CO 2	3	2	3	2	3
CO 3	3	2	3	2	3
CO 4	3	2	3	3	3
CO 5	3	2	3	3	3

UNIT I

INTRODUCTION: Introduction and basic taxonomy of recommender systems – Traditional and non-personalized Recommender Systems – Overview of data mining methods for recommender systems- similarity measures- Dimensionality reduction – Singular Value Decomposition (SVD).

UNIT II

CONTENT-BASED RECOMMENDATION SYSTEMS: High-level architecture of content-based systems – Item profiles, Representing item profiles, Methods for learning user profiles, Similarity-based retrieval, and Classification algorithms.

UNIT III

COLLABORATIVE FILTERING: A systematic approach, Nearest-neighbor collaborative filtering (CF), user-based and item-based CF, components of neighborhood methods (rating normalization, similarity weight computation, and neighborhood selection.

UNIT – IV

ATTACK-RESISTANT RECOMMENDER SYSTEMS: Introduction – Types of Attacks – Detecting attacks on recommender systems – Individual attack – Group attack – Strategies for robust recommender design – Robust recommendation algorithms. **Hybrid approaches:** Opportunities for hybridization, **Monolithic hybridization design:** Feature combination, Feature augmentation

UNIT – V

EVALUATING RECOMMENDER SYSTEMS: Evaluating Paradigms – User Studies – Online and Offline evaluation – Goals of evaluation design – Design Issues – Accuracy metrics – Limitations of Evaluation measures

Recent Developments of Recommender Systems: Recommender systems in personalized web search, knowledge-based recommender system, Social tagging recommender systems, Trust-centric recommendations, Group recommender systems

TEXT BOOKS:

1. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer, 2016.
2. Dietmar Jannach , Markus Zanker , Alexander Felfernig and Gerhard Friedrich , Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
3. Jannach D., Zanker M. and FelFering A., "Recommender Systems: An Introduction", Cambridge University Press, 1st Edition, 2011.

REFERENCE BOOKS:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of massive datasets, 3rd edition, Cambridge University Press, 2020.
2. S. Berkovsky, I. Cantador and D. Tikk, Collaborative Recommendations: Algorithms, Practical Challenges and Applications. UK: World Scientific Publishing Co, 2019.(ISBN: 9789813275348)

26ADE107

REINFORCEMENT LEARNING
(Program Elective-3)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. To understand the fundamentals of Reinforcement Learning, agent–environment interaction, and bandit problems. To understand retrieval models, evaluation techniques, and query languages.
2. To Apply Markov Decision Processes and Dynamic Programming techniques for decision-making problems.
3. To Analyse Monte Carlo and Temporal-Difference learning methods for value estimation and control.
4. To evaluate advanced learning techniques such as eligibility traces and planning methods.
5. To Design scalable Reinforcement Learning solutions using function approximation and real-world applications.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Explain the basic concepts of Reinforcement Learning and multi-arm bandit problems.
2. Apply Markov Decision Processes and Dynamic Programming techniques.
3. Analyze Monte Carlo and Temporal-Difference learning methods.
4. Evaluate eligibility traces and planning approaches in RL.
5. Design RL models using approximation methods and real-world applications.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	-	2	2
CO 2	2	2	2	3	3
CO 3	2	2	1	3	2
CO 4	2	2	1	2	2
CO 5	3	3	1	3	3

UNIT-I

THE REINFORCEMENT LEARNING PROBLEM AND MULTI-ARM BANDITS

The Reinforcement Learning Problem: Reinforcement Learning-Elements of Reinforcement Learning- Limitations and Scope-Extended Example: Tic-Tac-Toe **Multi-arm Bandits:** An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation Tracking a Nonstationary Problem, Optimistic Initial Values, Upper Confidence Bound Action Selection, Gradient Bandits.

UNIT-II

FINITE MARKOV DECISION PROCESSES AND DYNAMIC PROGRAMMING

The Agent Environment Interface Goals and Rewards Returns Unified Notation for Episodic and Continuing Tasks, The Markov Property ,Markov Decision Processes ,Value Functions ,Optimal Value Functions. **Dynamic Programming:** Policy Evaluation ,Policy Improvement ,Policy Iteration, Value Iteration ,Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming

UNIT-III

MONTE CARLO METHODS AND TEMPORAL-DIFFERENCE LEARNING

Monte Carlo Methods : Monte Carlo Prediction, Monté Carlo Estimation of Action Values, Monté Carlo Control, Monté Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off -Policy Monte Carlo Control.

Temporal-Difference Learning Prediction, Advantages of TD Prediction Methods, Optimality of TD (0),Sarsa: On-Policy TD Control, Q-Learning: Off-Policy TD Control.

UNIT-IV
ELIGIBILITY TRACES AND PLANNING
Eligibility Traces: n-Step TD Prediction, The Forward View of TD (λ), The Backward View of TD(λ), Equivalences of Forward and Backward Views, Sarsa (λ), Watkins's Q(λ), Off-policy Eligibility Traces using Importance Sampling, Implementation Issues. **Planning and Learning with Tabular Methods:** Models and Planning, Integrating Planning, Acting, and Learning, When the Model Is Wrong, Prioritized Sweeping, Full vs. Sample Backups, Trajectory Sampling, Heuristic Search.

UNIT-V
APPROXIMATION SOLUTION METHODS AND APPLICATIONS
On-policy Approximation of Action Values: Value Prediction with Function Approximation, Gradient-Descent Methods, Linear Methods, Control with Function Approximation. **Policy Approximation:** Actor Critic Methods, Eligibility Traces for Actor–Critic Methods, R-Learning and the Average, Reward Setting.**Applications and Case Studies:** TD-Gammon-Samuel's Checkers Player, the Acrobot, Elevator Dispatching, Dynamic Channel Allocation.

Text Books:
1. Sutton & Barto, "Reinforcement Learning: An Introduction", MIT Press 2018, 2nd Edition.

Suggested Reading:
1. Vincent François-Lavel, Peter Henderson, Riashat Islam, Marc G. Bellemare, Joelle Pineau "An Introduction to Deep Reinforcement Learning", Now Publishers, 2018
2. Csaba Szepesvari, "Algorithms for Reinforcement Learning", Morgan & Claypool Publishers, 2010
3. Maxim Lapan "Deep Reinforcement Learning Hands-On" Packt publisher, 2nd edition, 2020

Web Resource:
1. NPTEL Course: Reinforcement Learning: https://nptel.ac.in/courses/106/106/106106143/
2. Swayam Course: Reinforcement Learning: https://swayam.gov.in/nd1_noc19_cs55/preview

26ADE113

HEALTHCAREANALYTICS

(Program Elective-3)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-Requisites

Basic understanding of statistics and probability, Python, Data Mining, Machine Learning.

COURSE OBJECTIVES

This course aims

1. To impart the fundamental concepts of Healthcare data analytics.
2. To give the knowledge about the Health care Data Sources.
3. To familiarize Advanced Data Analytics for Healthcare.
4. To learn the Health IoT data analytics.
5. To implement the Applications and Practical Systems for Healthcare.

COURSE OUTCOMES

By the end of this course, students should be able to:

1. Describe the basics of healthcare data analytics.
2. Explain the Healthcare Data Sources.
3. Discuss the Advanced Data Analytics for Healthcare.
4. Express the Health IoT data analytics.
5. Apply the practical Systems for Healthcare.

CO-PO ARTICULATION MATRIX

PO/PSO CO	PO1	PO2	PO3	PSO1	PSO2
CO1	3	2	2	2	3
CO2	2	2	3	2	2
CO3	2	2	3	2	2
CO4	3	2	3	3	3
CO5	2	2	3	2	3

UNIT – I

INTRODUCTION

Introduction- Healthcare Data Sources and Basic Analytics – Healthcare Data Sources : Electronic Health Records: Components of HER- Coding system- Biomedical Image Analysis: Biomedical Imaging Modalities- Object Detection- Image Segmentation- Image Registration- Feature Extraction- Mining of Sensor Data in Healthcare: Mining Sensor Data in Medical Informatics: Scope and Challenges- Sensor Data Mining Applications.

UNIT – II

HEALTHCARE DATA SOURCES

Biomedical Signal Analysis: Types of Biomedical Signals- ECG Signal Analysis- Denoising of Signals- Multivariate Biomedical Signal Analysis- Cross-Correlation Analysis- Methods to Study Connectivity- Genomic Data Analysis for Personalized Medicine: Genomic Data Generation Methods and Standards for Genomic Data Analysis- Types of Computational Genomics Studies towards Personalized Medicine.

UNIT – III

ADVANCED DATA ANALYTICS FOR HEALTHCARE

Basic Statistical Prediction Models- Alternative Clinical Prediction Models- Survival Models Evaluation and Validation- Temporal Data Mining for Healthcare Data: Association Analysis Temporal Pattern Mining- Sensor Data Analysis- Other Temporal Modeling Methods- Visual Analytics for Healthcare: Visual Analytics and Medical Data Visualization- Visual Analytics in Healthcare.

UNIT – IV

HEALTH IOT DATA ANALYTICS

Internet of things in the healthcare industry- IoT healthcare architecture- Characteristics of IoT health data- Health data analytics using Internet of things- Computational intelligence in Internet of things for future healthcare applications.

UNIT – V

APPLICATIONS AND PRACTICAL SYSTEMS FOR HEALTHCARE

Data Analytics for Pervasive Health: Supporting Infrastructure and Technology – Basic Analytic Techniques- Advanced Analytic Techniques- Applications – Fraud Detection in Healthcare- Data Analytics for Pharmaceutical Discoveries- Clinical Decision Support Systems.

TEXTBOOK:

1. Chandan K. Reddy , Charu C. Aggarwal, Healthcare Data Analytics 1st Edition, Kindle Edition, CRC press, 2020.

2. Sanjay Kumar Singh Ravi Shankar Singh Anil Kumar Pandey Udmale S.S. Ankit Chaudhary , IoT-Based Data Analytics for the Healthcare Industry Techniques and Applications 1st Edition, Elsevier, Academic Press

REFERENCE BOOKS

1. Prasant Kumar Pattnaik, Suneeta Mohanty (Editor), Satarupa Mohanty (Editor) Format: Kindle Edition, Smart Healthcare Analytics in IoT Enabled Environment 1st edition Kindle Edition, Springer Nature Switzerland AG 2020.
2. Nilanjan Dey, Amira Ashour, Simon James Fong , Chintan Bhatt , Healthcare Data Analytics and Management 1st Edition, Elsevier, Academic Press 2018.
3. Sanket Shah, Healthcare Analytics: A Comprehensive Guide, Kindly Edition, 2020.

26ADE117

AUGMENTED AND VIRTUAL REALITY

Instruction	(Program Elective-3)	3L Hours per week
Duration of SEE		3 Hours
SEE		60 Marks
CIE		40 Marks
Credits		3

COURSE OBJECTIVES: This course aims to

1. Introduce the fundamental concepts of Virtual Reality (VR), Augmented Reality (AR), and Extended Reality (XR).
2. Provide knowledge of human perception, 3D transformations, and rendering techniques for immersive systems.
3. Enable understanding of interaction techniques, input devices, and user experience in virtual environments.
4. Familiarize students with modern VR/AR development tools, frameworks, and platforms.
5. Explore applications of VR/AR systems and emerging trends in immersive technologies.

COURSE OUTCOMES:

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

1. Understand fundamentals of VR, AR, and XR concepts.
2. Apply 3D transformations and interaction techniques in virtual environments.
3. Analyze modern VR/AR development tools and frameworks.
4. Design interaction techniques in virtual environments.
5. Evaluate applications and usability of AR/VR systems.

CO-PO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO 1	2	2	3	2	2
CO 2	3	2	2	3	2
CO 3	3	3	3	3	3
CO 4	2	2	2	2	1
CO 5	2	3	3	2	2

UNIT-I

Introduction to VR, AR, and XR: History and evolution of VR and AR, Extended Reality (XR) concepts, comparison of AR, VR, and MR, technology and features of augmented reality, challenges in AR systems, AR system architecture and functionality.
Human factors: Human visual system, perception of depth, color, contrast, resolution, stereo vision.
VR Hardware: Head-Mounted Displays (HMDs), controllers, sensors, tracking systems.
Graphics and Rendering Basics: Introduction to graphics pipeline, real-time rendering concepts, 3D transformations (translation, rotation, scaling), model-view-projection matrices, lighting and shading concepts, introduction to Physically Based Rendering (PBR).

UNIT-II

3D Interaction and User Experience in Virtual Reality:3D interaction techniques and manipulation methods ,Input devices: controllers, hand tracking, gesture input, voice interaction ,Navigation and travel techniques in virtual environments ,Spatial interaction and user movement ,System control techniques: graphical user interfaces in VR (world-space UI), voice commands, gesture-based interaction ,Multimodal interaction techniques ,Human-computer interaction (HCI) and user experience (UX) design principles in VR ,Evaluation of interaction techniques and usability in VR systems

UNIT-III

Development Tools and Frameworks in Virtual Reality: Modern VR/AR platforms: Unity 3D (XR Toolkit), Unreal Engine ,Open standards: OpenXR, WebXR ,Scene representation: world space, coordinate systems, environment design ,Object properties: geometry, position, orientation, hierarchy ,Scene graph and asset management ,Bounding volumes and collision detection ,Level of Detail (LOD) techniques ,Scripting for VR applications (Unity C#, Unreal

Blueprints) ,User interface design in VR: spatial UI, world-space UI ,Basic GUI and interaction panels in immersive environments.

UNIT-IV

VR applications: Pose Tracking I, Tracking with light house, Pose Tracking II, Advanced positional tracking, Panoramic Imaging and Cinematic, VR Spatial Sound and the Vestibular System, VR Engines and Other Aspects of VR, Latency, eye tracking, post-rendering warp. The Future: Virtual environment, modes of interaction 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-V

Augmented and Mixed Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

TEXT BOOKS:

1. LaValle "Virtual Reality", Cambridge University Press, 2016.
2. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.

Suggested Reading:

1. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013
3. Ange Anderson, Virtual Reality, Augmented Reality and Artificial Intelligence in Special Education, 2019

Web Resource:

1. https://nptel.ac.in/courses/106/106/106106138/
2. https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ge08/
3. https://www.coursera.org/learn/ar?
4. https://www.coursera.org/specializations/virtual-reality

26ADE120

FEDERATED MACHINE LEARNING

(Program Elective-4)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Understand the key concepts and issues behind Federated Learning
2. Get familiar with key theoretical results of Federated Learning
3. Understand the key concepts of reinforcement Learning

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Knowledge of the basic concepts, architecture, and applications of FL.
2. Understanding of new research and application trends in FL.
3. Analyze distributed Machine Learning
4. Analyze horizontal federated learning
5. Understand the significance of Federated Learning for Vision, Language, and Recommendation

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	1	1	1	1	1
CO 2	2	2	1	2	3
CO 3	2	2	1	3	3
CO 4	1	2	-	2	2
CO 5	2	3	2	2	2

UNIT - I

Introduction: Motivation, Federated Learning as a Solution, The Definition of Federated Learning, Categories of Federated Learning, Current Development in Federated Learning, Research Issues in Federated Learning, Open-Source Projects, Standardization Efforts, The Federated AI Ecosystem Background: Privacy-Preserving Machine Learning, PPML and Secure ML, Threat and Security Models, Privacy Threat Models, Adversary and Security Models, Privacy Preservation Techniques, Secure Multi- Party Computation, Homomorphic Encryption, Differential Privacy.

