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COLLEGE of
ENGINEERING & TECHNOLOGY
(AN AUTONOMOUS INSTITUTE)
KASABA BAWADA, KOLHAPUR

D. Y. Patil College of Engineering and Technology

Kasaba Bawada, Kolhapur

(An Autonomous Institute)

NBA Accredited

Accredited by NAAC with 'A' Grade

Structure and Syllabus of Third Year B. Tech in Computer Science and Engineering (Artificial Intelligence–Machine Learning)

Department of Computer Science and Engineering (AI-ML)

Effective from Academic year 2025-26

PRINCIPAL
D. Y. Patil College of Engineering And Technology
Kasaba Bawada, Kolhapur.
(An Autonomous Institute)

HEAD OF DEPARTMENT
Computer Science and Engineering
(Artificial Intelligence and Machine Learning)
D. Y. Patil College of Engg. & Tech.,
Kasaba Bawada, Kolhapur-416 006

Teaching and Evaluation Scheme from Year 2025-26 (as per NEP 2020)

SEMESTER-V													
Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme				Theory			Practical		Total Marks
				Credits	Contact Hrs								
					L	P	T	ISE	MSE	ESE	INT	OE/ POE	
1	231AIMLPCCL301	PCC	Machine Learning -I	3	3	-	-	20	30	50	-	-	100
2	231AIMLPCCL302	PCC	Database Engineering	3	3	-	-	20	30	50	-	-	100
3	231AIMLPCCL303	PCC	Cloud Computing	3	3	-	-	20	30	50	-	-	100
4	231AIMLPCCP301	PCC	Machine Learning-I Laboratory	1	-	2	-	-	-	-	25	25	50
5	231AIMLPCCP302	PCC	Database Engineering Laboratory	1	-	2	-	-	-	-	25	25	50
6	231AIMLPCCP303	PCC	Cloud Computing Laboratory	1	-	2	-	-	-	-	25	-	25
7	231AIMLMDML301	MDM-3	ODL only -Data Representation and Visualization Techniques	4	3	2	-	20	30	50	25	-	125
8	231AIMLOECL301	OEC-III	Machine Learning with Python	2	2	-	-	-	-	50	-	-	50
9	231AIMLPECL301-303	PEC-I	Professional Elective - I	3	3	-	-	20	30	50	-	-	100
10	231AIMLPECP301-303	PEC-I	Professional Elective – I Laboratory	1	-	2	-	-	-	-	25	-	25
11	231AIMLMCL301	MC	Finishing School Training V	Audit	3*	-	-	50*	-	-	-	-	Grade
12	231AIMLCCAP301	CCA	Liberal Learning	-	-	-	-	50*	-	-	-	-	Grade
			Total	**22**	**17**	**10**	**-**	**100**	**150**	**200**	**125**	**50**	**725**

* - Values not included in total

Min. Marks for Passing: 40% of total marks of individual course

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Professional Elective-I:		
Sr. no.	**Course Code**	**Name of the Course**
1.	231AIMLPECL301	Digital Image Processing
2.	231AIMLPECL302	Big Data
3.	231AIMLPECL303	DevOps and Kubernetes

Professional Elective-I Laboratory:		
Sr. no.	**Course Code**	**Name of the Course**
1.	231AIMLPECP301	Digital Image Processing Laboratory
2.	231AIMLPECP302	Big Data Laboratory
3.	231AIMLPECP303	DevOps and Kubernetes Laboratory

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Teaching and Evaluation Scheme from Year 2025-26 (as per NEP 2020)

SEMESTER-VI

Sr. No.	Course Code	Course Type	Course Name	Teaching Scheme: Credits	Contact Hrs: L	P	T	Theory: ISE	MSE	ESE	Practical: INT	OE/ POE	Total Marks
1	231AIMLPCCL304	PCC	Machine Learning-II	3	3	-	-	20	30	50	-	-	100
2	231AIMLPCCL305	PCC	Deep Learning	2	2	-	-	-	-	50	-	-	50
3	231AIMLPCCL306	PCC	Information Security	3	3	-	-	20	30	50	-	-	100
4	231AIMLPCCP304	PCC	Machine Learning-II Laboratory	1	-	2	-	-	-	-	25	25	50
5	231AIMLPCCP305	PCC	Deep Learning Laboratory	1	-	2	-	-	-	-	25	25	50
6	231AIMLMDML302	MDM-4	Exploratory Data Analysis and Interpretation	2	2	-	-	-	-	50	-	-	50
7	231AIMLPECL304-306	PEC-II	Professional Elective - II	3	3	-	-	20	30	50	-	-	100
8	231AIMLPECL307-309	PEC-III	Professional Elective - III	3	3	-	-	20	30	50	-	-	100
9	231AIMLPECP304-306	PEC-II	Professional Elective – II Laboratory	1	-	2	-	-	-	-	25	-	25
10	231AIMLPECP307-309	PEC-III	Professional Elective – III Laboratory	1	-	2	-	-	-	-	25	-	25
11	231AIMLVSECP301	VSEC	Application Development	2	1	2	-	25	-	-	25	-	50
12	231AIMLMCL302	MC	Finishing School Training VI	Audit	3*	-	-	50*	-	-	-	-	Grade
13	231AIMLCCAP302	CCA	Liberal Learning	-	-	-	-	50*	-	-	-	-	Grade
			Total	**22**	**17**	**10**	**-**	**105**	**120**	**300**	**125**	**50**	**700**

* - Values not included in total

Min. Marks for Passing: 40% of total marks of individual course

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Professional Elective-II:			Professional Elective-II Laboratory :		
Sr. no.	Course Code	Name of the Course	Sr. no.	Course Code	Name of the Course
1.	231AIMLPECL304	Soft Computing	1.	231AIMLPECP304	Soft Computing Laboratory
2.	231AIMLPECL305	Advanced Data Structures	2.	231AIMLPECP305	Advanced Data Structures Laboratory
3.	231AIMLPECL306	Reinforcement Learning	3.	231AIMLPECP306	Reinforcement Learning Laboratory
Professional Elective-III:			**Professional Elective-III Laboratory :**		
Sr. no.	Course Code	Name of the Course	Sr. no.	Course Code	Name of the Course
1.	231AIMLPECL307	Applied AIML	1.	231AIMLPECP307	Applied AIML Laboratory
2.	231AIMLPECL308	Pattern Recognition	2.	231AIMLPECP308	Pattern Recognition Laboratory
3.	231AIMLPECL309	Advanced Database Systems	3.	231AIMLPECP309	Advanced Database Systems Laboratory

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Course Plan

Course Title: Machine Learning -I	
Course Code: 231AIMLPCCL301	Semester :V
Teaching Scheme:L-T-P:3-0-0	Credits:3
Evaluation Scheme: ISE+MSE Marks:20+30	ESE:50

Course Description:

This course provides a comprehensive introduction to Machine Learning (ML), covering fundamental concepts, terminologies, algorithms, and real-world applications. Students will gain hands-on experience with essential ML libraries such as NumPy, Pandas, Matplotlib, Scikit-learn, and TensorFlow, enabling them to implement and analyze various ML models.

The course begins with core ML concepts, including different learning types, problem categories, performance measures, and lifecycle management. It then progresses to regression techniques, focusing on hypothesis representation, cost functions, and gradient descent for parameter optimization.

Further, students will explore classification methods, including logistic regression, multiclass classification, and regularization techniques to prevent overfitting. The course also delves into Bayesian learning, covering Naïve Bayes classifiers, Bayesian belief networks, and Hidden Markov Models.

Advanced topics such as Decision Trees, Random Forests, and Support Vector Machines (SVM) will be discussed, highlighting their theoretical foundations, construction, and optimization techniques like kernel tricks and cost functions.