UNIT - II

Distributed Machine Learning: Introduction to DML, The Definition of DML, DML Platforms, Scalability- Motivated DML, Large-Scale Machine Learning, Scalability-Oriented DML Schemes, Privacy-Motivated DML, Privacy-Preserving Decision Trees, Privacy-Preserving Techniques, Privacy-Preserving DML Schemes, Privacy- Preserving Gradient Descent, Vanilla Federated Learning, Privacy-Preserving Methods.

UNIT - III

Horizontal Federated Learning: The Definition of HFL, Architecture of HFL, The Client- Server Architecture, The Peer-to-Peer Architecture, Global Model Evaluation, The Federated Averaging Algorithm, Federated Optimization, The FedAvg Algorithm, The Secured FedAvg Algorithm, Improvement of the FedAvg Algorithm, Communication Efficiency, Client Selection Vertical Federated Learning: The Definition of VFL, Architecture of VFL, Algorithms of VFL, Secure Federated Linear Regression, Secure Federated Tree-Boosting.

UNIT - IV

Federated Transfer Learning: Heterogeneous Federated Learning, Federated Transfer Learning, The FTL Framework, Additively Homomorphic Encryption, The FTL Training Process, The FTL Prediction Process, Security Analysis, Secret Sharing-Based FTL Incentive Mechanism Design for Federated Learning: Paying for Contributions, Profit- Sharing Games, Reverse Auctions, A Fairness-Aware Profit Sharing Framework, Modeling Contribution, Modeling Cost, Modeling Regret, Modeling Temporal Regret, The Policy Orchestrator, Computing Payoff Weightage.

UNIT - V

Federated Learning for Vision, Language, and Recommendation: Federated Learning for Computer Vision, Federated CV, Federated Learning for NLP, Federated NLP, Federated Learning for Recommendation Systems, Recommendation Model, Federated Recommendation System Federated Reinforcement Learning: Introduction to Reinforcement Learning, Policy, Reward, Value Function, Model of the Environment, RL Background Example, Reinforcement Learning Algorithms, Distributed Reinforcement Learning, Asynchronous Distributed Reinforcement Learning, Synchronous Distributed Reinforcement Learning, Federated Reinforcement Learning, Background and Categorization.

TEXT BOOK:

1. Federated Learning, Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, and HanYu - Synthesis Lectures on Artificial Intelligence and Machine Learning 2019.

SUGGESTED READING:

1. Kairouz, Peter, and McMahan, H. Brendan, Advances and Open Problems in Federated Learning. United States, Now Publishers, 2021.
2. Heiko Ludwig, Nathalie Baracaldo, Federated Learning: A Comprehensive Overview of Methods and Applications. Poland, Springer International Publishing, 2022.
3. Verma, Dinesh C. Federated AI for Real-World Business Scenarios. United States, CRC Press, 2021.
4. Lam M. Nguyen, Pin-Yu Chen, Trong Nghia Hoang, Federated Learning: Theory and Practice. United Kingdom, Elsevier Science, 2024.

A. Jose Anand, R. Kavitha, R. Srinivasan, S. Suresh, Saravanan Krishnan, Handbook on Federated Learning: Advances, Applications and Opportunities. N.p., Taylor & Francis Group, 2024.

5. Chaoqun You, Gang Feng, Lei Zhang, Yao Sun, Federated Learning for Future Intelligent Wireless Networks. United Kingdom, Wiley, 2023.

WEB LINKS:

1. https://www.tensorflow.org/federated
2. https://openmined.github.io/PySyft/index.html
3. https://opendp.org/

26ADE121

EDGE COMPUTING

(Program Elective-4)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. To introduce the concepts of Edge Computing.
2. To understand the IoT Architecture, Implementation of Edge Computing with help of IoT Architecture with Core Modules.
3. To understand the Raspberry Pi Hardware Layouts and Operating systems and Configuration of Raspberry Pi.
4. To understand the Implementation of Interface of Raspberry Pi with Micro Computer and Edge to Cloud Protocols and MQTT State transitions.
5. To familiarize with the concepts of Edge Computing with Raspberry Pi and Industrial and Commercial IoT.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Understanding edge computing and its differentiation
2. Analyze Edge Analytics and Security
3. Configuring and programming Raspberry Pi
4. Implementing MQTT for edge-cloud communication
5. Exploring edge computing applications and Use cases.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	2	3	2
CO 2	2	2	2	3	2
CO 3	3	3	3	2	2
CO 4	2	2	3	3	3
CO 5	3	3	1	2	3

UNIT - I

Edge Computing and Its Essentials: Introduction, Edge Computing Architecture, Background Essentials: IoT Devices, Networking Architecture, Network Management and Control., Edge Computing State-of-the-Art Interfaces and Devices, Edge Computing Simulators

UNIT - II

Edge Analytics & Security: Edge Data Analytics, Potential of Edge Analytics, Architecture of Edge Analytics, Machine Learning for Edge Devices, Edge Analytics: Case Study. **Edge Data Storage Security:** Privacy Preserving Schemes, Edge-Based Attack Detection and Prevention

UNIT - III

Raspberry Pi: Introduction to Raspberry Pi, About Raspberry Pi Board, Hardware Layout and Pin outs, Operating systems on Raspberry Pi, Configuring Raspberry Pi, Programming Raspberry Pi, Connecting Raspberry Pi via SSH, Remote access tools, Interfacing DHT Sensor with Pi, Pi as Webserver, Pi Camera, Image & Video Processing using Pi.

UNIT - IV

Interfacing Raspberry Pi & MQTT: Implementation of Microcomputer Raspberry Pi and device Interfacing, Edge to Cloud Protocols- Protocols, MQTT, MQTT publish-subscribe, MQTT Architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats, MQTT 3.1.1 working example.

UNIT – V

Edge Computing Use Cases and Case Studies: Edge Computing High-Potential Use Cases: Autonomous Vehicles, Smart Cities, Industrial Automation, Network Functions, Gaming, Content Delivery, Financial Sector, Augmented Reality, Healthcare Sector, **Realization of Edge Computing in Healthcare Ensuring Storage Security:** Devices and Setup, Case Study I: Pulse Oximeter to Detect ARDS in Edge Server, Case Study II: Blood Pressure Monitor to Predict Hypotension in Edge Server, Case Study III: Body Composition Scale to Detect Heat Index in Edge Server, Use Case - Edge Computing/Analytics in Industrial IOT

TEXTBOOKS:

1. Anitha Kumari, G. Sudha Sadasivam, D. Dharani and M. Niranjana Murthy,"Edge Computing Fundamentals, Advances and Applications", CRC Press, 2022.
2. Simon Monk, "Raspberry Pi Cookbook", 3rd Edition, O'Reilly Media, Inc 2019,ISBN: 978149204322.

SUGGESTED READING:

1. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama, Wiley Publication, 2019, ISBN: 9781119524984.
2. David Jensen, "Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent. Edge, Microsoft Azure
3. Perry Lea, "IoT Edge Computing for Architects", Second Edition, Packet Publishing, 2020, ISBN: 9781839214806.

WEB RESOURCES:

1. https://What Is Edge Computing? | IBM
2. https://What Is Edge Computing? Everything You Need to Know

26ADE122

ADVANCED DATA STRUCTURES AND ALGORITHMS

(Program Elective-4)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES

This course aims to:

1. Understand time and space complexity using mathematical models
2. Learn advanced structures like heaps, hash tables, B-trees, and disjoint sets.
3. Acquire knowledge on the various paradigms like greedy, divide & conquer, and dynamic programming.
4. Analyze and apply algorithms for solving shortest path problems in weighted graphs.
5. Introduce concepts of number theory, cryptography, and approximation algorithms.

COURSE OUTCOMES

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

1. Analyze complexity using asymptotic notations and recurrence relations.
2. Apply advanced structures like heaps, trees, hash tables, and disjoint sets.
3. Use algorithm design paradigms such as Divide & Conquer, Greedy, and Dynamic Programming
4. Solve graph problems including shortest paths, MST, and network flows.
5. Understand NP-Completeness and apply approximation algorithms for complex problems.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	3	2	3
CO 2	3	2	3	2	3
CO 3	3	2	3	2	3
CO 4	3	2	3	1	3
CO 5	3	2	3	3	3

UNIT I

Algorithm Analysis & Mathematical Foundations: Growth of functions, Asymptotic Notations, Mathematical Induction, Recurrence Relations: Substitution Method, Recursion Tree Method, Master Theorem, Amortized Analysis, Probabilistic Analysis & Randomized Algorithms.

UNIT II

Advanced Data Structures: Heaps and Priority Queues, Binary Search Trees, AVL Trees, Red-Black Trees, Splay Trees, Skip Lists, Hash Tables and Hash Functions, B-Trees and External Memory Structures. Fibonacci Heaps, Disjoint Sets (Union-Find).

UNIT III

Sorting & Algorithmic Techniques: Heap Sort, Quick Sort, Randomized Quick Sort, Linear Time Sorting: Radix Sort, Bucket Sort, Medians and Order Statistics, Algorithm Design Paradigms: Divide and Conquer, Greedy Method, Dynamic Programming, Optimal Binary Search Trees , Huffman Coding.

UNIT IV

Graph Algorithms & Network Flow: Graph Representation (Adjacency List/Matrix), Graph Traversals: BFS, DFS, Topological Sorting, Minimum Spanning Trees (Prim's, Kruskal's), Shortest Paths: Single Source (Dijkstra, Bellman-Ford), All-Pairs (Floyd-Warshall), Network Flow: Ford-Fulkerson Algorithm, Edmonds-Karp Algorithm, Maximum Bipartite Matching, Minimum Cost Flow.

UNIT V

Emerging Areas in Algorithms: Text Processing: String Matching Algorithms, Tries and Applications, Text Compression, Pattern Matching, Number Theory & Cryptography: Fundamental Number Algorithms, Cryptographic Techniques, Security Protocols, Computational Geometry: Convex Hull Algorithms, Range Trees, Quad Trees and k-D Trees, Advanced Concepts: NP-Completeness, Approximation Algorithms.

TEXT BOOKS:

1. Thomas H Cormen, Charles. E.Leiserson, Ronald L.Rivest, and Clifford.Stein, Introduction to Algorithms", Third Edition MIT Press, ISBN: 978-0262033848, 2009.
2. Abirami A, Priya R L, "Advanced Data Structures and Algorithms", ISBN: 978-93-55517-937, 2023.

Suggested Reading:

1. Alfred V Aho, John E Hopcrof," The Design and Analysis of Computer Algorithms", Pearson Education, Fourth Edition ISBN: 978813170205, 2009.
2. Mark Allen Weiss," Data Structures and Algorithm Analysis in C++", Addison-Wesley, Third edition, ISBN: 978-0132847377, 2013

26ADE124

GENERATIVE AND AGENTIC AI

(Program Elective-4)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

PREREQUISITE: Knowledge on Deep Learning concepts

COURSE OBJECTIVES:

This course aims to:

1. To understand the core concepts of Generative AI, LLMs, and Transformer models.
2. To develop AI agents and applications using LangChain, RAG, LangGraph, and open-source tools.
3. To build and deploy ethical, efficient, and real-world AI solutions.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Understand the fundamentals of Generative AI, Large Language Models, and Transformer architectures.
2. Explore prompt engineering, LangChain, Retrieval-Augmented Generation (RAG), and Agentic AI systems.
3. Design AI agents and graph-based AI workflows using open-source frameworks.
4. Develop AI applications using LangChain, LangGraph, vector databases, and open-source LLMs.
5. Build practical AI solutions with deployment, optimization, and ethical AI considerations.

CO-PO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PSO1	PSO 2
CO 1	3	2	3	2	3
CO 2	3	3	3	2	3
CO 3	3	2	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

UNIT-I

Foundations of Generative AI and Large Language Models: Introduction to Generative AI, applications of Generative AI, Traditional AI vs Generative AI vs Agentic AI, fundamentals of Large Language Models (LLMs), evolution of LLMs from GPT-1 to frontier AI models, comparing major LLMs including GPT, Claude, Gemini, DeepSeek, and Llama models, Transformer architecture, attention mechanism, self-attention, encoder-decoder architecture, embeddings and positional encoding, tokenization techniques, model selection strategies for different AI applications, open-source vs API-based models, inference optimization, and cost optimization strategies for LLM applications.

UNIT-II

Prompt Engineering and LangChain Fundamentals: Prompt engineering fundamentals, zero-shot and few-shot prompting, chain-of-thought prompting, structured prompting techniques, prompt optimization methods, introduction to LangChain 1.0, create_agent abstraction, chains and runnables, middleware systems, prompt templates, OpenAI API integration, Anthropic API integration, Google Gemini API integration, DeepSeek API integration, multi-provider AI model integration, function calling, structured outputs using JSON, streaming responses, batch processing, and cost-optimized AI pipelines.

UNIT III:

Retrieval-Augmented Generation (RAG) Systems: Introduction to Retrieval-Augmented Generation (RAG), traditional RAG vs Agentic RAG, self-improving retrieval systems, embeddings and semantic search, vector databases including ChromaDB, Pinecone, and Qdrant, document ingestion pipelines, chunking strategies, embedding generation techniques, building production RAG pipelines, hybrid search methods combining semantic and keyword search, MCP-enhanced RAG systems, hallucination reduction techniques, scalable document processing, and retrieval optimization methods.

UNIT-IV

Agentic AI and AI Agent Development: Fundamentals of Agentic AI, planning, reasoning, and acting workflows, AI agent lifecycle, autonomous systems, human-in-the-loop AI systems, single-agent and multi-agent architectures, enterprise AI agent applications, agent design patterns, LangChain 1.0 agents, middleware integration, tool integration patterns, memory systems in AI agents, introduction to Model Context Protocol (MCP), MCP architecture, MCP-enhanced AI agents, tool orchestration, collaborative multi-agent systems, and AI workflow automation.