Course Objectives:

1. To study the fundamental concepts, terminologies, and types of machine learning, along with essential ML tools and frameworks.
2. To apply various machine learning algorithms such as regression, classification, Bayesian learning, decision trees, and SVM to solve real-world problems.
3. To analyze machine learning models by evaluating performance metrics, addressing overfitting/underfitting issues, and optimizing model parameters.

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Course Outcomes (COs):

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

PCCL301.1	Explain the fundamental concepts of Machine Learning and utilize essential libraries like NumPy, Pandas, Matplotlib, Scikit-learn, and TensorFlow for data processing.
PCCL301.2	Describe key terminologies, learning types, performance measures, and challenges in Machine Learning, and illustrate the steps involved in building an ML model.
PCCL301.3	Implement regression techniques, including simple and multivariate linear regression, logistic regression, and gradient descent, for predictive modeling.
PCCL301.4	Develop classification models using logistic regression, K-Nearest Neighbors (KNN), and regularization techniques to handle overfitting and improve model performance.
PCCL301.5	Apply Bayesian learning methods, including Naïve Bayes and Bayesian belief networks, for probabilistic reasoning in ML applications.
PCCL301.6	Construct and evaluate decision trees, random forests, and support vector machines (SVM) using appropriate algorithms and optimization techniques

Prerequisite:	Linear Algebra, Statistics, Probability Theory.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCL301.1	3	2	1	-	3	-	-	-	-	2	3	-	-	2
PCCL301.2	3	3	2	2	3	2	-	-	-	2	3	-	-	2
PCCL301.3	3	3	3	3	3	-	-	-	-	2	2	2	-	2
PCCL301.4	2	3	2	2	1	-	-	-	-	-	-	2	1	3
PCCL301.5	3	2	3	2	2	-	-	-	-	-	-	2	1	3
PCCL301.6	3	2	3	2	3	-	-	-	-	-	-	2	1	3

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Content	Hours
Unit 1: Fundamentals of Machine Learning Introduction to Numpy, Pandas, Mathplotlib, Sciktlearn, Tensorflow basics and their implementation	07
Unit 2: Machine Learning Basic Terminologies Machine Learning: Definition, Terminology, Types of learning, Machine Learning Problem categories ,Lifecycle, Performance measures, tools and framework, data visualization, Issues in Machine Learning, Steps in developing a Machine Learning Application, Application of Machine Learning, Errors in ML- Bias & Variance, Overfitting, Underfitting	07
Unit 3: Regression: Simple regression–hypothesis, cost function, parameter learning with gradient descent, learning rate, Gradient Descent for linear regression. **Multivariate Linear Regression**–Multiple features, hypothesis functions, Gradient Descent for multiple variables, Features scaling, Logistic Regression	07
Unit 4: Classification-logistic regression: Definition, Hypothesis representation, decision boundary, Cost function, Gradient Descent for Logistic Regression. Multiclass Classification, Regularization – Overfitting & Underfitting, cost function, Regularized Linear Regression, K-Nearest Neighbor Classifier	06
Unit 5: Bayesian Learning- Introduction Bayes theorem, Naïve Bayes theorem, Naïve Bayes Classifier, Bayesian belief Networks, Introduction to Hidden Markov Model Issues in Hidden Markov Model.	08
Unit 6: Decision Trees and SVM Definition, terminology, the need, advantages, and limitations. Constructing and understanding Decision trees, common problems with Decision trees, Decision tree algorithms, Constructing Decision Trees using Gini Index (Regression), random forest, and examples. Introduction to Support Vector Machines, Linear Support Vector Machines soft margin SVM, hard margin SVM, Kernel Tricks.	07

Text Books:

1. Machine Learning, Anuradha Srinivasa Raghavan, and Vincy Joseph ,Kindle Edition, 2020, WILEY.
2. Introduction to Machine Learning, Ethem Alpaydin, Second Edition, 2010, Prentice Hall
3. Practical Machine Learning Sunila Gollapudi Packt Publishing Ltd

Reference Books:

1.Machine Learning by Tom M.Mitchell, International Edition 1997, McGraw Hill Education

Online Resources:

1. https://www.coursera.org/learn/machine-learning
2. https://nptel.ac.in/courses/106106139

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Course Plan

Course Title : Database Engineering	
Course Code : 231AIMLPCCL302	Semester : V
Teaching Scheme :L-T-P:3-0-0	Credits : 3
Evaluation Scheme : ISE + MSE Marks : 20 + 30	ESE Marks : 50

Course Description:

This course provides a fundamental understanding of database systems, focusing on data modeling, relational database design, storage, indexing, concurrency control, and security. Students will learn about E-R modeling, SQL, PLSQL, and normalization techniques for efficient database design. The course also covers data storage strategies, indexing methods, transaction management, and database security mechanisms to ensure integrity and security in modern database applications.

Course Objectives:

1. To study database concepts, relational models, SQL, and PLSQL for efficient data management.
2. To apply normalization techniques, indexing, and concurrency control mechanisms to enhance database performance and reliability.
3. To analyze database security measures, access control techniques, and recovery mechanisms for secure and fault-tolerant database systems.

Course Outcomes (COs):

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

PCCL302.1	**Describe** fundamental database concepts, architectures, and the E-R model.
PCCL302.2	**Explain** relational database models, SQL queries, and PLSQL programming.
PCCL302.3	**Apply** normalization techniques to design efficient relational databases.
PCCL302.4	**Demonstrate** data storage techniques, indexing methods, and hashing for optimized retrieval.
PCCL302.5	**Illustrate** transaction management, concurrency control, and recovery mechanisms.
PCCL302.6	**Summarize** database security principles, access control mechanisms, and authorization techniques.

Prerequisite:	Set Theory and Data Structures

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

COs	PO's											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCL302.1	3	2	-	-	-	-	-	-	-	1	-	-	-	2
PCCL302.2	3	3	2	-	2	-	-	-	-	1	-	-	-	2
PCCL302.3	3	3	3	2	2	-	-	-	-	1	-	2	-	3
PCCL302.4	3	3	3	2	2	-	-	-	-	1	-	2	-	3
PCCL302.5	3	3	3	3	2	1	-	-	-	1	-	-	-	2
PCCL302.6	3	2	2	2	1	2	2	3	-	-	-	-	-	2

Content	Hours
Unit 1: Introduction to databases and E-R model Purpose of Database Systems, View of data, Database architecture, Database users and administrator, E-R model: Entity sets, Relationship sets, Mapping Constraints, Keys, E-R Diagram, Reducing E-R Diagrams to relational schemas, Extended E-R features: Specialization, Generalization, and Aggregation	7
Unit 2: Relational Model, SQL and PLSQL Relational Model: Structure of Relational Databases, Database Schema, Keys, Schema Diagram, Relational Algebra. SQL: Overview of the SQL Query Language, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Aggregate Functions, Nested Sub queries, Modification of the Database, Join Expressions, Views. PLSQL: Triggers, Stored Procedures, PL/SQL Processing with Cursors, PL/SQL Stored Functions. Dynamic SQL	9
Unit 3: Relational Database Design Referential Integrity, features of good relational designs, functional dependency, closure of a set of functional dependencies and Canonical cover. Normalization: Purpose of normalization, First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce-Codd Normal Form (BCNF).	7
Unit 4: Data Storage and Indexing Storage and File structure: Overview of physical storage media, RAID, File Organization, Organization of Records in Files, Data Dictionary Storage, Database Buffer. Indexing and Hashing: Basic Concepts, Ordered Indices, B+ Tree Index Files, Multiple Key Access. Static Hashing, Dynamic Hashing. Index definition in SQL.	8

Unit 5: Concurrency Control and Crash Recovery Transaction concept, Transaction state, Concurrent Executions, Serializability, Recoverability, Testing for Serializability, Lock-Based Protocols, Graph based Protocols, Timestamp Based Protocols, Validation based protocols, Failure Classification, Recovery and Atomicity, Log-Based Recovery, Check points, Shadow Paging, Buffer Management	7
Unit 6: Database Security and Authorization: Introduction to Database Security Issues, Discretionary Access Control Based on Granting and Revoking Privileges, Mandatory Access Control and Role-Based Access Control for Multilevel Security, Introduction to Statistical Database Security	5

Text Books:

1. A. Silberschatz, H.F. Korth, S. Sudarshan, "Database System Concepts", 6th Edition, McGraw Hill Education. (Unit 1,2, 3,4,5)
2. Thomos Connolly, CarolynBegg, "Database Systems- A practical approach to Design, Implementation and Management", 3rd Edition, Pearson Education. (Unit3-Normalization)
3. Coronel, Morris, Rob, "Database Systems, Design, Implementation and Management", Ninth Edition, Cengage Learning, (Unit2-PLSQL)
4. Ramez Elmasriand Shamkant Navathe, "Fundamentals of Database Systems", Pearson Education, Fifth Edition (Unit 6)

Reference Books:

1. Raghu Ramkrishnan, Johannes Gehrke, "Database Management System", Fourth Edition, McGraw Hill Education.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc19_cs46/preview

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Course Plan

Course Title: Cloud Computing	
Course Code: 231AIMLPCCL303	Semester: V
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE+MSE Marks: 20+30	ESE Marks: 50

Course Description:

This course provides a comprehensive overview of Cloud Computing technologies, focusing on both foundational concepts and modern advancements. Students will explore cloud service and deployment models, virtualization, containerization, microservices architecture, and cloud security. Advanced topics such as serverless computing, edge and multi-cloud strategies, AI/ML cloud services, and emerging trends like green and quantum cloud computing are also covered. Through real-world case studies and platform exposure (AWS, Azure, GCP), learners gain both conceptual understanding and practical insights into designing and managing cloud-native applications.

Course Objectives:

1. To introduce students to the core principles and service models of cloud computing and develop a clear understanding of its advantages, challenges, and deployment strategies.

2. To enable students to implement virtualization and containerization technologies using tools like Docker and Kubernetes for scalable cloud application development.

3. To expose students to advanced topics such as serverless computing, edge/fog architectures, cloud security, and future trends including AI/ML services and sustainability in the cloud.

Course Outcomes (COs):

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

PCCL303.1	Understand the fundamental concepts, service models, and deployment models of cloud computing along with its benefits and challenges.
PCCL303.2	Explain various virtualization techniques, hypervisors, and their role in enabling cloud infrastructure.
PCCL303.3	Apply containerization and orchestration tools like Docker and Kubernetes to build and manage cloud-native applications.

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PCCL303.4	Analyze cloud storage services, networking configurations, and implement basic cloud security and compliance practices.
PCCL303.5	Evaluate serverless computing, edge fog computing, and multi-cloud strategies for modern cloud-based solutions.
PCCL303.6	Explore and assess cloud platforms, cloud-based AI ML services, and emerging trends in cloud computing.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCL303.1	3	2	1	-	2	-	-	-	-	1	2	1	-	2
PCCL303.2	3	2	1	-	2	-	-	-	-	1	2	-	2	3
PCCL303.3	3	3	2	-	2	-	-	-	-	1	2	2	2	3
PCCL303.4	3	3	2	2	3	-	-	-	-	-	1	-	2	3
PCCL303.5	3	2	2	2	3	2	3	-	-	1	2-	2	2	3
PCCL303.6	3	2	1	1	3	2	3	-	-	1	3	-	2	2

Content	Hours
Unit 1: Introduction to Cloud Computing: Evolution of Cloud Computing, Definition, Characteristics and Benefits, Cloud Deployment Models: Public, Private, Hybrid, Community, Cloud Service Models: IaaS, PaaS, SaaS, Challenges and Risks in Cloud Computing, Comparison with Traditional Computing Paradigm, Case Study: Google Cloud, AWS, Azure Overview	8
Unit 2: Virtualization in Cloud: Introduction to Virtualization, Types of Virtualization: Hardware, OS, Server, Storage, Network, Hypervisors: Type 1 and Type 2, Virtual Machine Monitor (VMM), Virtualization and Security, VM Migration Techniques, Open Source Virtualization Tools: Xen, KVM, VMware	8
Unit 3: Containerization and Microservices: Introduction to Containers and Containerization, Docker Architecture and Commands, Docker Compose and Docker Hub, Introduction to Kubernetes: Architecture, Pods, Services, Microservices vs Monolithic Architecture, Container Orchestration with Kubernetes, Comparison: VMs vs Containers, Case Study: Cloud-Native Application Development	8

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Unit 4:Cloud Storage, Networking and Security: Cloud Storage: Types (Object, Block, File), Storage Services: Amazon S3, Azure Blob Storage, Google Cloud Storage, Cloud Networking: Virtual Private Cloud (VPC), Load Balancers, DNS, Identity and Access Management (IAM), Data Privacy, Confidentiality and Compliance (GDPR, HIPAA), Threats in the Cloud: DDoS, Data Breaches, Encryption and Key Management	7
Unit 5: Serverless, Edge, and Multi-Cloud Computing: Serverless Computing and FaaS (AWS Lambda, Azure Functions), Introduction to Edge and Fog Computing, Use Cases of Edge and IoT Integration, Multi-Cloud and Hybrid Cloud Strategies, Cloud Cost Optimization and Billing Models, DevOps and CI/CD in Cloud Environment, Case Study: Multi-Cloud Deployment with Terraform	7
Unit 6: Cloud Platforms, Applications and Future Trends: Introduction to Cloud Platforms: AWS, Azure, GCP, Big Data and Cloud (Hadoop on Cloud, Google BigQuery), AI/ML as Cloud Services (Amazon SageMaker, Azure ML), Cloud Monitoring and Logging Tools, Sustainability and Green Cloud Computing, Quantum Computing and Cloud, Future Trends: Cloud Native, FinOps, NoOps	7

Text Books:

1.Distributed System: principles and paradigms-Tanenbaum, Steen .Unit I, II
2.Cloud Computing for Dummies, Judith Hurwitz, R. Bloor, M. Kanfman, F. Halper, Wiley India Edition, Unit -I,II,IV,V
3.Cloud Computing Black Book, Jayaswal, Kallakurchi, Houde, Shah, Dreamtech Press, Unit-III
4.Cloud Security, Ronald Krutzand Russell Dean Vines, Wiley-India, Unit-V
5.Enterprise Cloud Computing, Gautam Shroff, Cambridge, Unit-VI

Reference Books:

1.Cloud Security & Privacy, Tim Mather, S. Kumar aswammy, S. Latif, SPD, O'REILLY
2.Cloud Computing: A Practical Approach, Anthony T. Velte, et. al, McGraw Hill
3.Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, Wiley India
4.Cloud Computing for Dummies, Judith Hurwitz, Marcia Kaufman, Fern Halper, Robin Bloor, Wiley Publication
5.Cloud Computing Bible, Barrie Sosinsky, Wiley India
6.Cloud Computing, Michael Miller, Que Publishing
7.Rajkumar Buyya et al., *Cloud Computing: Principles and Paradigms*, Wiley
8.Thomas Erl, *Cloud Computing: Concepts, Technology & Architecture*, Pearson
9.Docker & Kubernetes documentation
10. AWS / Azure / GCP official tutorials and labs

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Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs14/preview

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Course Plan

Course Title: Machine Learning-I Laboratory	
Course Code: 231AIMLPCCP301	**Semester: V**
Teaching Scheme: L-T-P:0-0-2	**Credits:1**
Evaluation Scheme: ISE Marks: Not Applicable	**INT-POE Marks:25+25**

Course Description:

The Machine Learning Laboratory provides hands-on experience in implementing and analyzing core machine learning algorithms using Python and popular libraries such as NumPy, Pandas, Matplotlib, Scikit-learn, and TensorFlow. Students will work on regression, classification, clustering, and Bayesian learning techniques while gaining expertise in model evaluation, optimization, and real-world applications.