UNIT-V LangGraph and Production AI Workflows: Introduction to LangGraph 1.0 architecture, graph-based AI workflows, nodes and edges in AI systems, state management and graph execution logic, conditional routing, multi-step reasoning workflows, node caching for development, pre-hooks and post-hooks for guardrails, workflow monitoring, implementing safety and validation checks, conversational memory systems, building production AI workflows, deployment using Streamlit and FastAPI, observability in AI systems, and production use cases of LangGraph-based AI applications.

TEXT BOOKS:

1. Valentina Alto, *Building Agentic AI Systems*, Packt Publishing Ltd., 2025.
2. Joseph Babcock and Raghav Bali, *Generative AI with Python and TensorFlow 2*, Packt Publishing Ltd., UK, 2021.

SUGGESTED READING:

1. Steve Tingiris, *Exploring GPT-3*, Packt Publishing Ltd., UK, 2021.
2. Elbert Gale, *Mastering AI Agents: From Design to Deployment of Autonomous Systems*, 2025.
3. Natenapis Faraksa, *Building AI Agent: Learn Building AI Agents, A Practical Guide for Building Intelligent Agents*, 2024.

WEB RESOURCES:

1. https://huggingface.co/
2. https://python.langchain.com/
3. https://langchain-ai.github.io/langgraph/
4. https://ollama.com/

26ADE126

HIGH PERFORMANCE COMPUTING

(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aim is to:

1. To understand fundamentals of High-Performance Computing and parallel architectures.
2. To learn parallel programming using OpenMP and MPI.
3. To design basic parallel algorithms using standard paradigms.
4. To develop GPU programming skills using CUDA.
5. To understand modern HPC trends and performance optimization techniques.

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Understand fundamentals of High-Performance Computing, parallel architectures, and system classifications.
2. Apply parallel programming concepts using OpenMP and MPI.
3. Design and analyze parallel algorithms using standard paradigms.
4. Implement GPU-based programs using CUDA.
5. Evaluate GPU performance and understand modern HPC trends and architectures.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	-	2	2	2
CO 2	3	-	1	3	3
CO 3	1	1	2	2	2
CO 4	3	2	3	3	3
CO 5	3	2	3	3	3

UNIT- I

Introduction: High Performance computing Disciplines, Impact of supercomputing on science, society and security, Anatomy, HPC Architectures, Key, Parallel Architecture Families—Flynn's Taxonomy, Multiprocessors, Shared-Memory Multiprocessors, Massively Parallel Processors, Commodity Clusters.

UNIT -II

OpenMP: Introduction, Overview, Parallel, Synchronization, Reduction. **MPI**: Introduction, Message-Passing Interface Basics Message-Passing Interface Data Types, Communicators, Communication Collectives, Broadcast, Scatter, Gather, Allgather.

UNIT-III

Parallel Algorithms: Introduction, Fork–Join, Divide and Conquer, Manager–Worker, Embarrassingly Parallel, Halo Exchange, The Advection Equation Using Finite Difference, Sparse Matrix Vector Multiplication, Permutation: Cannon's Algorithm, Task Dataflow: Breadth First Search.

UNIT-IV

GPU Computing with CUDA: Architecture of a modern GPU, Heterogeneous data parallel computing model, CUDA program structure, A vector addition kernel, Multidimensional grids and data — CUDA threads organization (grids, blocks, warps), GPU architecture and scheduling — Streaming Multiprocessors and warp execution, CUDA device memory types — global, shared, constant, registers, Memory coalescing, Shared memory and tiling, A tiled matrix-matrix multiplication kernel.

UNIT-V

GPU Performance & Modern HPC: GPU performance considerations — occupancy, control divergence, warp scheduling. Parallel patterns — reduction, scan, histogram. Introduction to tensor cores and mixed precision computing. MPI+X programming model. Modern HPC architectures — Lightweight Architectures, the World's Fastest Machines, Exascale Computing.

TEXT BOOK:

1. High Performance Computing, **Modern** Systems and Practices**, Thomas** Sterling, Matthew Anderson, Maciej Brodowicz, Foreword by C. Gordon Bell,School of Informatics, Computing, and Engineering, Indiana University, Bloomington, Morgan Kaufmann publishers,2018 Edition.
2. Programming Massively Parallel Processors: A Hands-on Approach, Wen-mei W. Hwu, David B. Kirk, Izzat El Hajj, 4th Edition, Morgan Kaufmann publishers, 2022.

SUGGESTED READING:

1. An Introduction to Parallel Programming, By Peter Pacheco, University of San Francisco, 2011 Edition.

26ADE110

EXPLAINABLE ARTIFICIAL INTELLIGENCE (EAI)

(Program Elective-5)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. To Understand the concepts within Explainable AI and interpretable machine learning
2. To Summarize, visualize, and explore the data using graphical and non-graphical techniques
3. To know the Importance of XAI in modern world
4. To Categorize XAI on the basis of their scope, agnosticity, data types and explanation techniques
5. To know the working principles and mathematical modelling of XAI techniques

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Describe the machine learning application's context and why explainability might help.
2. Understand the concepts of model validation, evaluation, and performance visualization for both supervised and unsupervised learning.
3. Demonstrate post hoc explainability techniques through a self-chosen set of programming platforms.
4. Illustrate the results from Explainable deep learning techniques and suggest how it helps the problem context.
5. Describe the comprehension of challenges and future related to Explainable AI

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	3	2	3	3
CO 2	3	-	2	2	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

UNIT-I

Introduction: Black-Box problem, Goals, Brief History, Purpose, Societal Impact, Types of Explanations, Trade- offs, Taxonomy, Flowchart for Interpretable and Explainable Techniques. **Pre-model Interpretability and Explainability:** Data Science Process and EDA, Exploratory Data Analysis, Feature Engineering/

UNIT-II

Model Visualization Techniques and Traditional Interpretable Algorithms: Model Validation, Evaluation, and Hyperparameters, Model Selection and Visualization, Classification Model Visualization, Regression Model Visualization, Clustering Model Visualization, Interpretable Machine Learning Properties, Traditional Interpretable Algorithms

UNIT-III

Model Interpretability: Advances in Interpretable Machine Learning: Interpretable vs. Explainable Algorithms, Tools and Libraries, Ensemble-Based, Decision Tree-Based, Rule-Based Techniques, Scoring System. **Post-Hoc Interpretability and Explanations:** Tools and Libraries, Visual Explanation, Feature Importance, Example-Based

UNIT-IV

Explainable Deep Learning: Applications, Tools and Libraries, Intrinsic, Perturbation, Gradient / Backpropagation

UNIT-V

Explainability: Time Series Forecasting, Natural Language Processing, and Computer Vision. **XAI: Challenges:** Properties of Explanation, Categories of Explanation, Taxonomy of Explanation Evaluation. **XAI: Future:** Formalization of Explanation Techniques and Evaluations, Adoption of Interpretable Techniques, Human-Machine Collaboration, Collective Intelligence from Multiple Disciplines, Responsible AI (RAI), XAI and Security, Causality and XAI

Text Books:

1. Uday Kamath and John Liu "Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning", Springer Cham, First Edition, 2021.

Suggested Reading:

1. Leonida Gianfagna and Antonio Di Cecco, "Explainable AI with Python", Springer International Publishing, First Edition, 2021.
2. Denis Rothman, "Hands-On Explainable AI (XAI) with Python", Packt Publishing, First Edition, 2020

Web Resources:

1. https://www.ibm.com/in-en/watson/explainable-ai
2. https://sites.google.com/view/explainable-ai-tutorial
3. https://cloud.google.com/explainable-ai

26ADE108

SCALABLE ALGORITHMS AND SYSTEMS FOR DATA ANALYSIS

(Program Elective-5)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1.Provide knowledge on scalability as a complexity notion of computation
2.Familiarize students with algorithmic techniques for the design of provably-good scalable algorithms
3.Give an overview of map reduce and link analysis for handling larger datasets.
4.Introduce Systems and approaches for large scale data-science problems.
5.Enable students with how large-scale machine learning and distributed machine learning approaches work

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1.Outline the characteristics of massive data and primitives of scalable algorithms.
2.Apply geometric and clustering techniques for local computation of data.
3.Solve large scale data science problems related to link analysis and finding similar items.
4.Examine the need of scalable systems for large scale data science such as web advertising and recommendation systems.
5.Determine useful information to be gained by analysing the large-scale data that is derived from social networks.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	-	2	2	2
CO 2	3	-	2	3	3
CO 3	1	-	2	2	2
CO 4	3	2	3	3	3
CO 5	3	1	3	3	3

UNIT-I

Scalable Algorithms: Challenges of Massive Data, The Scalability of Algorithms, Complexity Class S, Scalable Reduction and Algorithmic Primitives. **Networks and Data:** Weighted Graphs and Affinity Networks, Possible Sources of Affinities, Beyond Graph Models for Social/Information Networks, Basic Problems in Data and Network Analysis, Sparse Networks and Sparse Matrices. **Significant Nodes: Sampling - Making Data Smaller:** Personalized PageRank Matrix, Multi-Precision Annealing for Significant Page Rank, Local Approximation of Personalized PageRank, Multi-Precision Sampling, Significant- PageRank Identification.

UNIT-II

Partitioning: Geometric Techniques for Data Analysis: CenterPoint and Regression Depth, Scalable Algorithms for Center points, Geometric Separators, Dimension Reduction: Random vs Spectral, Scalable Geometric Divide- and-Conquer, Graph Partitioning: Vertex and Edge Separators, Multiway Partition of Network and Geometric Data,Spectral Graph Partitioning: The Geometry of a Graph.

UNIT-III

Overview of data mining: and map-reduce, Hash Functions, shingling of documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures, Link-analysis Page Rank,Link Spam, Hubsand authorities. **Frequent Item sets:** Market based model, A-Priori Algorithm, Handling larger data sets in memory, Limited-pass algorithms.

UNIT-IV

Clustering: Hierarchical clustering, k-means, CURE, Clustering in Non Euclidean Spaces, Clustering for Streams and Parallelism. **Advertising on the web:** Matching problem, The ad-words problem. **Recommendation systems:** Content Based Recommendations, Collaborative Filtering, Dimensionality Reduction, The NetFlix Challenge.

UNIT- V

Mining Social-Network Graphs: Social Networks as Graphs, Clustering of Social-Network Graphs ,Direct Discovery of Communities, Partitioning of Graph, Finding Overlapping Communities ,Simrank , Counting Triangles , Neighborhood Properties of Graphs. **Large-scale machine Learning:** The Machine-Learning Model ,Perceptrons, Support-Vector Machines, Learning from Nearest Neighbors ,Comparison of Learning Methods.

Text Books:

1. Shang Hua Teng, Scalable algorithms for data and network analysis, Foundation Trends Theoretical Computer Science, Firstedition, Now Publishers Inc.,2016
2. Nathalie Japkowicz, Jerzy Stefanowski, Big Data Analysis: New Algorithms for a NewSociety, Firstedition, Springer,2016
3. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, Mining of massive datasets, Cambridge University Press,2014

Suggested Reading:

2. Jimmy Lin and Chris Dyer, Data-Intensive Text Processing with MapReduce, First edition,Morgan and Claypool Publishers,2010
3. Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, Advanced Analytics with Spark: Patternsfor Learning from Data at Scale,Oreilly, 2015
4. Ankit Jain, Mastering Apache Storm: Processing big1 data streaming in real time, PacktPublishing,201

26ADE111

QUANTUM COMPUTING

(Program Elective-5)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To understand the principles of quantum computation and mechanics
2. To learn about the operators involved in Quantum computing and their applications.
3. To study the information theory aspects of quantum computing.
4. To explore the various error corrections available for quantum computing
5. To understand the principles of quantum computation and mechanics

COURSE OUTCOMES: After the completion of this course, the student will be able to

1. Understand the basic principles of quantum computation and quantum mechanics.
2. Analyze and design quantum circuits using quantum gates and understand their computational advantages over classical methods.
3. Analyse the behaviour of basic quantum algorithms.
4. Learn about the operators involved in Quantum computing and their applications
5. Understand quantum error correction techniques and fault-tolerant quantum computation mechanisms.

CO-PO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO 1	2	2	3	2	2
CO 2	3	2	3	3	2
CO 3	3	3	3	3	3
CO 4	2	2	2	2	1
CO 5	2	3	3	2	2

UNIT-I

Review of Linear Algebra: Vector Space, Hilbert Space, Bases, Matrices, Eigenvalues and Eigen vectors, Hermitian matrices, Unitary matrices. Introduction to Quantum Computing. Dirac Notation, Qubits, Bloch Sphere, Postulates of Quantum Mechanics, Classical Computation Vs Quantum Computation.

UNIT-II

Measurements: Composite system, reduced state, mixed state. Single Qubit gates – two qubit gates – Multiple Qubits gates, Universal gates, Quantum circuit model of computation, Quantum computational complexity-no cloning theorem.

UNIT-III

Introduction to Quantum Simulator (Qiskit): Explore gates and circuits with Quantum composer, Programming using Qiskit. Entanglement, Bell's inequality circuit on two and three qubits, Quantum parallelism, Quantum teleportation, Super-dense coding.

UNIT-IV

Phase kick-back, Deutsch algorithm, Deutsch-Jozsa algorithm, Simon algorithm, Quantum Foruier Transform, Grover's quantum search algorithm, Shor's algorithm.

UNIT-V

Quantum key distribution. Comparison Between Classical and Quantum Information Theory, Applications of Quantum Information. Classical error correction codes, Quantum error correction codes, Three and nine qubit quantum codes. Fault tolerant quantum computation.

TEXT BOOKS:

1.M.A.Neilsen, I.L Chuang, "Quantum Computation and Quantum Information", Cambridge University Press, Cambridge (2013).
2. P. Kaye, R. Laflamme and M. Mosca, "An Introduction to Quantum Computing", Oxford University Press (2006).

SUGGESTED READING:

1. Chris Bernhardt, "Quantum computing for everyone", MIT press,2020.
2. Parag K.Lala, "Quantum Computing – A Beginners's Introduction", First Edition, TMH, 2019.
3. NPTEL course on "Introduction to Quantum Computing: Quantum Algorithms and Qiskit" by IBM and IIT Madras.

26ADE109

CYBER PHYSICAL SYSTEMS

(Program Elective-5)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives

This course aims to:

1. Introduce basics of cyber-physical system and Industrial revolution 4.0 concepts
2. Design CPS requirements based on operating system and hardware architecture constraints.
3. Understand the concepts involved in Cyber Physical Systems Security.