The course covers fundamental algorithms, including Linear Regression, Logistic Regression, K-Nearest Neighbors, Naïve Bayes, Decision Trees, Support Vector Machines (SVM), and Clustering techniques. Students will also apply their knowledge through mini projects like house price prediction using Random Forest and movie review classification using Naïve Bayes.

Course Objectives:

1. To implement and analyze fundamental machine learning algorithms such as regression, classification, and clustering using Python and relevant libraries.
2. To develop and evaluate machine learning models for real-world applications, including sentiment analysis and predictive analytics.
3. To optimize and fine-tune machine learning models by applying appropriate performance evaluation techniques and hyperparameter tuning.

Course Outcomes (COs):

PCCP301.1	Implement and analyze regression models, including Simple Linear Regression and Multivariate Linear Regression, to predict continuous values.
PCCP301.2	Apply and evaluate classification techniques such as Logistic Regression, K-Nearest Neighbors (KNN), and Naïve Bayes for binary and multiclass classification problems.
PCCP301.3	Construct and utilize probabilistic models like Naïve Bayes Classifier and Bayesian Networks for decision-making in uncertain environments.
PCCP301.4	Develop and analyze decision-based learning models such as Decision Trees and Support Vector Machines (SVM) for predictive analytics.
PCCP301.5	Implement and compare clustering techniques like K-Means and Agglomerative Clustering for unsupervised learning applications.
PCCP301.6	Design and evaluate machine learning applications, including sentiment analysis and real-world predictive modeling, using advanced algorithms like Random Forest and Naïve Bayes.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCP301.1	3	2	3	2	2	-	-	-	-	-	-	-	-	3
PCCP301.2	3	3	3	2	2	-	-	-	-	-	-	-	-	3
PCCP301.3	3	3	2	2	3	-	-	-	-	-	-	2	-	3
PCCP301.4	3	3	3	3	3	-	-	-	-	-	-	2	-	3
PCCP301.5	3	3	3	3	3	-	-	-	-	-	-	2	-	3
PCCP301.6	3	3	3	3	3	2	-	-	-	2	-	2	-	3

List of Experiments			
Exp. No.	**Name of Experiment**	**S/O**	**Hours**
1	Implementation of simple Linear Regression	O	2
2	Implementation of Multivariate Linear Regression	O	2
3	Implementation of Logistic Regression for Binary Classification	O	2
4	Implementation of Multiclass Classification	O	2
5	Implementation of KNN Classifier	O	2
6	Implementation of Naïve Bayes Classifier	O	2
7	Implementation of Bayesian Network Algorithm	O	2
8	Implementation of Decision Tree Algorithm	O	2
9	Implementation of SVM Algorithm	O	2
10	Implementation of K-means Clustering	O	2
11	Implementation of Agglomerative Clustering	O	2
12	Design and analysis of sentiment analysis model	O	2
13	Implement a mini-project on Regression	O	2
14	Implement a mini-project on Classification	O	2

S-STUDY, O-OPERATIONAL

Note: Minimum 12 experiments are to be performed based on above experiment list

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Text Books:

1. Machine Learning, Anuradha Srinivasaraghavan, and Vincy Joseph, Kindle Edition, 2020, WILEY.
2. Machine Learning– An Algorithmic Perspective by Stephen Marsland.

Reference Books:

1.Machine Learning by Tom M. Mitchell, International Edition 1997, McGraw Hill Education

Online Resources

1. https://www.coursera.org/learn/machine-learning
2. https://nptel.ac.in/courses/106106139

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Course Plan

Course Title: Database Engineering Laboratory	
Course Code: 231AIMLPCCP302	**Semester: V**
Teaching Scheme: L-T-P: 0-0-2	**Credits: 1**
Evaluation Scheme: ISE Marks: Not Applicable	**INT-POE Marks:25+25**

Course Description:

The Database Engineering Laboratory course provides hands-on experience in designing, implementing, and managing relational databases. Students will learn to create Entity-Relationship (ER) models, convert them into relational schemas, and manipulate databases using SQL. The course covers essential database operations, including Data Definition Language (DDL), Data Manipulation Language (DML), functions, views, subqueries, and transaction management. Advanced topics such as PL/SQL procedures, triggers, cursors, database connectivity, hashing techniques, indexing, and database security (DCL commands) are also explored. By the end of this course, students will be proficient in database development and optimization, preparing them for real-world database applications.

Course Objectives:

1. To design and implement relational databases using ER modeling and SQL commands for efficient data storage and retrieval.
2. To develop database applications using advanced SQL concepts, PL/SQL procedures, triggers, and database connectivity techniques.
3. To explore and apply advanced database techniques such as indexing, hashing, and access control for performance optimization and security.

Course Outcomes (COs):

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

PCCP302.1	Design an Entity-Relationship (ER) model for a given real-world scenario and convert it into relational tables.
PCCP302.2	Implement SQL queries using DDL and DML commands to create and manipulate relational databases effectively.
PCCP302.3	Demonstrate the use of SQL functions, aggregate functions, and set operations to retrieve and process data efficiently.
PCCP302.4	Develop database solutions using Views, Subqueries, PL/SQL functions, procedures, cursors, and triggers for automation and optimization.
PCCP302.5	Integrate databases with object-oriented programming languages to establish database connectivity and implement security concepts using DCL commands.
PCCP302.6	Analyze and implement advanced database techniques such as hashing and indexing to improve query performance.

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

COs	POS											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCP302.1	3	3	2	2	2	-	-	-	-	-	1	-	-	3
PCCP302.2	3	3	2	2	1	-	-	-	-	-	-	-	-	3
PCCP302.3	-	3	3	1	-	-	-	-	-	-	-	2	1	3
PCCP302.4	3	3	2	2	2	-	-	-	-	-	1	2	1	3
PCCP302.5	-	2	2	-	-	-	-	-	-	-	-	2	1	4
PCCP302.6	3	3	2	2	2	-	-	-	-	-	1	2	1	3

Sr. No.	List of Experiments	S/O	Hrs
1	ER Diagram of an Organization - Draw an E-R Diagram for any organization like Insurance Company, Library systems, College Management systems, Hospital Management systems etc. Use data modeling tools like Oracle SQL Developer to draw an ER diagram.	S	2
2	Conversion of ER Diagram to Tables- Convert the above-mentioned E-R Diagram in Relational Tables.	S	2
3	DDL Statements – Execute DDL commands to create, alter, rename, truncate and drop tables in SQL. Apply all types of constraints, such as primary key, foreign key, not null, unique, and check.	O	2
4	DML Statements – Use DML Queries to insert, delete, update & display records of the tables.	O	2
5	SQL character functions, String functions – Display the results using String operations.	O	2
6	Aggregate functions – Display the records using Aggregate functions and Group by, having, between, Order by clauses.	O	2
7	Join operations and set operations – Display the results of union, intersection, set difference, Cartesian product and Join operations of two different tables.	O	2
8	Views, Sub queries- Create Views for the table . Solve sub queries for given questions	O	2

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9	Demonstrate PLSQL Functions and Procedures.	O	2
10	Demonstrate Cursors, and triggers using PL/SQL.	O	2
11	Database Connectivity – Write a program of Database connectivity with any object oriented language.	O	2
12	Write a program to implement Static Hashing.	O	2
13	Study of DCL commands (Grant, Revoke)	O	2
14	Write a program to implement dynamic hashing and demonstrate how records are inserted, deleted, and searched efficiently.	O	2
15	Implement indexing techniques such as Single-level Indexing, Multi-level Indexing, or B+ Tree Indexing to optimize query performance.	O	2
16	Mini Project based on above experiments	O	2

S-STUDY, O-OPERATIONAL

Note: Minimum 12 experiments are to be performed and 16th experiment is compulsory.

Text Books:

1. A. Silberschatz, H. F. Korth, S. Sudarshan, "Database System Concepts", 6th Edition, McGraw Hill Education.
2. Thomos Connolly, Carolyn Begg, "Database Systems - A practical approach to Design, Implementation and Management", 3rd Edition, Pearson Education.
3. Coronel, Morris, Rob, "Database Systems, Design, Implementation and Management", Ninth Edition, Cengage Learning
4. Ramez Elmasri and Shamkant Navathe, "Fundamentals of Database Systems", Pearson Education, Fifth Edition.

Reference Books:

1. Raghu Ramkrishnan, Johannes Gehrke, "Database Management System", Fourth Edition, McGraw Hill Education.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc19_cs46/preview

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Course Plan

Course Title: Cloud Computing Laboratory	
Course Code: 231AIMLPCCP303	Semester :V
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE marks: Not Applicable	INT Marks: 25

Course Description:

The Cloud Computing Laboratory offers practical exposure to core and emerging cloud computing technologies. Students will gain hands-on experience in virtualization, containerization, cloud storage, virtual networks, IAM, serverless computing, and cloud monitoring using popular platforms like AWS, Azure, and GCP. It also introduces learners to modern cloud practices including Kubernetes orchestration, microservices, edge computing, and DevOps basics. The lab reinforces theoretical concepts and equips students to work with real-world cloud environments and tools.

Course Objectives:

1. To familiarize students with popular cloud platforms and virtual machines through practical deployment and configuration.
2. To provide hands-on experience with virtualization and containerization technologies including Docker, Docker Compose, and Kubernetes.
3. To enable students to implement essential cloud services like IAM, storage, serverless functions, networking, and monitoring.
4. To simulate edge computing and microservices scenarios to understand distributed and modern application deployments.

Course Outcomes (COs):

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

PCCP303.1	Demonstrate proficiency in cloud platforms and virtual machine provisioning using AWS, Azure, or GCP.
PCCP303.2	Configure and manage virtualization environments and deploy private clouds using tools like VirtualBox and OpenStack.
PCCP303.3	Implement and manage cloud storage services and containerized applications using Docker and Docker Compose.
PCCP303.4	Deploy applications using Kubernetes and understand microservices-based architecture.

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PCCP303.5	Apply cloud-native concepts including serverless computing, IAM, and load balancing to design secure and scalable services.
PCCP303.6	Design and simulate cloud networking, edge computing scenarios, and monitor resources for performance and security.

Prerequisite:	Computer Network, Operating Systems

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCP303.1	3	3	2	3	2	-	2	-	-	2	-	-	-	L-3
PCCP303.2	3	3	3	2	3	2	2	-	-	2	-	-	-	L-3
PCCP303.3	3	3	3	3	3	2	2	-	-	-	-	-	2	L-3
PCCP303.4	2	3	2	2	-	-	2	-	-	-	-	-	2	L-3
PCCP303.5	2	3	2	2	-	-	2	-	-	-	-	-	2	L-3
PCCP303.6	3	3	3	2	3	2	-	-	-	2	-	-	-	L-3

List of Experiments			
Exp. No.	**Name of Experiments**	**S/O**	**Hours**
1	**Introduction to Cloud Platforms** Explore AWS / Azure / GCP consoles, create a free-tier account, navigate services.	O	2
2	**Create and Configure a Virtual Machine in the Cloud** Launch and configure a Linux/Windows VM using AWS EC2 / Azure VM.	O	2
3	**Install and Use Virtualization Tools** Install VirtualBox or VMware Workstation, create and manage virtual machines.	O	2
4	**Set Up a Private Cloud using OpenStack or Eucalyptus** Deploy a basic OpenStack or Eucalyptus environment and manage instances.	O	2
5	**Implement Cloud Storage using AWS S3 or Azure Blob** Create buckets, upload/download data, set permissions, configure lifecycle rules.	O	2
6	**Introduction to Docker and Container Lifecycle** Install Docker, pull base images, build custom images, run containers.	O	2
	Docker Compose for Multi-Container Applications Use Docker Compose to deploy a web server and database container stack.	O	2

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8	**Kubernetes Basics: Deploy an Application in a Cluster** Deploy a sample application using `kubectl`, create pods, services, and deployments.	O	2
9	**Microservices Simulation using Docker and REST APIs** Containerize and run a microservices-based app (e.g., two interlinked services).	O	2
10	**Serverless Function Deployment** Create and deploy a simple serverless function using AWS Lambda or Azure Functions.	O	2
11	**Configure IAM Roles and Policies in AWS** Create users, assign roles, and apply policies to control resource access.	O	2
12	**Implement Load Balancing in the Cloud** Deploy multiple instances and configure a load balancer (AWS ELB / Azure LB).	O	2
13	**Cloud Networking using VPC/Subnets** Create a custom VPC with subnets, route tables, and security groups.	O	2
14	**Edge Computing Simulation** Simulate an IoT device sending data to a cloud endpoint using MQTT or REST API.	O	2
15	**Monitor and Analyze Cloud Resources** Use AWS CloudWatch / Azure Monitor to track VM performance and generate alerts.	O	2

S-STUDY, O-OPERATIONAL

Note: A minimum of 12 experiments are to be performed from the above experiment list.

Text Books:

1. Cloud Security, Ronald Krutz and Russell Dean Vines, Wiley-India.
2. Enterprise Cloud Computing, Gautam Shroff, Cambridge

Reference Books:

1. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej Goscinski, Wiley India
2. Cloud Computing for Dummies, Judith Hurwitz, Marcia Kaufman, Fern Halper, Robin Bloor, Wiley Publication
3. Rajkumar Buyya et al., *Cloud Computing: Principles and Paradigms*, Wiley
4. Thomas Erl, *Cloud Computing: Concepts, Technology & Architecture*, Pearson
5. Docker & Kubernetes documentation
6. AWS / Azure / GCP official tutorials and labs

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Online Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs14/preview

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Course Plan

Course Title: ODL Only—Data Representation and Visualization Techniques	
Course Code:231AIMLMDML301	Semester: V
Teaching Scheme: L-T-P:3-0-2	Credits: 4
Evaluation Scheme: ISE+MSE:20+30	ESE Marks:50 INT Marks:25

Course Description:

This course helps students to understand different visualization techniques. It also helps to study visualization tools and libraries. This will help to learn the nature of data across different domains and the concepts and skills of data visualization by understanding, questioning, and problematizing how data are generated, analyzed, and used. It will be able to apply its concepts and skills to visualize your own data, interpret the findings, and examine the impacts of data-driven decisions.

Course Objectives:

1. To study different visualization techniques.
2. To learn basic libraries and tools to represent data in visual form.

Course Outcomes (COs):

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

MDML301.1	Apply data visualizations in order to derive more meaning out of data
MDML301.2	Understand python visualization libraries
MDML301.3	Apply data visualization on different types of data
MDML301.4	Explain how data visualization helps in understanding hidden patterns and insights from data.
MDML301.5	Implement and utilize Python visualization libraries like Matplotlib, Pandas, Seaborn, GGPlot, and Plotly to create meaningful data visualizations.
MDML301.6	Explain the fundamental concepts of Time Series Data Analysis, including date and time handling, resampling, frequency conversion, and moving window functions.