Course Outcomes

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

1. Explain the fundamentals of Industry 4.0 and Cyber-Physical Systems.
2. Apply embedded system modeling and design principles in CPS.
3. Analyse the operation of sensors, actuators, and real-time sensor networks.
4. Evaluate security mechanisms and challenges in Cyber-Physical Systems.
5. Design Cyber-Physical System solutions for real-world applications.
6.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	-	2	2
CO 2	2	2	2	3	3
CO 3	2	2	1	3	2
CO 4	2	2	1	2	2
CO 5	3	3	1	3	3

UNIT - I

INTRODUCTION TO INDUSTRY 4.0 AND CYBER PHYSICAL SYSTEM:

Industry 4.0 - Globalization and Emerging Issues, The Fourth Revolution - Smart and Connected Business Perspective, Basics of Industrial IoT - Industrial Processes - Industrial Sensing & Actuation, Industrial Internet Systems - Basic principles of design and validation of CPS, Cyber-Physical Systems (CPS) in the real world, Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

UNIT - II

EMBEDDED SYSTEMS MODELING AND DESIGN AND CPS:

Platform components, Embedded Systems definition, specification, and languages. Concepts, requirements, examples. Embedded system models at different abstraction levels. Test benches, design under test, Intellectual Property components. Discrete event simulation, semantics, algorithms. Design and analysis techniques for decentralized computer architectures, communication, and hardware-software systems. Cyber Physical System Hardware Platform, Processors, Sensors, Actuators, Network, Wireless Hart, CAN, Automotive Ethernet, Software stack, Real-Time Operating system (RTOS) - Scheduling Real-Time control tasks.

UNIT – III

SENSORS, ACTUATORS AND SENSOR NETWORKS:

Sensors, Actuators and Sensor Networks & Real-Time and Distributed Systems - Fundamental principles and applications of sensors, actuators. Smart sensors and micro sensor/micro actuator array devices. Introduction to signal processing and sensor/actuator networks, deployment and architecture, wireless communication, multiple access control layer, data gathering, routing and querying, collaborating signal processing, Time dependent systems, clock synchronization, real-time communication protocols, specification of requirements, task scheduling. Validation of timelines, real-time configuration management. Middleware architecture for distributed real-time and secure services.

UNIT – IV

SECURITY OF CYBER PHYSICAL SYSTEMS:

Security of Cyber Physical Systems, Embedded and CPS security attacks and countermeasures, authentication, identification, confidentiality, data integrity, authorization, access control, malware attacks and counter-measures, security protocols. Privacy issues vehicular devices and smart metering. Applications of public key and symmetric cryptography, digital certificates, credentials. Security and vulnerability of cyber-physical infrastructure networks, Mobile and wireless network security, Robust wireless infrastructure, Cloud computing and data security, Event Awareness and System Monitoring for Cyber Physical Infrastructure.

UNIT – V

CYBER-PHYSICAL SYSTEMS CASE STUDIES AND PROJECTS:

Cyber Physical Systems Case Studies and Projects, Automotive: SW controllers for Antilock braking system, Adaptive Cruise Control, Lane Departure Warning, Suspension Control, Healthcare: Artificial Pancreas/Infusion Pump/Pacemaker, Green Buildings: automated lighting, AC control, power distribution grid, robotics, civil infrastructure, avionics Transportation.

TEXT / REFERENCE BOOKS:

1. "Industry 4.0: The Industrial Internet of Things", Alasdair Gilchrist (Apress)
2. "Industrial Internet of Things: Cyber manufacturing Systems" Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)
3. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, http://LeeSeshia.org, ISBN 978-1-312-42740-2, 2015.
4. Rajeev Alur. Principles of Cyber-Physical Systems. MIT Press. 2015.
5. K. J. Astrom and R. M. Murray. Feedback Systems: An Introduction for Scientists and Engineers. Prince- ton University Press, 2009. http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page.
6. Sajal Das, Krishna Kant, and Nan Zhang, Securing Cyber-Physical Critical Infrastructure – Foundations & Challenges, Morgan Kaufmann, 2012.

26ADE123

MINING MASSIVE DATA SETS

(Program Elective-5)

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

COURSE OBJECTIVES:

This course aims to:

1. Introduce computational techniques and the statistical challenges involved in data mining.
2. Familiarize students with MapReduce, distributed file systems, and algorithms designed for large-scale data processing.
3. Present methods for similarity search, clustering, recommendation systems, and link analysis.
4. Explore advanced topics such as data stream mining, social network analysis, dimensionality reduction, and machine learning models.

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Apply MapReduce and distributed computing algorithms to solve large-scale data mining problem
2. Implement techniques for similarity search, frequent itemset mining, and clustering.
3. Analyse data streams and social network graphs, and perform link analysis using PageRank and its variants.
4. Design and evaluate recommendation systems, and apply dimensionality reduction and machine learning models.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	2	3	3
CO 2	3	2	3	2	2
CO 3	3	2	2	2	2
CO 4	3	2	3	3	2

UNIT-I

Data Mining – Modeling, Statistical Limits of Data Mining, Role of Words in Document Analysis, Hash Functions, Index Structures, MapReduce and the Modern Software Stack, Distributed File Systems, MapReduce – Algorithms Using MapReduce, Extensions of MapReduce, Communication Cost Model, Complexity Theory for MapReduce.

UNIT-II

Finding Similar Items – Applications of Near-Neighbor Search, Document Shingling Methods, Similarity-Preserving Set Summaries, Locality-Sensitive Hashing for Document Comparison, Distance Measures for Similarity Evaluation.

UNIT-III

Mining Data Streams – Stream Data Models, Sampling Techniques for Data Streams, Filtering Methods for Streaming Data, Link Analysis – PageRank, Efficient Computation of PageRank, Topic-Sensitive PageRank, Detection of Link Spam.

UNIT-IV

Frequent Itemsets – Market-Basket Analysis, Association Rules and the Apriori Algorithm, Handling Large-Scale Datasets in Main Memory, Clustering – Fundamentals of Clustering Methods, Hierarchical Clustering, K-Means Algorithm, CURE (Clustering Using Representatives) Algorithm.

UNIT-V

Recommendation Systems – Models of Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction, Mining Social-Network Graphs – Representing Social Networks as Graphs, Clustering of Social-Network Graphs, Community Detection, Graph Partitioning, Identifying Overlapping Communities,

SimRank, Dimensionality Reduction – Eigenvalues and Eigenvectors of Symmetric Matrices, Principal Component Analysis, Singular Value Decomposition, Large-Scale Machine Learning – Machine Learning Models, Perceptrons, Support Vector Machines

TEXT BOOKS:

1. Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman, *Mining of Massive Datasets*, Cambridge University Press, 2014.
2. Tom White, *Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale*, O'Reilly Media, 4th Edition, 2015.

SUGGESTED READING:

1. Jiawei Han, Micheline Kamber, Jian Pei, *Data Mining: Concepts and Techniques*, 4th Edition, Morgan Kaufmann, 2022.
2. Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, *Introduction to Data Mining*, 2nd Edition, Pearson, 2021.

WEB RESOURCES:

1. https://www.cs.cmu.edu/~christos/courses/826.F09/slides/DM-Intro.pdf
2. https://stanford.edu/~rezab/sparkworkshop/slides/xian

26EGA101

ENGLISH FOR RESEARCH PAPER WRITING

(Audit Course-1 and 2)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

PREREQUISITE: Writing to express on science and technological concepts with good taste for research and development.

COURSE OBJECTIVES:

This course aims to:

1. Motivate learners for academic writing and thus encourage them for continuous professional updating and up-gradation.
2. Facilitate a practical understanding of the multiple purposes of Writing Research Papers and help them infer the benefits and limitations of research in science and technology.
3. Brainstorm and develop the content, formulating a structure and illustrating the format of writing a research paper.
4. Survey and select a theme/topic for a thorough reading and to writing a research paper.
5. Understand to implement the intricacies of writing and publishing a research paper.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Improve work performance and efficiency. Illustrate the nuances of research paper writing and draw conclusions on professional usefulness.
2. Classify different types of research papers and organize the format and citation of sources.
3. Explore various formats of APA, MLA and IEEE and set up for writing a research paper.
4. Draft paragraphs and write theme based thesis statements in a scientific manner.
5. Develop an original research paper while acquiring the knowledge of how and where to publish their papers

CO-PO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO 1	1	2	1	1	1
CO 2	1	1	1	1	1
CO 3	1	2	2	1	1
CO 4	1	2	1	1	1
CO 5	2	3	1	1	1

UNIT - I

Academic Writing: Meaning & Definition of a research paper; Purpose of a research paper - Scope, Benefits, Limitations and outcomes for professional development, An introduction to methods and Approaches of Research.

UNIT - II

Research Paper Format: Title - Abstract - Introduction - Discussion - Findings - Conclusion - Style of Indentation - Font size/Font types - Indexing - Citation of sources.

UNIT - III

Process of Writing a research paper, Writing to Draft a Format, Develop content, Adapting, Reviewing, Paraphrasing& Plagiarism Checks.

UNIT - IV

Choosing a topic - Thesis Statement - Outline - Organizing notes - Language of Research - Word order, Paragraphs - Writing first draft-Revising/Editing - The final draft and proof reading. Understanding APA, MLA, IEEE formats.

UNIT - V

Research Paper Publication Reputed Journals –Paid, Free and peer reviewed journals, National/International - ISSN No, No. of volumes, Scopus Index/UGC Journals. Getting Papers Published.

TEXT BOOKS:

1. Kothari, C. R. and Gaurav, Garg, Research Methodology Methods and Techniques", 4thEdition, New Age International Publishers, New Delhi, 2019.
2. Ellison, Carroll. "Writing Research Papers", McGraw Hill's Concise Guide, 2010.
3. Lipson, Charles. "Cite Right: A Quick Guide to Citation Styles-- MLA, APA, Chicago, the Sciences, Professions, and More", 2nd Edition,. University of Chicago Press. Chicago, 2018.

SUGGESTED READING:

1. Day, Robert A. "How to Write and Publish a Scientific Paper", Cambridge University Press, 2006
2. Girden, E. R. "MLA Hand book for writers of Research Papers", 7th Edition, East West Press Pvt. Ltd, New Delhi, 2009
3. Bailey, Stephen. "Academic Writing: A Handbook for International Students", Routledge, 2018

WEB RESOURCES:

1. https://onlin://onlinecourses.nptel.ac.in/noc 18_mg13/preview
2. https://nptel.ac.in/courses/121/106/121106007/
3. https://www.classcentral.com/course/swayam-introduction-to-research-5221

WRITING TOOLS:

1. https://owl.purdue.edu/owl_exercises/index.html - The Owl writing lab
2. https://www.turnitin.com/login_page.asp?lang=en_us – Turn tin software

26CEA101

DISASTER MITIGATION AND MANAGEMENT

(Audit Course-1 and 2)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	Pass/Fail

Course Objectives:

To enable the students to

1. To equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities, including natural, climatic and human-induced factors and associated impacts
2. To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
3. To enable the students to understand risks, vulnerabilities and human errors associated with human-induced disasters
4. To enable the students to understand and assimilate the impacts of any disaster on the affected area, depending on its position/ location, environmental conditions, demographic, etc
5. To equip the students with the knowledge of the chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of national and global conventions.

Course Outcomes:

At the end of the course, students will be able to

1. Ability to analyse and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at different levels
2. Ability to understand and choose the appropriate activities and tools, and set up priorities to build a coherent and adapted disaster management plan
3. Ability to understand various mechanisms and consequences of human-induced disasters for the participa- tory role of engineers in disaster management
4. To understand the impact on various elements affected by the disaster and to suggest and apply appropriate measures for the same
5. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans and the ability to understand various participatory ap- proaches/strategies and their application in disaster management

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4
CO1	2	3	2	1
CO2	3	3	2	2
CO3	2	3	3	2
CO4	3	3	2	3
CO5	3	2	2	3

UNIT- I:

Introduction: Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster-Natural and manmade; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDM).

UNIT- II:
Natural Disasters: Hydro meteorological disasters: Causes, Early warning systems- monitoring and manage- ment, structural and non-structural measures for floods, drought and Tropical cyclones; Geographical based dis- asters: Tsunami generation, causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various hydro-meteorological and geographical based disasters.

UNIT- III:
Human induced hazards: Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to vari- ous chemical industrial hazards eg.: Bhopal gas tragedy; Management of chemical terrorism disasters and bio- logical disasters; Radiological Emergencies and case studies; Case studies related to major power break downs, fire accidents, traffic accidents, oil spills and stampedes, disasters due to double cellar construction in multisto- ried buildings.

UNIT- IV:
Disaster Impacts: Disaster impacts- environmental, physical, social, ecological, economic, political, etc.; health, psycho-social issues; demographic aspects- gender, age, special needs; hazard locations; global and na- tional disaster trends; climate change and urban disasters.

UNIT- V:
Concept of Disaster Policies and legislation for disaster risk reduction
Management: Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recov- ery; risk analysis, vulnerability and capacity assessment; post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local in situations, NGOs and other stakeholders;, DRR programmers in India and the activities of National Disaster Management Authority.

Text Books:
1. Pradeep Sahni*," Disaster Risk Reduction in South Asia*", Prentice Hall, 2003.
2. B. K. Singh,*" Handbook of Disaster Management*: *techniques &Guidelines*", Rajat Publication, 2008.
3. Ministry of Home Affairs". *Government of India, "National disaster management plan, Part I and II",*
4. K. K. Ghosh," *Disaster Management",* APH Publishing Corporation, 2006.

Suggested Reading:
1. http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india1.pdf
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs)
3. Hazards, Disasters and your community: A booklet for students and the community, Ministry of home affairs.

26EEA101

"Sanskrit for Computational Thinking & Engineering Applications"

(Audit Course-1 and 2)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

COURSE OBJECTIVES

1. To introduce Sanskrit as a structured language useful for logical thinking and algorithm design
2. To connect Sanskrit concepts with modern engineering domains (AI, circuits, structures, systems)
3. To develop computational and analytical skills using Sanskrit-based principles
4. To enable students to explore interdisciplinary applications for research and innovation

COURSE OUTCOMES

After completion, students will be able to:

1. Apply structured Sanskrit rules to improve logical and algorithmic thinking
2. Relate concepts from Sanskrit texts to modern Engineering principles
3. Develop simple computational models inspired by Sanskrit grammar/logics
4. Use Sanskrit-based frameworks in AI, coding logic, or system design
5. Identify interdisciplinary research opportunities combining Sanskrit & Engineering

CO–PO MATRIX

CO/PO	PO-1	PO-2	PO-3	PO-4
CO-1	**2**	**1**	**2**	**1**
CO-2	**2**	**1**	**2**	**2**
CO-3	**3**	**1**	**2**	**3**
CO-4	**2**	**2**	**2**	**2**
CO-5	**3**	**2**	**2**	**2**

UNIT–I:

Sanskrit as a Structured Language: Sanskrit as rule-based system -Basics: alphabets, word formation (only essentials) -Sandhi as **data compression analogy** -Samasa as **modular design / block abstraction**-Simple sentence formation (very minimal grammar).

UNIT–II:

Sanskrit & Computational Thinking: Paninian grammar → rule engine / compiler design -Shiva Sutras → encoding system-
Binary concepts in Pingala (Chandas → digital logic) -Recursion & patterns in Sanskrit structures

UNIT–III:

Sanskrit in Core Engineering Domains

Civil / Mechanical: Sulba Sutras → geometry, measurements -Ancient construction logic → modular design

Electrical / ECE: Concept of energy (Agni, Surya) → symbolic + physical mapping **-**Wave & sound (Nada → signal analogy)

Systems Thinking: Interconnectedness → system design philosophy

UNIT–IV: Sanskrit & Modern Technology
Sanskrit & Artificial Intelligence (knowledge representation) -Natural Language Processing (NLP) -Formal languages & syntax -Command-based structures → programming analogy

UNIT–V: Mini Applications & Case Studies
Case study: Sanskrit → Algorithm (simple flowchart) -Chandas → binary pattern generation-Design a simple rule-based system using Sanskrit logic -Mini presentation / activity

TEXT BOOKS:

1. Kapil Kapoor – Language, Linguistics and Literature- Indian Perspective ; Academic Foundation, New Delhi; 1994 (1st Edition); ISBN: 978-8171880577
2. Frits Staal : *A Reader on the Sanskrit Grammarians;* MIT Press / Motilal Banarsidass ; 1972 (Original); ISBN: 978-0262191340
3. George Gheverghese Joseph: The Crest of the Peacock"; Princeton University Press; 2000 (2nd Edition; widely used); ISBN: 978-0691135267
4. B.V. Subbarayappa: "Indian Scientific Heritage" – National Institute of Advanced Studies (NIAS), Bangalore; 2006 ISBN: 978-8185015026
5. M. Krishnamachariar : "History of Sanskrit Literature"; Motilal Banarsidass Publishers; Reprint 1993 (Original: 1937, TTD PRESS); ISBN: 978-8120802841

SUGGESTED READING:

1. Pingala. *Chandah Shastra* (various editions, Nirnaya Sagar Press / Chowkhamba)
2. Bharati, A., et al. *Natural Language Processing: A Paninian Perspective*, PHI, 1995
3. Selected IEEE / Springer Papers on Sanskrit & AI

26ECA101

VALUE EDUCATION

(Audit Course I and II)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

PREREQUISITE:

COURSE OBJECTIVES:

This course aims to

1. Understand Value Education, Self-development and National development.
2. Imbibe good human values and Morals in students.
3. Cultivate individual and National character.

COURSE OUTCOMES:

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

1. Summarize classification of values and values for self-development.
2. Identify the importance of values in personal and professional life.
3. Apply the importance of social values for better career and relationships.
4. Analyze ethical issues in modern technology
5. Discuss concept of soul and reincarnation and promote responsible citizenship

CO-PO ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	3
CO2	2	2	2	2	3
CO3	2	2	2	2	3
CO4	2	2	2	2	3
CO5	2	2	2	2	3

UNIT - I

Human Values, Ethics and Morals: Concept of Values, Human Values, Indian concept of humanism, Values for self-development, Social values, Individual attitudes, Work ethics, Moral and non- moral behavior, Standards and Principles based on religion, Culture and Tradition.

UNIT - II

Value Cultivation, and Self-Management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT - III

Spiritual Outlook and Social Values: Personality and Behaviour Development, Scientific attitude and Spiritual (soul) outlook, Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, Avoiding fault finding in others, Reduction of anger, Forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance., Happiness Vs Suffering, Love for truth, Aware of self-destructive habits, Appreciation and co-operation.

UNIT - IV

Technology, Society, and Sustainability: Ethics in emerging technologies (AI, Data, 5G, IoT); Privacy and cybersecurity, Environmental ethics and sustainable development; Social responsibility of engineers, Policy and governance.

UNIT - V

Universal Values and Global Perspectives: Mind your mind, Self-control**,** Concept of soul, Science of Reincarnation, Concepts of Dharma and Karma, The qualities of Devine and Devilish, Satwic, Rajasic and Tamasicgunas. Global citizenship, Happiness and meaningful life.

TEXT BOOKS:

1. Chakroborty, S.K. “Values & Ethics for organizations Theory and practice”, Oxford University Press, New Delhi, 1998.
2. Jaya Dayal Goyandaka, “Srimad Bhagavad Gita”, with Sanskrit Text, Word meaning and Prose meaning, Gita Press, Gorakhpur, 2017.

REFERENCE BOOKS:

1. George Reynolds, Ethics in Information Technology, 6th Edition, Cengage Learning, 2018
2. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, 1st Edition, Farrar, Straus and Giroux, 2019.

26EGA102

CONSTITUTION OF INDIA

(Audit Course-1 and 2)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

PREREQUISITE: Knowledge on basics of the Constitution and the Government.

COURSE OBJECTIVES:

This course aims to:

1. The history of Indian Constitution and its role in the Indian democracy.
2. Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. Have knowledge of the various Organs of Governance and Local Administration.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Understand the making of the Indian Constitution and its features.
2. Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Have an insight into various Organs of Governance - composition and functions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Electoral Process, special provisions.

CO-PO Articulation Matrix

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	1	1	-	1	1
CO 2	1	1	-	1	1
CO 3	1	1	-	1	1
CO 4	1	1	-	1	1
CO 5	1	1	-	1	1

UNIT-I

History of making of the Indian constitutions - History, Drafting Committee (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties - Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance - Parliament : Composition, Qualifications, Powers and Functions. Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

UNIT-IV

Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: ZillaPanchayat, Elected Officials and their roles, CEO ZillaPanchayat: positions and role. Block level: Organizational Hierarchy(Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

TEXT BOOKS:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Busi, S. N., Dr. B. R. Ambedkar, Framing of Indian Constitution'', 1st Edition, Ava Publishers, New Delhi, 2015.
3. Jain, M. P., "Indian Constitution Law", 7th Edition, Lexis Nexis, New Delhi, 2014.
4. Basu, D.D. "Introduction to the Constitution of India", Lexis Nexis, New Delhi., 2015.

SUGGESTED READING:

1. Bhargava, Rajeev. (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.
2. NCERT, Indian Constitution at Work, 1st Edition, Government of India, New Delhi 2006, reprinted in 2022.
3. Ravindra Sastry, V. (ed.), Indian Government & Politics, 2nd edition, Telugu Akademy, 2018.

Web Resources:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

26ADA101

PEDAGOGY STUDIES
(Audit Course – 1 and 2)

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

COURSE OBJECTIVES:

1. To present the basic concepts of design and policies of pedagogy studies.
2. To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
3. To familiarize various theories of learning and their connection to teaching practice.
4. To create awareness about the practices followed by DFID, other agencies and other researchers.
5. To provide understanding of critical evidence gaps that guides the professional development.

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers to learning.
5. Understand Research gaps and learn the future directions.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	1	1	1	1	1
CO 2	1	1	1	1	1
CO 3	2	2	2	2	2
CO 4	1	1	1	1	1
CO 5	2	2	2	2	2

UNIT I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology-Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and searching.

UNIT II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III

Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and pedagogic strategies.

UNIT IV

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT-V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

TEXT BOOKS:

1. Ackers J, Hardman F, “Classroom Interaction in Kenyan Primary Schools, Compare”, 31 (2): 245 – 261, 2001.
2. Agarwal M, “Curricular Reform in Schools: The importance of evaluation”, Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.

26EGA103

STRESS MANAGEMENT BY YOGA

(**Audit Course – 1 and 2**)

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

PREREQUISITE: Knowledge on Yoga Practices.

COURSE OBJECTIVES:

This course aims to:

1. Create awareness about different types of stress and the role of yoga in the management of stress.
2. Promote positive health and overall well-being (Physical, mental, emotional, social and spiritual).
3. Prevent stress related health problems by yoga practice.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas
5. Improve work performance and efficiency

CO-PO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO 1	1	1	-	-	1
CO 2	1	1	-	-	1
CO 3	1	1	-	-	1
CO 4	1	1	-	-	1
CO 5	1	1	-	-	1

UNIT - I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali).

UNIT - II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT - III

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT - IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT – V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

TEXT BOOKS:

1. Janardhan, Swami, "Yogic Asanas for Group Training - Part-I": Yogabhyasi Mandal, Nagpur.
2. Vivikananda, Swami**.** "Rajayoga or Conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.
3. Nagendra H.R and R. Nagaratna, “Yoga Perspective in Stress Management”, Swami Vivekananda Yoga Prakashan, Bangalore.

WEB RESOURCES:

1 https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2 https://freevideolectures.com/course/3539/indian-philosophy/11

26EGA104

PERSONALITY DEVELOPMENT THROUGH LIFE'S ENLIGHTENMENT SKILLS

(**Audit Course – 1 and 2**)

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	0

PREREQUISITE: Awareness on Personality Development.

COURSE OBJECTIVES:

This course aims to:

1. Learn to achieve the highest goal happily.
2. Become a person with stable mind, pleasing personality and determination.
3. Awake wisdom among themselves.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

CO-PO Articulation Matrix

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	1	1	-	1	1
CO 2	1	1	-	1	1
CO 3	1	1	-	1	1
CO 4	1	1	-	1	1
CO 5	1	1	-	1	1

UNIT - I

Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT - II

Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75& 78 (do's) - Approach to day to day works and duties.

UNIT - III

Introduction to Bhagavadgeetha for Personality Development – Shrimad Bhagawad Geeta: Chapter 2– Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT - IV

Statements of basic knowledge – Shrimad Bhagawad Geeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT - V

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

TEXT BOOKS:

1. Gopinath, P., "Bhartrihari's Three Satakam (Niti-sringar-vairagya)", Rashtriya Sanskrit Sansthanam, New Delhi, 2018.
2. Swarupananda, Swami, "Srimad Bhagavad Geeta", Advaita Ashram (Publication Dept), Kolkata, 2017.

Online Resources:

1. http://nptel.ac.in/downloads/109104115/

26CSO101

BUSINESS ANALYTICS
(Open Elective)

Instruction	3 L Hours per Week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

PREREQUISITE: Basic of programming, basic mathematics.

COURSE OBJECTIVES: This course aims to
1. Understanding the basic concepts of business analytics and applications.
2. Study various business analytics methods including predictive, prescriptive and prescriptive analytics.
3. Prepare the students to model business data using various data mining, decision making methods.

COURSE OUTCOMES:
After the completion of this course, the student will be able to
1. Identify and describe complex business problems in terms of analytical models.
2. Apply appropriate analytical methods to find solutions to business problems that achieve stated objectives.
3. Interpret various metrics, measures used in business analytics
4. Illustrate various descriptive, predictive and prescriptive methods and techniques.
5. Model the business data using various business analytical methods and techniques.
6. Create viable solutions to decision making problems.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO 3	PO 4
CO 1	3	2	2	1
CO 2	3	3	2	1
CO 3	3	3	3	1
CO 4	3	3	3	1
CO 5	3	3	3	1
CO 6	3	3	3	1

1-Slightly, 2-Moderately, 3-Substantially

UNIT-I
Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT-II
Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization.

UNIT-III
Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT-IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. Clustering: Distance and similarity measures used in clustering, clustering algorithms, K-Means and Hierarchical algorithms, Prescriptive Analytics- Linear Programming (LP) and LP model building,

UNIT-V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process,cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox.

TEXTBOOKS:

1. U Dinesh Kumar, "Business Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015

SUGGESTED READINGS:

1. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015.

26MEO102

INTRODUCTION TO OPTIMIZATION TECHNIQUES
(Open elective)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to

1. Understand the LPP models.
2. Understand the Transportation and Assignment techniques.
3. Understand the procedure of Project Management along with CPM and PERT techniques.
4. Understand the concepts of queuing theory and inventory models.
5. Understand sequencing techniques.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Formulate a linear programming problems (LPP).
2. Build and solve Transportation Models and Assignment Models.
3. Apply project management techniques like CPM and PERT to plan and execute project successfully.
4. Apply queuing and inventory concepts in industrial applications.
5. Apply sequencing models in industries.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	3	1	2	2
CO 2	3	1	3	1	2	2
CO 3	1	1	3	2	3	2
CO 4	2	1	3	2	2	3
CO 5	2	1	3	2	2	3

UNIT - I

Operations Research: Definition, Scope, Models, Linear programming problems (LPP), Formulation, Graphical Method, and Simplex Method.

UNIT - II

Transportation Models: Finding an initial feasible solution, North West corner method, Least cost method, Vogel's approximation method, Finding the optimal solution, Special cases in transportation problems, Unbalanced transportation problem, Degeneracy in transportation, Profit maximization in transportation.

UNIT- III

Project Management: Definition, Procedure and objectives of project management, Differences between PERT and CPM, Rules for drawing network diagram, Scheduling the activities, Fulkerson's rule, Earliest and lat- est times, Determination of ES and EF times in forward path, LS & LF times in backward path, Determination of critical path, Duration of the project, Free float, Independent float and total float.

UNIT - IV

Queuing Theory and Inventory:: Kendols notation, Single server models, Inventory control, Deterministic inventory models, Probabilistic inventory control models.

UNIT -V

Sequencing Models: Introduction, Objectives, General assumptions, Processing 'n' jobs through two machines, Processing 'n' jobs through three machines**.**

Text Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008.
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi,2008.

Suggested Reading:

1. Hitler Libermann, Operations Research, McGraw Hill Pub, 2009.

Harvey MWagner, Principles of Operations Research, Prentice Hall of India,2010.

26CE O101

COST MANAGEMENT OF ENGINEERING PROJECTS
(Open elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60Marks
CIE	40Marks
Credits	3

Course Objectives:

This course aims to

1. To enable the students to understand the concepts of Project management.
2. To provide knowledge on concepts of Project Planning and scheduling.
3. To create an awareness on Project Monitoring and Cost Analysis
4. To provide adequate knowledge to the students on Recourse Management Costing-Variance Analysis
5. To train the students with the concepts of Budgetary Control for cost management and to provide basic platform on Quantitative techniques for cost management.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Acquire in-depth knowledge about the concepts of project management and understand the principles of project management
2. Determine the critical path of a typical project using CPM and PERT techniques.
3. Prepare a work break down plan and perform linear scheduling using various methods.
4. Solve problems of resource scheduling and levelling using network diagrams.
5. Learn the concepts of budgetary control and apply quantitative techniques for optimizing project cost

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1	3	3	3	1	-	2
CO2	2	3	2	1	-	1
CO3	1	3	2	1	-	1
CO4	3	3	2	1	1	3
CO5	2	3	3	1	1	3

UNIT - I

Project Management: Introduction to project managements, stakeholders, roles, responsibilities and functional relationships. Principles of project management, objectives and project management system. Project team, organization, roles, and responsibilities. Concepts of project planning, monitoring, staffing, scheduling and controlling

UNIT - II

Project Planning and Scheduling: Introduction for project planning, defining activities and their interdependency, time and resource estimation. Work break down structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes

UNIT- III

Project Monitoring and Cost Analysis: introduction-Cost concepts in decision making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision- Making, Time cost trade off Crashing project schedules, its impact on time on time, cost. Project direct and indirect costs.