Prerequisite:	Python, R Programming

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
MDML301.1	3	3	2	2	-	-	-	-	-	-	-	3	3	L-3
MDML301.2	3	2	1	-	-	-	-	-	-	-	-	2	1	L-2
MDML301.3	3	3	2	2	1	-	-	-	-	-	-	3	2	L-3
MDML301.4	3	3	3	3	2	-	-	-	-	-	-	3	3	L-2
MDML301.5	3	2	2	2	2	-	-	-	-	-	-	3	2	L-3
MDML301.6	3	2	2	2	-	-	-	-	-	-	-	3	2	L-2

Content	Hours
Unit 1: Visualization and Computer Graphics Overview of Visualization, 2-D Graphics, SVG example, 2-D Drawing, 3-D Graphics, Photorealism, Non-Photorealism, the human retina: Perceiving Two Dimensions, Perceiving Perspective	7
Unit 2: Visualization tools Line plots, area plots, histograms, bar charts, pie charts, scatter plots, bubble plots, waffle charts, word clouds	7
Unit 3: Visualization of numerical data Introduction, Data, Mapping, Charts, Glyphs, Parallel coordinates, Stacked graphs, Tufte's Design Rules, Using Color.	7
Unit 4: Visualization of non-numerical data Graphs and Networks, Embedding Planar Graphs, Graph Visualization, Tree Maps, Principal Component Analysis, Multidimensional Scaling	7
Unit 5: Python visualization libraries matplotlib, pandas, seaborn, ggplot, and plotly	7
Unit 6: Time Series Data Analysis Time Series Data Analysis: Date and Time Data Types and Tools, Time Series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.	7

Text Books:

1. Taming Python by Programming, Jeeva Jose, Khanna Book Publishing House.
2. Data Visualization with Python and JavaScript: Scrape, Clean, Explore & Transform Your Data, Kyran Dale, O'Reilly, 2016.
3. Introduction to Computing & Problem Solving with Python, Jeeva Jose, Khanna Publishing House.

Reference Books:

1. Data Visualization with Python: Create an impact with meaningful data insights using interactive and engaging visuals, Mario Döbler , Packt Publishers, 2019.
2. Mastering Python Data Visualization, Kirthi Raman, Packt Publishers, 2015

Online Resources:

1. Data Science for Engineers, Prof. Raghunathan Rengaswamy Prof. Shankar Narsimhan, IIT Madras
https://onlinecourses.nptel.ac.in/noc20_cs72/preview

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Course Plan

Course Title: Machine Learning With Python	
Course Code: 231AIMLOECL301	Semester: V
Teaching Scheme: L-T-P:2-0-0	Credits:2
Evaluation Scheme: ISE +MSE: NA	ESE : 50

Course Description:

This course provides a comprehensive introduction to Machine Learning (ML) using Python, covering fundamental concepts, algorithms, and real-world applications. Students will explore Python programming essentials and gain hands-on experience in data manipulation, regression, classification, clustering, and model evaluation using industry-standard libraries such as NumPy, Pandas, Matplotlib, and Scikit-learn. The course also covers supervised and unsupervised learning techniques, including regression, decision trees, support vector machines (SVM), and clustering methods. Through practical implementation and evaluation of ML models, students will develop a strong foundation for applying machine learning to real-world problems.

Course Objectives:

1. To develop machine learning models using Python and its libraries for data preprocessing, visualization, and analysis.
2. To implement and evaluate supervised and unsupervised learning algorithms, including regression, classification, and clustering, for real-world applications.
3. To analyze and optimize machine learning models using appropriate performance metrics and validation techniques.

Course Outcomes (COs):

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

OECL301.1	Demonstrate proficiency in Python programming concepts, including data types, control structures, functions, and libraries essential for machine learning.
OECL301.2	Differentiate between various machine learning paradigms and apply suitable Python libraries for ML tasks such as data preprocessing and visualization
OECL301.3	Implement and evaluate regression models, including simple, multiple, and non-linear regression, using appropriate performance metrics.
OECL301.4	Apply and analyze classification algorithms such as K-Nearest Neighbors (KNN), Decision Trees, and Logistic Regression for predictive modeling
OECL301.5	Develop and optimize Support Vector Machine (SVM) models for both classification and regression tasks, considering different kernel function
OECL301.6	Implement and assess unsupervised learning techniques like K-Means, Hierarchical Clustering, and Density-Based Clustering for data segmentation and recommendation systems

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Prerequisite:	Python Programming

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

COs	POs												PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
OECL301.1	3	2	2	-	2	-	-	-	-	-	-	-	2	2	L-2
OECL301.2	3	2	2	2	-	-	-	-	-	-	-	-	2	2	L-2
OECL301.3	3	3	3	3	2	-	-	-	-	-	-	-	2	-	L-3
OECL301.4	3	3	3	3	3	-	-	-	-	-	-	-	2	-	L-3
OECL301.5	3	2	2	2	2	-	-	-	-	-	-	-	2	2	L-2
OECL301.6	3	2	2	2	2	-	-	-	-	-	-	-	2	-	L-2

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Content	Hours
Unit 1: Introduction to Python Data Types, Operators, Expression, Indexing & Slicing, Strings, Conditionals, Functions, Control Flow, Nested Loops, Sets & Dictionaries.	5
Unit 2: Introduction to Machine Learning Machine Learning Vs Statistical Modelling, Supervised vs Unsupervised Learning, Supervised Learning Classification, Unsupervised Learning, Reinforcement Learning, Applications, Python libraries suitable for Machine Learning: Pandas, Numpy, Scikit-learn, visualization libraries: matplotlib etc.	5
Unit 3: Regression Simple Linear Regression, Multiple Linear Regression, Non-linear Regression, Model Evaluation in Regression Models, Evaluation Metrics in Regression Models	5
Unit 4: Classification Introduction to Classification, K-Nearest Neighbour, Decision Trees, Logistic Regression, , Logistic regression vs Linear regression, Evaluation Metrics in Classification.	5
Unit 5: Support Vector Machines Linear SVM Classification, Nonlinear SVM Classification , SVM Regression , Decision Function and Predictions : Training Objective , Quadratic Programming , The Dual Problem.	5
Unit 6: Unsupervised Learning : Clustering Intro to Clustering, K-Means Clustering, Hierarchical Clustering, Density-Based Clustering, Content-based recommender systems, Collaborative Filtering.	5

Text Books:

1. Introduction to Machine Learning with Python: A Guide for Data Scientists 1st Edition by Andreas C. Müller, Sarah Guido, O'Reilly, 2016 (Unit-1, Unit-2)
2. Hands–On Machine Learning with Scikit–Learn and TensorFlow 2e: Concepts, Tools, and Techniques to Build Intelligent Systems, Aurelien Geron, O'Reilly, 2017 (Unit-3, Unit-4, Unit-5, Unit-6)

Reference Books:

1. Python Machine Learning - Third Edition, Sebastian Raschka , Vahid Mirjalili, Packt Publishers, 2019.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2. https://www.edx.org/course/machine-learning-with-python-a-practical-introduct

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Professional Elective-I

Course Plan

Course Title: Digital Image Processing	
Course Code: 231AIMLPECL301	**Semester: V**
Teaching Scheme: L-T-P: 3-0-0	**Credits: 3**
Evaluation Scheme: ISE +MSE: 20+30	**ESE:50**

Course Description:

This course provides fundamental knowledge and techniques in digital image processing, covering image acquisition, enhancement, restoration, segmentation, and object recognition. Students will learn spatial and frequency domain processing, filtering techniques, noise reduction methods, and pattern recognition approaches. The course equips students with the theoretical foundation and practical skills needed for applications in computer vision, medical imaging, remote sensing, and machine learning.

Course Objectives:

1. To study the fundamental concepts, techniques, and applications of digital image processing.
2. To learn various image transformation, enhancement, restoration, and segmentation techniques.
3. To apply image processing methods for object recognition and real-world applications in fields like computer vision and medical imaging.

Course Outcomes (COs):

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

PECL301.1	Describe fundamental concepts, applications, and components of digital image processing.
PECL301.2	Explain digital image acquisition, sampling, quantization, and transformation techniques.
PECL301.3	Apply spatial and frequency domain techniques for image enhancement.
PECL301.4	Analyze image restoration techniques and noise reduction methods.
PECL301.5	Demonstrate various image segmentation techniques for object detection.
PECL301.6	Implement object recognition techniques using decision-theoretic and structural methods.