UNIT – IV

Resources Management and Costing-Variance Analysis: Planning, Enterprise Resource Planning, Resource scheduling and levelling. Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis

Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement

UNIT - V

Boundary Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.
Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. Charles T Horngren "Cost Accounting A Managerial Emphasis", Pearson Education; 14 edition (2012),
2. Charles T. Horngren and George Foster, "Advanced Management Accounting" Prentice-Hall; 6th Revised edition (1 February1987)
3. Robert S Kaplan Anthony A. Atkinson, "Management & Cost Accounting", Pearson; 2 edition (18 October1996)

Suggested Reading:

1. K. K Chitkara, "Construction Project Management: Planning, scheduling and controlling", Tata McGrawHill Education. (2004).
2. Kumar Neeraj Jha "Construction Project Management Theory and Practice", Pearson Education India; 2 edition (2015)

26MEO101

INDUSTRIAL SAFETY
(Open Elective)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to cover:

1. Causes for industrial accidents, preventive steps to be taken, Factories act 1948 and 5S Techniques.
2. Fundamental concepts of Maintenance Engineering.
3. About Safety in advanced manufacturing systems.
4. The basic concepts and importance of fault tracing.
5. The steps involved in periodic and preventive maintenance of various industrial equipments.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Identify causes of industrial accidents and recommend preventive measures.
2. Select appropriate tools and practices for various maintenance procedures.
3. Apply different Safety measures in advanced manufacturing systems.
4. Diagnose faults in equipment such as machine tools, IC engines, and boilers.
5. Implement periodic and preventive maintenance for industrial equipment including motors, pumps, air compressors, and machine tools.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	2	2	1	1
CO 2	3	3	2	2	1	1
CO 3	3	3	2	2	1	1
CO 4	3	3	2	2	1	1
CO 5	3	3	3	2	1	1

UNIT - I

SAFETY MANAGEMENT CONCEPTS AND INDUSTRIAL SAFETY PRACTICES

Industrial Safety & Legal Aspects: Industrial accidents – causes, types, consequences, and preventive measures. Mechanical and electrical hazards and their control. Fire hazards, prevention and firefighting meth-ods. Safety color codes and safety signage. Salient provisions of the Factories Act 1948 related to health, safety, and welfare.
Safety Audit: Types of safety audits – audit methodology, preparation of audit checklists, Non-Conformity Reporting (NCR). Analysis and interpretation of accident records and safety reports.
5S Techniques: Introduction, objectives, and elements of 5S (Sort, Set in order, Shine, Standardize, Sustain). Benefits of 5S in enhancing workplace safety, productivity, and efficiency.

UNIT - II

Fundamentals of Maintenance Engineering: Definition and objectives of maintenance engineering. Primary and secondary functions and responsibilities of the maintenance department. Types of maintenance (preventive, predictive, breakdown, corrective) and their applications. Tools and equipment used in maintenance activities. Maintenance cost and its relationship with replacement decisions and economy. Concept of service life and factors affecting the lifespan of equipment.

UNIT- III

Safety in advanced manufacturing systems: Machine safety in CNC, robotics, and Flexible Manufacturing Systems (FMS). Human–machine interaction safety. Safety in Industry 4.0 environments including cyber-physical systems, smart factories, and digital twins. Safety in additive manufacturing (powder handling and laser safety). Safety in material handling systems (conveyors, cranes, AGVs) and manufacturing processes (welding, casting, forging, machining). Electrical safety in automation and Lockout/Tagout (LOTO) procedures.

UNIT - IV

Fault Tracing: Concept and importance of fault tracing. Decision tree approach – need, structure, and applica-tions. Sequence of fault-finding activities and systematic troubleshooting procedures. Development and repre-sentation of fault diagnosis using decision trees. Fault tracing in industrial equipment including machine tools, pumps, air compressors, internal combustion engines, boilers, and electrical motors. Types of faults in machine tools and their general causes.

UNIT - V

Maintenance and Condition Monitoring

Periodic and Preventive Maintenance: Periodic inspection, concept and need. Cleaning, servicing, and over-hauling of mechanical components and electrical motors. Common motor faults and remedies. Preventive main-tenance definition, steps, and advantages. Maintenance procedures for machine tools, pumps, air compressors, and DG sets.

Condition monitoring and basic concepts of Proactive maintenance for Industry 4.0.

Text Books:

1. L. M. Deshmukh, Industrial Safety Management, McGraw Hill Education, New Delhi, 1st Edition, 2010.
2. M.R. Sahoo, Industrial Safety Engineering, RK Publications, New Delhi, 1st Edition, 2015.
3. H. P. Garg, “Industrial Maintenance”, S. Chand and Company, may 1987.
4. Das Akhil Kumar, Principles of Industrial Safety Management Understanding the Ws of Safety at Work, Second edition, PHI Learning Pvt Ltd, Jan 2020

Suggested Reading:

1. Parth B. Shah, Industrial Safety and Maintenance Engineering, Technical publications, 2021.
2. Higgins & Morrow, “Maintenance Engineering Handbook”, McGraw-Hill Education Eighth Edition, February 2014.
3. M.P. Poonia, S.C. Sharma, Khanna Publishing House - Technology & Engineering, year 2019.

26MEO103

COMPOSITE MATERIALS

Instruction	(Open Elective)	3 L Hours per Week
Duration of SEE		3 Hours
SEE		60 Marks
CIE		40 Marks
Credits		3

Course Objectives: This course aims to

1. Provide concepts of Composite materials and their constituents.
2. Explain the Classification of the reinforcements and matrix materials.
3. Provide Fabrication methods of metal matrix composites.
4. Explain manufacturing of Polymer matrix composites.
5. Elucidate Failure mechanisms in composite materials.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand composite materials and their reinforcements.
2. Summarize micro-mechanics approach as applied to UD lamina.
3. Apply fabrication methods of metal, ceramic and carbon matrix composites.
4. Apply fabrication methods of polymer matrix composites..
5. Analyze the lamina and laminate from failure perspective.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	3	1	-	3
CO 2	3	1	3	1	-	3
CO 3	3	1	3	1	-	3
CO 4	3	1	3	1	-	3
CO 5	3	1	3	1	-	3

UNIT - I

Introduction: Definition Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II

Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements.

Mechanical Behaviour of composites: Rule of mixtures, Inverse rule of mixtures. Iso-strain and Iso-stress conditions.

UNIT- III

Processing of Metal Matrix Composites: Casting - Solid State diffusion technique, Cladding - Hot isostatic pressing. Properties and applications.

Processing of Ceramic Matrix Composites: Liquid Metal Infiltration - Liquid phase sintering.

Processing of Carbon - Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT - IV

Processing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs - hand layup method - Autoclave method - Filament winding method - Compression moulding - Reaction injection moulding. Properties and applications.

UNIT - V

Strength: Lamina Failure Criteria, strength ratio, maximum stress criteria, maximum strain criteria, interactive failure criteria and hygrothermal failure. Laminate first ply failure -insight strength**.**

Text Books:

1. K.K.Chawla, "Composite Materials- Science and Engineering", 4th edition, Springer Verlag, 2019.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubrama- niam, John Wiley & Sons, NY, Indian edition, 2007..
3. R.M. Jones. Mechanics of Composite Materials. 2 nd ed. CRC press. 2018.

Suggested Reading:

1. Deborah D.L. Chung, "Composite Materials Science and Applications" 2nd edition, Springer Verlag, 2010.
2. Sanjay K. Mazumdar, "Composites Manufacturing- materials, product and process engineering", 1st edition, CRC press, 2002. Daniel Gay, "Composite Materials Design and Applications" 3r

26EEO102

ELECTRIC VEHICLES & FUTURE MOBILITY

(Open elective)

Instruction:	3L Hours per Week
Duration of SEE:	3 Hours
SEE:	60 Marks
CIE:	40 Marks
Credits:	3

Prerequisite:

No prior knowledge required. Basic understanding of science is sufficient.

Course Objectives

This course aims to:

1. Introduce the fundamentals of electric vehicles and their importance in modern transportation.
2. Explain the basic components and working of electric vehicles.
3. Familiarize students with battery technologies and charging infrastructure.
4. Create awareness about environmental benefits and challenges of EV adoption.
5. Provide insights into future mobility trends including smart transportation systems.

Course Outcomes

Upon completion of this course, students will be able to:

1. Understand the basic concepts and need for electric vehicles.
2. Explain the components and working principles of EV systems.
3. Analyze battery technologies and charging methods.
4. Evaluate the environmental and economic impact of EVs.
5. Appreciate future mobility trends and emerging transportation technologies.

CO–PO Articulation Matrix

CO \ PO	PO1	PO2	PO3	PO4
CO1	1	1	1	1
CO2	2	1	1	1
CO3	2	2	1	2
CO4	1	-	-	2
CO5	2	2	1	1

1 - Slightly; 2 - Moderately; 3 – Substantially

UNIT – I: Introduction to Electric Vehicles

History and evolution of transportation.-Need for electric mobility – energy crisis and environmental concerns.-Types of vehicles: Conventional, Hybrid, Plug-in Hybrid, Battery Electric Vehicles (BEV).-Basic comparison between IC engine vehicles and electric vehicles.
Overview of EV ecosystem.

UNIT – II: Components and Working of Electric Vehicles

Main components:Electric motor -Battery pack -Controller and power electronics -Transmission system -Working principle of EVs.-Types of motors used in EVs (overview).-Regenerative braking concept.

UNIT – III: Batteries and Charging Infrastructure

Battery basics – types (Lead-acid, Lithium-ion, emerging technologies).-Battery parameters – capacity, energy density, charging cycles.-Charging methods:Slow charging; Fast charging; Wireless charging (intro) -Charging infrastructure – public and private charging stations.
Battery management system (BMS) – basic concept.

UNIT – IV: Environmental and Economic Aspects

Environmental impact of EVs – emissions comparison.-Lifecycle analysis (production to disposal).-Cost comparison – EV vs conventional vehicles.-Government policies and incentives (India focus).-Challenges in EV adoption – range anxiety, infrastructure, cost.

UNIT – V: Future Mobility and Emerging Trends

Smart mobility and intelligent transportation systems.-Electric public transport – buses, metros.
Autonomous and connected vehicles (intro).-Vehicle-to-Grid (V2G) concept.-Future trends: Sustainable mobility, shared mobility, green transportation.

Textbooks

1. James Larminie & John Lowry, *Electric Vehicle Technology Explained*, Wiley.
2. Mehrdad Ehsani et al., *Modern Electric, Hybrid Electric and Fuel Cell Vehicles*, CRC Press.
3. Government of India, *EV Policy Reports and Mobility Guidelines*.

Suggested Reading

1. NITI Aayog, *India Electric Mobility Reports*.
2. International Energy Agency (IEA), *Global EV Outlook*.
3. Bureau of Energy Efficiency (BEE), EV awareness materials.
4. IEEE Journals on Electric Mobility.

NPTEL / Online Resources

S.No	Course Name	Instructor	Institute
1	Electric Vehicles	Prof. S. Banerjee	IIT Kharagpur

Other Online Resources:

1. https://nptel.ac.in
2. https://niti.gov.in
3. https://iea.org

26ADE131

PREDICTIVE ANALYTICS in R Lab

(Based on Program Elective-2)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. To introduce the fundamental concepts of predictive analytics.
2. To impart the knowledge on various steps that are necessary for constructing the predictive model.
3. To gain knowledge on the assessment of predictive models for decision making.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Understand the fundamental concepts of predictive analytics.
2. Define the problem and prepare the data for analysis.
3. Construct different predictive models for decision making.
4. Apply descriptive modeling techniques for the given data.
5. Understand and apply appropriate algorithms for analyzing the data in healthcare domain.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	2	2	3
CO 2	3	2	2	2	3
CO 3	2	2	3	2	2
CO 4	3	2	3	3	3
CO 5	2	3	3	3	2

Lab Experiments can be implemented using R

1. Clustering-based data analytics using R. (K-Means, SOM algorithms)
2. Demonstrate the statistics for a sample data like mean, standard deviation, normal/uniform distribution, variance and correlation.
3. Demonstrate missing value analysis, fixing missing values and outlier analysis using Healthcare domain datasets.
4. Demonstrate data visualisation, histograms and multiple variable summaries.
5. Demonstrate transformation, scaling, binning, fixing skewed values and sampling.
6. Demonstration of the Apriori algorithm on the transaction dataset to find association rules.
7. Demonstration of Linear and Logistic regression using various domain datasets.
8. Demonstration of predictive models such as Decision Tree, Neural Network, and K-Nearest Neighbour using various domain datasets.
9. Demonstration of Temporal Mining Techniques
10. Demonstration of predictive analytics using healthcare data and microarray data.

TEXT BOOKS:

1. Dean Abbott, Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst, John Wiley & Sons Inc. Publishers, First edition, 2014.
2. Chandan K. Reddy, Charu C. Aggarwal, Healthcare Data Analytics, Chapman & Hall/CRC, Data Mining and Knowledge Discovery Series, 2015.

REFERENCE BOOKS:

1. Manohar Swamynathan, Mastering Machine Learning with Python in Six Steps, Apress Publishers, First edition, 2017.

26ADE128

CYBER SECURITY LAB

(Based on Program Elective-2)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. To give an overview about TCP and Port Scanning using NMAP.
2. To familiarize with the concepts of Netcat and Open VAS
3. To facilitate understanding of DAMN and Cross-site scripting, snort tool, and Net stumbler.

COURSE OUTCOMES:

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

1. Examine Port scanning to determine the services are running on the systems.
2. Illustrate the Netcat and Open VAS and uses such as simple sniffing abilities, and port redirection.
3. Demonstrate SQL injection technique often used to attack data-driven applications.
4. Experiment with Cross-site Scripting (XSS), a client-side attack that leverages the user's browser to execute malicious code.
5. Design and develop an intrusion prevention system capable of real-time traffic analysis and packet logging.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	2	3	2
CO 2	2	2	3	3	2
CO 3	3	2	3	3	2
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

LIST OF PROGRAMS:

1. Demonstrate TCP Scanning Using NMAP.
2. Illustrate Port scanning Using NMAP.
3. Implement TCP/UDP Connectivity using Netcat.
4. Examine Network Vulnerability using Open VAS.
5. Demonstrate Practice of Web Application Penetration Testing.
6. Implement SQL injection manually using Damn Vulnerable Web App.
7. Experiment on Practical Identification of SQL-Injection Vulnerabilities.
8. Implement Cross-site Scripting Techniques to check malicious code.
9. Demonstrate intrusion detection system using SNORT tool or any other sofware.
10. Perform wireless audit on an access point or a router and decrypt WEP and WPA Using Net Stumbler.

TEXT BOOKS:

1. Nina,Godbole,SunitBelapure, ”Cyber Security understanding Cyber Crimes,Computer forensics and Legal Perspectives”,Wiley India Pvt.Ltd., 2013
2. Anti-Hacker Tool Kit (Indian Edition) by Mike Shema,Fourth Edition, Publication McGraw Hill,2014.

SUGGESTED READING:

1. William Stallings “Cryptography and Network Security Principles and Practice, 6th Edition, Pearson 2014.
2. Dr.V.K.Jain,”Cryptography and Network Security”, First Edition, Khanna Book publishing New Delhi 2013.
3. Nina Godbole,”Information Systems Security Security Management, Metrics, Frameworks and Best Practices”,Wiley ,2nd Edition,2012

WEB RESOURCES:

https://www.udemy.com/the-complete-cyber-security-course-end-point-protection/

With Effect from AY 2026 – 27

26ADE129

BIG DATA ANALYTICS LAB

(Based on Program Elective-2)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

PREREQUISITE: DBMS

COURSE OBJECTIVES:

This course aims to:

1. To provide the knowledge to setup a Hadoop Cluster and to develop programs using MapReduce
2. To introduce Pig, PigLatin and HiveQL and NoSQL to process big data.
3. To introduce the latest big data frameworks and writing applications using Spark
4. To demonstrate real-time data ingestion and processing with Kafka and Spark Streaming.

COURSE OUTCOMES:

After successful completion of this course student will be able to

1. Understand Hadoop working environment
2. Work with big data applications in multi node clusters using MapReduce
3. Write scripts using Pig and Hive to solve real world problems and analyse the datasets.
4. Use Spark working environment to solve real world problems.
5. Acquire practical skills in integrating Kafka with Spark Streaming.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	1	2	3	2
CO 2	3	2	2	3	2
CO 3	3	1	2	3	2
CO 4	3	1	2	3	2
CO 5	3	1	2	3	3

LIST OF PROGRAMS:

1. Demonstrate the following using HDFS
   i. Basic HDFS commands
   ii. Working with Hadoop file system: Reading, Writing and Copying
2. Develop the following applications using MapReduce
   i. Word count application using Map Reduce on single node cluster
   ii. Analysis of Weather Dataset on Multi node Cluster using Hadoop
   iii. Real world case studies on Map Reduce applications
3. Working with Hive on the following
   i. HiveQL
   ii. Writing User Defined Functions in Hive
4. Demonstrate the working of NoSQL database MongoDB
5. Implement the following on Spark
   i. Processing large datasets on Spark framework
   ii. Word count application
6. Create an Iceberg table on Spark or Flink.
7. Demonstrate upserts and deletes of records using Apache Hudi.
8. Implement streaming using Kafka.

TEXT BOOKS:

1. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media Inc, 2015.
2. TanmayDeshpande, “HadoopReal-World Solutions Cookbook”, Second Edition, Packt Publishing 2016.
3. Neha Narkhede, Gwen Shapira, Todd Palino, "Kafka: The Definitive Guide", 2nd Edition, O'Reilly Media, 2017
4. Viktor Gamov, "Kafka Streams in Action", 1st Edition, Manning Publications, 2018

SUGGESTED READING:

1. Edward Capriolo, Dean Wampler, and Jason Rutherglen, "Programming Hive", O'Reilly Media Inc, October 2012.
2. VigneshPrajapati, "Big data Analytics with R and Hadoop", Packt Publishing, November 2013.
3. Nick Pentreath, “Machine Learning with Spark”, First Edition, Packt Publishing.

WEB RESOURCES:

1. http://www.iitr.ac.in/media/facspace/patelfec/16Bit/index.html
2. https://class.coursera.org/datasci-001/lecture

26ADE132

ROBOTIC PROCESS AUTOMATION LAB

(Based on Program Elective-2)

Instruction	2 L Hours per Week
CIE	50 Marks
Credits	1

Course Objectives:

This course aims to:

1. Understand and apply the foundational concepts of RPA in practical scenarios.
2. Effectively use RPA platforms for creating and managing automation tasks.
3. Develop skills in sequencing workflows and using various control flows and data manipulation techniques.
4. Develop expertise in interacting with and automating user interface elements.
5. Handle exceptions and debug RPA workflows effectively.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Apply the basic concepts of RPA to real-world problems.
2. Utilize RPA platforms to build and manage automation tasks.
3. Create workflows using sequences, control flows, and data manipulation techniques.
4. Explain interactions with user interface elements.
5. Solve issues related to exceptions and debug RPA workflows.

CO-PO Articulation Matrix

PO/PSO / CO	PO1	PO2	PO3	PSO1	PSO2
CO 1	2	1	-	**1**	**1**
CO 2	-	-	-	**2**	**2**
CO 3	2	1	1	**2**	**1**
CO 4	1	-	1	**1**	**1**
CO 5	-	1	-	**2**	**2**

List of Experiments:

1. Identify and utilize various components of an RPA platform to automate a simple task.
2. Implement basic operations on different data types.
3. Create a bot to perform Desktop and Gmail Login Steps using Web Recoding.
4. Create a bot to perform email automation, which can ready emails to extract pdf attachments.
5. Create an automation project that uses control flow, loops, and decision-making activities.
6. Create a bot to read pdf and performing OCR and then entering the extracted data into an excel.
7. Implement clipboard management tasks to automate copying and pasting data between applications.
8. Automate file operations, such as reading from and writing to CSV/Excel files, and converting data tables.
9. Create an automation workflow that performs mouse and keyboard activities on different controls.
10. Create an RPA workflow that demonstrates common exceptions and their handling techniques.

Text Books:

1. Tom Taulli, “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, 2020, lSBN-13 (electronic):978-7-4842-5729-6, Publisher: A press
2. Alok Mani Tripathi, “Learning Robotic Process Automation”, Publisher: Packet Publishing Release Date: March 2018 ISBN: 9787788470940

Suggested Reading:

1. Frank Casale, Rebecca Dilla, Iieidi Jaynes, Lauren Livingston, “Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation.

2. Richard Murdoch, “Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant”
3. Srikanth Merianda, “Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation”

Online Resources:

1. Learning Robotic Process Automation, https://www.packtpub.com/in/business/learning-robotic- process-automation
2. Automation Anywhere University, https://university.automationanywhere.com/
3. https://www.urbanpro.com/ghaziabad/rpa-robotics-process-automation-automation-anywhere/11461411
4. www.uipath.com/rpa/robotic-process-automation
5. https://www.coursera.org/specializations/roboticprocessautomation

26ADE138

NATURAL LANGUAGE PROCESSING LAB
(Based on Program Elective-2)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. To develop the ability to preprocess and clean textual data.
2. To enable students to transform unstructured text into machine-readable formats
3. To impart knowledge of semantic representation techniques
4. To equip students with skills to design and implement machine learning-based NLP models
5. To provide hands-on experience in developing real-world NLP applications

Course Outcomes:

Upon successful completion of the course the students will be able to:

1. Preprocess and clean text data
2. Convert text into machine-readable formats
3. Apply embeddings and similarity measures
4. Build ML-based NLP models
5. Develop real-world NLP applications

CO-PO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	2	1	2
CO2	2	2	3	2	3
CO3	2	2	3	2	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

LIST OF PROGRAMS

1. **Use NLTK for Text Preprocessing by**
   a) Loading a text dataset
   b) Performing tokenization (word & sentence)
   c) Removing stop words
   d) Applying stemming and lemmatization
2. **Perform Text Cleaning and Normalization by**
   a) Removing punctuation, special characters
   b) Converting text to lowercase
   c) Handle numbers and whitespace
   d) Normalizing contractions
3. **Extract Features using Bag of Words by**
   a) Implementing CountVectorizer
   b) Generating BoW matrix
   c) Analyzing word frequency distribution
4. **Use TF-IDF Representation to**
   a) Implement TF-IDF using Tf-idfVectorizer
   b) Compare with BoW
   c) Visualize important terms
5. **Build Language Modeling using n-grams for**
   a) Generating unigrams, bigrams, trigrams
   b) Building simple probabilistic language model
   c) Analyzing phrase frequency
6. **Generate Word Embeddings using Word2Vec to**
   a) Train Word2Vec model
   b) Find similar words

c) Visualize embeddings

7. **Find Text Similarity using Cosine Similarity in**
   a) Convertion of text using TF-IDF and embeddings
   b) Building document similarity matrix
8. **Implement Text Classification using Machine Learning as**
   a) Prepare dataset
   b) Train classifiers
   c) Evaluate Model performance
9. **Build Sentiment Analysis System using**
   a) TextBlob or ML model
   b) Classify text as positive/negative/neutral
   c) Comparison of rule-based vs ML approach
10. **Create NLP Chatbot using**
    a) Create intents and responses
    b) Implement pattern matching or ML model
    c) Test chatbot interaction

TEXT BOOK:

1. Aman Kedia Mayank Rasu, Hands-On Python Natural Language Processing, First Edition,2020, PACKT publishers
2. Thushan Ganegedara, Natural Language Processing with TensorFlow.,2018, Packt Publishing Ltd

SUGGESTED READING:

1. Steven Bird, Evan Klein and Edward Loper, “Natural Language Processing with Python”, O'Reilly Media, Inc., 2009..
2. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2nd Edition, Pearson Education, 2009.
3. Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, 2ndEdition, Chapman and Hall/CRC Press, 2010
4. Nitin Hardaniya, Jacob Perkins, “Natural Language Processing: Python and NLTK”, Packt Publishers, 2016

DATASETS:

1. https://www.kaggle.com/datasets
2. https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/multilabel.html#siam-competition2007
3. https://archive.ics.uci.edu/ml/index.php

WEB RESOURCES:

1. https://pythonprogramming.net/tokenizing-words-sentences-nltk-tutorial/
2. http://www.nptelvideos.in/2012/11/natural-language-processing.html
3. https://github.com/keon/awesome-nlp

26ADE133

FEDERATED MACHINE LEARNING LAB

(Based on Program Elective-4)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

The students will be able to

1. Develop a foundational understanding of federated learning concepts, including decentralized training, privacy preservation, and model aggregation.
2. Learn how to set up federated learning environments using popular Python libraries like PySyft, TensorFlow Federated, or PyTorch, allowing for decentralized model training.
3. Explore and implement privacy preservation techniques such as differential privacy and homomorphic encryption to protect individual data privacy within federated learning setups.
4. Dive deep into advanced federated learning algorithms like FedProx, FedAvg-M, or FedAdapt, understanding their principles and practical applications.
5. Apply federated learning to real-world datasets and use cases, like healthcare, finance, or IoT data, and analyze the challenges and complexities involved in practical deployments.

COURSE OUTCOMES:

1. Create federated learning environments using Python libraries like PySyft, TensorFlow Federated, or PyTorch, allowing for decentralized model training.
2. Practical experience in integrating privacy preservation mechanisms like differential privacy and homomorphic encryption into federated learning, ensuring data privacy.
3. Deep understanding of advanced federated learning algorithms (e.g., FedProx, FedAvg-M, FedAdapt) and their applications in solving complex machine learning problems.
4. Apply federated learning to real-world datasets and use cases, demonstrating their ability to address practical challenges in various domains.
5. Develop problem-solving skills and adaptability, enabling them to design fault-tolerant mechanisms, explore model compression techniques, and handle heterogeneity in federated learning scenarios.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	2	3	3
CO 2	2	1	3	3	3
CO 3	2	2	3	3	3
CO 4	2	2	2	3	3
CO 5	2	1	3	3	2

LIST OF EXPERIMENTS

1. Create a federated learning environment using Python libraries like PySyft, TensorFlow Federated, or PyTorch.
2. Implement federated averaging to train a simple model on decentralized nodes.
3. Integrate differential privacy mechanisms (e.g., Laplace noise) into federated learning to protect individual data privacy.
4. Experiment with homomorphic encryption libraries (e.g., PySEAL) to secure model updates during federated learning.
5. Implement secure aggregation protocols (e.g., Secure Multi-Party Computation) for aggregating model updates securely.
6. Create a federated learning scenario with heterogeneous devices (e.g., different types of smartphones) and analyze the challenges.
7. Generate synthetic non-IID data and observe how it affects federated learning model performance.
8. Explore advanced federated learning algorithms like FedProx, FedAvg-M, or FedAdapt.
9. Experiment with model compression techniques (e.g., quantization, pruning) in the context of federated learning to reduce communication overhead.
10. Introduce node failures or adversarial nodes and implement fault-tolerant mechanisms to ensure robustness in federated learning.

11. Apply federated learning to real-world datasets and use cases, such as healthcare, finance, or IoT data.

Text Books:

1. Nakayama, Kiyoshi, and George Jeno. Federated Learning with Python. 1st ed. Packt Publishing, 2022.
2. Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, and Han Yu, Federated Learning, - Synthesis Lectures , on Artificial Intelligence and Machine Learning, Morgan & Claypool Publishers, 2019.

Suggested Reading:

1. Kairouz, Peter, and McMahan, H. Brendan, Advances and Open Problems in Federated Learning. United States, Now Publishers, 2021.
2. Heiko Ludwig, Nathalie Baracaldo, Federated Learning: A Comprehensive Overview of Methods and Applications. Poland, Springer International Publishing, 2022.
3. Verma, Dinesh C. Federated AI for Real-World Business Scenarios. United States, CRC Press, 2021.
4. Lam M. Nguyen, Pin-Yu Chen, Trong Nghia Hoang, Federated Learning: Theory and Practice. United Kingdom, Elsevier Science, 2024.
5. Jose Anand, R. Kavitha, R. Srinivasan, S. Suresh, Saravanan Krishnan, Handbook on Federated Learning: Advances, Applications and Opportunities. N.p., Taylor & Francis Group, 2024.
6. Chaoqun You, Gang Feng, Lei Zhang, Yao Sun, Federated Learning for Future Intelligent Wireless Networks. United Kingdom, Wiley, 2023.