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Prerequisite:	Basics of Programming, Mathematics.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL301.1	3	2	-	-	-	-	-	-	-	1	-	-	-	2
PECL301.2	3	3	2	-	2	-	-	-	-	1	-	-	-	2
PECL301.3	3	3	3	2	2	-	-	-	-	1	-	-	-	2
PECL301.4	3	3	3	3	2	1	-	-	-	1	-	1	1	3
PECL301.5	3	3	3	3	2	1	-	-	-	1	-	2	1	3
PECL301.6	3	3	3	3	2	2	3	3	-	1		2	1	3

Content	Hours
Unit 1: Digital Image Processing Examples of Fields that Use Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System	07
Unit 2: Digital Image Fundamentals Elements of Visual Perception, Image Sensing and Acquisition , Image Sampling and Quantization, Digital Image Signal Processing, Fourier Transform, Cosine Transform, Wave let Transform	07
Unit 3: Image Enhancement in Spatial Domain Basic gray-level transformation, Histogram processing, Basics of Spatial Filtering, Smoothing Spatial Filters , Sharpening Spatial Filters, Combining Spatial Enhancement Methods, Frequency Domain	08
Unit 4: Image Restoration A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only, Periodic Noise Reduction by Frequency Domain Filtering, Geometric Mean Filter	08

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Unit 5: Image Segmentation Fundamentals, Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation, Boundary Descriptors, Regional Descriptors, Use of Principal Components for Description	07
Unit 6: Object Recognition Patterns and Pattern Classes, Recognition Based on Decision-Theoretic Method, Structural Methods , Case Study: Handwritten text Recognition	06

Text Books:

1. Digital Image. Processing. Third Edition. Rafael C. Gonzalez. University of Tennessee. Richard E. Woods. NledData Interactive. Pearson International Edition.

Reference Books:

1. Digital Image Processing Using MATLAB
2. Principles of Digital Image Processing, Core Algorithms Wilhelm
3. Fundamentals of Digital Image Processing by Sanjay Sharma

Online Resources:

1. https://www.coursera.org/courses?query=image%20processing
2. https://onlinecourses.nptel.ac.in/noc19_ee55/preview

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Course Plan

Course Title: Big Data	
Course Code: 231AIMLPECL302	**Semester: V**
Teaching Scheme: L-T-P:3-0-0	**Credits: 3**
Evaluation Scheme: ISE +MSE:20+30	**ESE: 50**

Course Description

This course introduces students to Big Data, covering its key technologies, platforms, storage solutions, and applications. Through hands-on experience, students will learn to work with Hadoop, Apache Spark, NoSQL databases, and real-time streaming platforms to process and analyze large-scale data. The course also explores machine learning and graph processing in Big Data, focusing on their real-world applications in industries like healthcare, finance, and retail.

Course Objectives:

1. To Study fundamentals of Big Data
2. To Learn Scalable Data Storage Solutions
3. To Process Real-Time Data Streams
4. To Apply Machine Learning and Graph Processing

Course Outcomes (COs):

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

PECL302.1	Understand the core concepts of Big Data, including its characteristics (Volume, Variety, Velocity, Veracity, and Value) and its impact on various industries.
PECL302.2	Identify and describe key Big Data architecture and platforms like Hadoop and Apache Spark, and explain their components and applications for data processing.
PECL302.3	Explain the principles behind distributed storage systems (e.g., HDFS, NoSQL) and real-time data processing tools like Kafka and Flink, and their practical uses.
PECL302.4	Apply machine learning techniques and graph processing algorithms to analyze and extract meaningful insights from large-scale datasets.
PECL302.5	Evaluate the performance and scalability of different Big Data solutions based on specific business or technical requirements.
PECL302.6	Use Big Data techniques to develop applications for link analysis, social network mining, and recommendation systems.

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Prerequisite:	Basic knowledge of programming (Python, Java, or Scala), databases (SQL), and data structures/algorithms.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL302.1	3	2	1	-	-	-	-	-	-	-	-	2	-	2
PECL302.2	3	3	2	2	2	-	-	-	-	-	-	2	-	2
PECL302.3	3	2	3	2	2	-	-	-	-	-	-	2	-	2
PECL302.4	3	3	3	3	3	-	-	-	-	-	-	1	-	3
PECL302.5	3	3	3	3	3	-	-	-	-	-	-	2	-	3
PECL302.6	3	3	3	2	2	-	-	-	-	-	-	2	-	3

Content	Hours
Unit 1: Introduction to Big Data Definitions and characteristics (Volume, Variety, Velocity, Veracity, and Value), Role of Big Data in transforming industries such as healthcare, finance, and retail, Structured, unstructured, and semi-structured data sources (IoT, social media, enterprise data), Issues like data privacy, security, and governance, Examples from industries: predictive analytics, customer segmentation, and fraud detection.	7
Unit 2: Introduction to Big Data Platforms Introduction to Apache Hadoop, Apache Spark, and their ecosystems, Components like HDFS, MapReduce, YARN, and Hive, Benefits and differences from Hadoop, real-time and batch processing capabilities, Choosing between Hadoop, Spark, and other Big Data platforms based on use cases. Installing and configuring a basic Hadoop/Spark cluster and running simple jobs.	7
Unit 3: Big Data Storage Solutions Introduction to Hadoop Distributed File System (HDFS) and cloud storage systems like Amazon S3, Overview of NoSQL databases such as MongoDB, Cassandra, and HBase for large-scale storage, Data Partitioning and Replication, Techniques to ensure scalability and fault tolerance.	7

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Data Consistency: CAP Theorem and its Implications for Big Data Storage. Choosing Storage Solutions: Criteria for selecting the right storage system based on data needs (e.g., consistency, speed, availability).	
Unit 4: Introduction to Big Data Streaming Platforms Real-Time Data Processing: Introduction to the need for real-time data analytics in Big Data. Apache Kafka: Overview of Kafka for building distributed streaming platforms. Apache Flink and Storm: Real-time processing with Flink and Storm for complex event processing. Event-Driven Architectures: How events trigger immediate actions and decisions in Big Data environments. Use Cases: Real-time applications in fraud detection, monitoring systems, and live recommendation engines.	7
Unit 5: Big Data Applications in Machine Learning and Graph Processing Machine Learning with Big Data: Introduction to machine learning algorithms like regression, classification, clustering, and anomaly detection. Apache Spark for Machine Learning: Using Spark MLlib for scalable machine learning applications on Big Data. Big Data for Graph Processing: Introduction to graph analytics and frameworks like Apache Giraph and GraphX. Applications of Machine Learning: Real-world use cases such as recommendation systems, predictive analytics, and sentiment analysis. Applications of Graph Processing: Examples from social networks, fraud detection, and route optimization.	7
Unit 6 : Big Data Analytics Applications Link Analysis : PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. Mining Social- Network Graphs : Social Networks as Graphs, Types , Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. Recommendation Engines: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	7

Text Books:

1. Bart Baesens, Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Wiley, 2014

Reference Books:

1. Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014.
2. Chuck Lam, Hadoop in Action, December, 2010.
3. Leskovec, Rajaraman, and Ullman, Mining of Massive Datasets, Cambridge University Press.

4. I.H. Witten and E. Frank, Data Mining: Practical Machine Learning Tools and Techniques.
5. Erik Brynjolfsson et al., The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, W. W. Norton & Company, 2014.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_cs92/preview

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Course Plan

Course Title: DevOps and Kubernetes	
Course Code: 231AIMLPECL303	Semester: V
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE +MSE:20+30	ESE Marks: 50

Course Description:

This course aims to provide students with a strong foundation in DevOps principles and practices, including automation, continuous integration and delivery, infrastructure as code, and containerization. It further introduces Kubernetes, the leading container orchestration platform, focusing on architecture, deployment, scaling, and advanced features used in real-world cloud-native applications. The course prepares students to adopt DevOps and Kubernetes in modern software engineering practices.