Web Links:

1. https://www.tensorflow.org/federated
2. https://openmined.github.io/PySyft/index.html
3. https://opendp.org/

With Effect from AY 2026 – 27

26ADE134

EDGE COMPUTING LAB
(Based on Program Elective-4)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:
This course aims to:
1. Understand the concept of edge computing
2. Understand the Edge computing Architecture
3. Implement the edge computing in IOT
4. Understand the concept of multi-access edge computing
5. Implement edge computing in MEC

COURSE OUTCOMES:
Upon completion of this course, students will be able to:
1. Set up the Arduino/Raspberry Pi IDE to program and control an LED light.
2. Implement and demonstrate two different communication protocols for data transmission.
3. Develop sensor-based programs using Raspberry Pi for data collection and processing.
4. Install and configure IoT Edge for Linux on Windows, and manage Azure IoT Edge devices to deploy modules for telemetry data.
5. Publish data using HTTP, interface sensors with MQTT for logging, and implement a simple machine learning model on Raspberry Pi.

CO-PO Articulation Matrix

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	3	2	1	2
CO 2	2	2	2	2	2
CO 3	2	3	2	3	3
CO 4	1	2	2	3	3
CO 5	2	2	3	2	2

LIST OF PROGRAMS

1. Set up the Arduino/Raspberry Pi IDE for a program to blink a LED light.
2. Implement any two Communications protocols
3. Sensor based programs using Raspberry Pi.
4. Installation tools to create and manage ECN's
5. Install and start the IoT Edge for Linux on Windows runtime on your device.
6. Deploy a module Manage your Azure IoT Edge device from the cloud to deploy a module that sends telemetry data to IoT Hub
7. Publishing Data using HTTP.
8. Sensor Interfacing and Logging using MQTT.
9. Any Case study implementing Thingspeak.
10. Implementing a simple machine learning model on Raspberry Pi.

TEXT BOOKS:

1. Colin Dow, "Hands-On Edge Analytics with Azure IoT: Design and develop IoT applications with edge analytical solutions including Azure IoT Edge"
2. Charles Bell,"MicroPython for the Internet of Things A Beginner's Guide to Programming with Python on Microcontroller", A Press.

SUGGESTED READING:

1. Peter Waher, “Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3”, First Edition, Packt Publishing, 2018
2. John C. Shovic, “Raspberry Pi IoT Projects: Prototyping Experiments for Makers”, Packt Publishing, 2016
3. R. Buyya, S.N. Srirama (2019), Fog and Edge Computing: Principles and Paradigms, Wiley-Blackwell, 2019.

WEB RESOURCES:

1. https://www.10 Best Edge Computing Project Ideas for Beginners
2. https://github.com/qijianpeng/awesome-edge-computing

26ADE135

ADVANCED DATA STRUCTURES AND ALGORITHMS LAB
(Based on Program Elective-4)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

The objectives of this course are

1. Impart the different algorithmic design paradigms to solve problems.
2. Familiarize the advanced concepts of tree data structures and graphs.
3. Learn the implementation of cryptographic algorithms.

COURSE OUTCOMES:

Upon successful completion of this course, students will be able to:

1. Analyze the time complexity of iterative and recursive algorithms and evaluate their efficiency.
2. Design and implement advanced data structures such as trees and hash tables for efficient data organization.
3. Apply algorithm design paradigms including Divide & Conquer, Greedy, and Dynamic Programming to solve computational problems.
4. Implement and analyze graph algorithms including BFS, DFS, shortest path algorithms, and network flow techniques.
5. Demonstrate solutions using advanced applications such as string pattern matching, Trie structures, and cryptographic algorithms like RSA.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	3	2	3	2	3
CO 2	3	2	3	2	3
CO 3	3	2	3	2	3
CO 4	3	2	3	1	3
CO 5	3	2	3	2	3

LIST OF PROGRAMS:

1. Implement programs to analyze time complexity of iterative and recursive algorithms.
2. Demonstrate the working of tree data structure and implement Binary Search Tree, AVL, Splay and Red Black trees.
3. Implement hash tables using chaining or probing
4. Demonstrate the greedy, divide & conquer and dynamic programming paradigms.
5. Implement Quick Sort (including randomized) and Heap Sort and Compare their performance
6. Implement Breadth First Search (BFS) and Depth First Search (DFS) using adjacency list.
7. Implement algorithms to find the maximum flow and minimum cost in network flows.
8. Implement Dijkstra and Bellman-Ford algorithms.
9. Implement string pattern matching techniques and tries.
10. Demonstrate information security algorithms like RSA.

TEXT BOOKS:

1. Thomas H Cormen, Charles. E.Leiserson, Ronald L.Rivest, and Clifford.Stein, Introduction to Algorithms", Third Edition MIT Press, ISBN: 978-0262033848, 2009.
2. Abirami A, Priya R L, "Advanced Data Structures and Algorithms", ISBN: 978-93-55517-937, 2023..

SUGGESTED READING:

1. Aho, A V Hopcraft, Ullman J D, "The Design and Analysis of Computer Algorithms", Pearson Ed, 2007.
2. Hari Mohan Pandy, "Design Analysis and Algorithms", University Science Press, 2009.
3. Cormen, Lieserson, Rivest, "Introduction to Algorithms", Second Edition, PHI, 2003.

26ADE137

GENERATIVE AI AND AGENTIC AI LAB

(Based on Program Elective-4)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. Understand the fundamentals of Generative AI, Large Language Models, and Transformer architectures.
2. Explore prompt engineering, LangChain, Retrieval-Augmented Generation (RAG), and Agentic AI systems.
3. Learn to build AI agents and graph-based AI workflows using open-source frameworks.
4. Develop AI-powered applications using vector databases, LangChain, and LangGraph.
5. Implement and deploy practical Generative AI and Agentic AI applications using open-source tools.

COURSE OUTCOMES:

Upon completion of this course, students will be able to:

1. Understand the architecture and working principles of Large Language Models and Generative AI systems.
2. Apply prompt engineering and LangChain techniques for AI application development.
3. Build Retrieval-Augmented Generation (RAG) systems using vector databases and embeddings.
4. Develop AI agents and graph-based workflows using LangChain and LangGraph.
5. Deploy practical AI applications using open-source frameworks and tools.

CO-PO Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PSO1	PSO 2
CO 1	3	2	3	3	3
CO 2	3	3	3	3	3
CO 3	3	3	3	3	3
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

LIST OF PROGRAMS:

1. Install Ollama and run open-source LLMs such as Llama 3 or Mistral for basic text generation.
2. Implement simple text generation using Hugging Face Transformers.
3. Implement tokenization using Hugging Face Tokenizers.
4. Generate sentence embeddings using Sentence Transformers.
5. Implement basic prompt engineering techniques using open-source LLMs.
6. Build a basic LLM application using LangChain and Ollama.
7. Develop a simple chatbot using LangChain conversation chains.
8. Load and process PDF documents using LangChain document loaders.
9. Store embeddings in ChromaDB vector database.
10. Implement similarity search using ChromaDB.
11. Build a simple Retrieval-Augmented Generation (RAG) pipeline using LangChain and ChromaDB.
12. Develop a basic AI agent using LangChain Agents and tool integration.
13. Build a graph-based workflow using LangGraph with simple state management.
14. Develop a basic AI web application using Streamlit and open-source LLM integration.
15. Build an end-to-end Agentic AI mini project such as a Resume Screening Agent, Research Assistant, Document Intelligence System, or AI Study Assistant using open-source tools.

SUGGESTED READING:

1. Elbert Gale, *Mastering AI Agents: From Design to Deployment of Autonomous Systems*, 2025.
2. Natenapis Faraksa, *Building AI Agent: Learn Building AI Agents, A Practical Guide for Building Intelligent Agents*, 2024.
3. Sujai G Pillai, *Build Your Own AI Agent: A Hands-On Guide for Beginners*, 2025.
4. Steve Tingiris, *Exploring GPT-3*, Packt Publishing Ltd., UK, 2021.
5. Joseph Babcock and Raghav Bali, *Generative AI with Python and TensorFlow 2*, Packt Publishing Ltd., UK, 2021.

26ADE139

HIGH PERFORMANCE COMPUTING LAB

(Based on Elective- 4)

Instruction	2 P Hours per week
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to:

1. To provide an understanding of High-Performance Computing concepts, architectures, and performance models.
2. To design and implement parallel programs using OpenMP and MPI.
3. To develop and analyze parallel algorithms and communication patterns.
4. To implement GPU-based programs using CUDA.
5. To evaluate performance and optimize applications on modern HPC systems.

COURSE OUTCOMES:

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

1. Analyze HPC architectures and evaluate performance using standard models.
2. Develop and compare shared-memory and distributed-memory parallel programs.
3. Design and implement parallel algorithms using appropriate patterns.
4. Develop GPU programs and optimize memory usage and execution.
5. Evaluate and optimize performance of parallel and GPU-based applications.

Mapping of Course Outcomes with program Outcomes and Program Specific Outcomes:

PO/PSO / CO	PO 1	PO 2	PO 3	PSO 1	PSO 2
CO 1	2	2	2	2	2
CO 2	3	3	2	3	2
CO 3	3	2	3	3	2
CO 4	3	3	3	3	3
CO 5	3	3	3	3	3

LIST OF PROGRAMS:

1. Set up the parallel computing environment. Identify and report the number of physical and logical CPU cores, cache hierarchy and (where available) GPU compute capability, number of streaming multiprocessors and warp size. Compute and tabulate Amdahl's and Gustafson's law speedup predictions for a chosen workload across varying processor counts.
2. Implement parallel computation of π using numerical integration in OpenMP. Compare three approaches — critical section, atomic, and reduction clause — and analyze their performance for varying thread counts.
3. Parallelize a matrix multiplication program using OpenMP and study the impact of different loop scheduling clauses (static, dynamic, guided) on execution time. Demonstrate and explain false sharing using a simple counter array example.
4. Implement an MPI program that distributes an array across processes and computes its global sum using point-to-point send/receive. Re-implement the same program using MPI_Reduce and compare the execution times.
5. Implement the parallel divide-and-conquer pattern using merge sort with OpenMP tasks. Implement the manager-worker pattern using MPI for an embarrassingly parallel workload (e.g., Monte Carlo estimation of π). Compare scalability with respect to thread/process count.
6. Implement the halo exchange pattern using MPI for a 1D heat-diffusion stencil computation. Verify correctness against a serial implementation and analyze communication overhead with varying problem and process sizes.
7. Implement a CUDA vector addition kernel for large vectors. Measure host-to-device transfer time and kernel execution time using CUDA events. Vary the block size and analyze its impact on performance.
8. Implement two versions of a 2D matrix copy kernel in CUDA — one with strided (uncoalesced) access and one with coalesced access. Measure effective memory bandwidth and use Nsight Compute to compare global memory load efficiency between the two versions.
9. Implement a tiled matrix multiplication kernel using shared memory in CUDA with tile sizes 16×16 and 32×32. Compare its performance against a naive global-memory kernel and against the cuBLAS library reference. Use Nsight Compute to confirm the reduction in global memory traffic.
10. Implement parallel reduction and a 256-bin histogram on the GPU using CUDA. For reduction, compare naive interleaved addressing, sequential addressing, and warp-level primitives. For histogram, compare global-memory atomics with a privatized shared-memory version. Profile both with Nsight Compute and analyze occupancy and stall reasons.

TEXT BOOKS:

1. An Introduction to Parallel Programming by Peter Pacheco and Matthew Malensek, 2nd Edition, Morgan Kaufmann Publishers, 2021.
2. Programming Massively Parallel Processors: A Hands-on Approach by Wen-mei W. Hwu, David B. Kirk and Izzat El Hajj, 4th Edition, Morgan Kaufmann Publishers, 2022.

SUGGESTED READING:

1. High Performance Computing, Modern Systems and Practices**,** Thomas Sterling,Matthew Anderson,Maciej Brodowicz, Foreword by C. Gordon Bell,School of Informatics, Computing, and Engineering, Indiana University, Bloomington, Morgan Kaufmann publishers,2018 Edition.

WEB RESOURCES:

1. https://www.openmp.org/
2. https://www.mpi-forum.org/
3. https://developer.nvidia.com/cuda-zone

26ADC110

MINI PROJECT

Instruction	2 Hours per week
CIE	50 Marks
Credits	1

Course Outcomes:

Upon completing this course, students will be able to:

1. Formulate a specific problem and give solution.
2. Develop model/models either theoretical/practical/numerical form.
3. Solve, interpret/correlate the results and discussions.
4. Conclude the results obtained.
5. Write the documentation in standard format.

Guidelines:

- As part of the curriculum in the II- semester of the programme each students shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter disciplinary/ industry relevance.
- The students can select a mathematical modelling based/Experimental investigations or Numerical modelling.
- All the investigations are clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of the work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and references.

Department Review Committee: Supervisor and Two Faculty Coordinators

Guidelines for awarding marks (CIE):		**Max. Marks: 50**
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Department Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

26ADC111

DISSERTATION PHASE- I

Instruction	20 Hours per week
CIE	100 Marks
Credits	10

Course Outcomes:

At the end of the course:

1. Students will be exposed to self-learning various topics.
2. Students will learn to survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.
3. Students will learn to write technical reports.
4. Students will develop oral and written communication skills to present.
5. Student will defend their work in front of technically qualified audience.

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Head, Chairperson-BoS, Supervisor and Project coordinator.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for the award of Marks:		**Max. Marks: 100**
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Department Committee	10	Relevance of the Topic
	10	PPT Preparation(s)
	10	Presentation(s)
	10	Question and Answers
	10	Report Preparation

Note: Department committee has to assess the progress of the student for every two weeks.

26ADC112

DISSERTATION PHASE- II

Instruction	32 Hours per week
Duration of SEE	Viva
SEE	100 Marks
CIE	100 Marks
Credits	16

Course Outcomes:

At the end of the course:

1. Students will be able to use different experimental techniques and will be able to use different software/ computational/analytical tools.
2. Students will be able to design and develop an experimental set up/ equipment/test rig.
3. Students will be able to conduct tests on existing set ups / equipment's and draw logical conclusions from the results after analysing them.
4. Students will be able to either work in a research environment or in an industrial environment.
5. Students will be conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

Guidelines:

- It is a continuation of Project work started in III semester.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be submitted in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of the solution and results with analysis.
- The report must bring out the conclusions of the work and future scope for the study.
- The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner (HoD and BoS Chair Person), and supervisor/co T supervisor.
- The candidate must be in regular contact with his/her supervisor/co-supervisor.

Guidelines for awarding marks in CIE:		**Max. Marks: 100**
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Department Review Committee	05	Review 1
	10	Review 2
	10	Review 3
	15	Final presentation with the draft copy of the report in standard format
	10	Submission of the report in a standard format
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format

Guidelines for awarding marks in SEE:		**Max. Marks: 100**
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
External and Internal Examiner(s)	20	Power Point Presentation
	40	Quality of thesis and evaluation
	20	Quality of the project • Innovations • Applications • Live Research Projects • Scope for future study • Application to society
	20	Viva-Voce