Course Objectives:

1. To study fundamental concepts of DevOps and its importance in software development
2. To explore various tools and practices used in CI/CD pipelines.
3. To gain practical knowledge of Kubernetes architecture, deployment, and orchestration.
4. To prepare students for industry practices in containerization and microservices deployment.

Course Outcomes (COs):

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

PECL303.1	Understand the fundamental concepts, principles, culture, lifecycle, and tools associated with DevOps and differentiate between SDLC, Agile, and DevOps approaches
PECL303.2	Apply version control using Git and design effective CI/CD pipelines using Jenkins and other tools, incorporating basic security principles in the pipeline.
PECL303.3	Demonstrate the ability to automate infrastructure provisioning and configuration using tools like Ansible and Terraform, and integrate testing and monitoring.
PECL303.4	Explain the architecture, components, and key objects of Kubernetes and use basic commands and YAML files to manage containerized applications.
PECL303.5	Deploy and scale applications on Kubernetes, manage storage, monitor workloads, and use Helm charts for efficient deployment.
PECL303.6	Evaluate advanced Kubernetes concepts like RBAC, multi-tenancy, service mesh, and GitOps, and analyze real-world use cases and trends in modern DevOps workflows.

Prerequisite:	Basic knowledge of programming (Python/Java),software engineering, Linux and cloud computing fundamentals.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL303.1	1	2	2	-	2	-	-	-	1	-	-	2	-	1
PECL303.2	2	2	2	2	2	-	-	-	2	-	-	2	2	2
PECL303.3	2	2	3	-	2	2	-	-	2	-	-	3	-	2
PECL303.4	2	3	3	-	3	2	-	-	3	2	-	-	3	3
PECL303.5	2	3	3	-	2	3	2	-	3	-	-	3	3	3
PECL303.6	3	3	3	-	3	3	3	-	3	3	-	-	3	3

Content	Hours
Unit 1: Introduction to DevOps Software Development Lifecycle (SDLC) vs Agile vs DevOps, DevOps principles, culture, and key practices, Benefits and challenges of DevOps adoption, Key DevOps tools overview (Git, Jenkins, Docker, Kubernetes, Ansible, etc.), DevOps lifecycle: Plan, Develop, Build, Test, Release, Deploy, Operate, Monitor, Case studies from industry (Netflix, Amazon, etc.)	7
Unit 2: Source Code Management and CI/CD Pipelines Git basics, branching strategies (GitFlow, trunk-based development), Introduction to Continuous Integration (CI) and Continuous Deployment (CD), Jenkins pipelines: declarative vs scripted, Integration with GitHub/GitLab/Bitbucket, Build automation and artifact repositories (Maven, Gradle, Nexus), Security in CI/CD (DevSecOps introduction)	8
Unit 3: Configuration Management and Infrastructure as Code (IaC) Introduction to Infrastructure as Code, Overview of Ansible, Chef, and Puppet, Writing playbooks in Ansible, Provisioning infrastructure using Terraform basics, Comparison of IaaS, PaaS, and SaaS in DevOps context, Automated testing and monitoring integration (e.g., with Prometheus, Grafana)	7
Unit 4: Introduction to Kubernetes Containerization overview and Docker recap, Introduction to Kubernetes: architecture and components (Pods, Nodes, Cluster, etc.), Kubernetes objects: Deployments, ReplicaSets, Services, ConfigMaps, Secrets, Kubernetes CLI (kubectl) and dashboard, Kubernetes networking basics, Hands-on YAML scripting for resource creation	7

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Unit 5: Kubernetes Application Deployment and Scaling Pod lifecycle and health checks (liveness, readiness probes), Rolling updates and rollbacks, Auto-scaling (Horizontal Pod Autoscaler), Helm introduction and chart creation, Managing persistent storage (Volumes, PersistentVolumeClaim), Kubernetes logging and monitoring basics	7
Unit 6: Advanced Kubernetes Concepts and Industry Use Cases Kubernetes security: Role-Based Access Control (RBAC), Network Policies, Namespaces and multi-tenancy, CI/CD integration with Kubernetes (Jenkins X, ArgoCD), Service mesh overview (Istio/Linkerd), Real-world use cases: GitOps, microservices deployment, blue-green deployment, Future trends: Kubernetes in hybrid/multi-cloud, serverless	8

Text Books:

1. The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations" by Gene Kim, Patrick Debois, John Willis, and Jez Humbl
2. Kubernetes Up & Running: Dive into the Future of Infrastructure" by Kelsey Hightower, Brendan Burns, and Joe Beda
3. "Docker Deep Dive" by Nigel Poulton

Reference Books:

1. The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win" by Gene Kim, Kevin Behr, and George Spafford
2. "Site Reliability Engineering: How Google Runs Production Systems" by Betsy Beyer, Niall Richard Murphy, David K. Rensin, Kent Kawahara, and Stephen Thorne
3. *Accelerate: The Science of Lean Software and DevOps* by Nicole Forsgren, Jez Humble, and Gene Kim, IT Revolution Press
4. *Site Reliability Engineering: How Google Runs Production Systems* by Betsy Beyer, Chris Jones, Jennifer Petoff, and Niall Richard Murphy, O'Reilly Media
5. *Terraform: Up & Running: Writing Infrastructure as Code* by Yevgeniy Brikman, O'Reilly Media
6. *Ansible for DevOps: Server and Configuration Management for Humans* by Jeff Geerling, Independently Published
7. Docker Deep Dive by Nigel Poulton, Independently Published
8. OfficialDocumentation:
   - Kubernetes Docs: https://kubernetes.io/docs/
   - Jenkins Docs: https://www.jenkins.io/doc/
   - Ansible Docs: https://docs.ansible.com/
   - Terraform Docs: https://developer.hashicorp.com/terraform/docs

Online Resources: 1. https://cloudxlab.com/course/all/?name=DevOps

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Professional Elective-I Laboratory
Course Plan

Course Title: Digital Image Processing Laboratory	
Course Code: 231AIMLPECP301	Semester: V
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
ISE Marks: Not Applicable	INT Marks: 25

Course Description:
This laboratory course provides hands-on experience in fundamental and advanced concepts of Digital Image Processing (DIP). Students will implement various image processing techniques, including image transformation, enhancement, restoration, segmentation, and object recognition. Through practical experiments, students will develop skills in image analysis, noise removal, edge detection, and morphological operations, preparing them for real-world applications such as biometric recognition, medical imaging, and computer vision. The course aims to bridge the gap between theory and practice, enabling students to apply digital image processing techniques effectively in diverse domains.

Course Objectives:

1. To implement fundamental image processing techniques such as image transformation, enhancement, and restoration.
2. To develop practical skills in applying image segmentation, edge detection, and object recognition techniques.
3. To analyze and apply digital image processing methods for real-world applications such as medical imaging, biometric recognition, and computer vision.

Course Outcomes (COs):
Upon successful completion of this course, the students will be able to:

PECP301.1	Understand the fundamental concepts of digital image processing, including image representation, transformation, and mathematical tools.
PECP301.2	Implement basic image transformation techniques such as grayscale conversion and quantization.
PECP301.3	Apply image enhancement techniques to improve image quality.
PECP301.4	Analyze and implement restoration techniques for noise removal in degraded images.
PECP301.5	Apply edge detection and segmentation techniques for feature extraction and object identification.

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PECP301.6	Develop real-world applications of image processing, such as object recognition and feature extraction.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECP301.1	3	3	2	2	3	2	-	-	-	-	-	2	-	2
PECP301.2	3	3	3	2	3	2	-	-	2	-	-	2	-	3
PECP301.3	3	3	3	3	3	2	2	-	2	2	-	1	-	3
PECP301.4	3	3	3	3	3	3	-	-	-	-	-	2	-	3
PECP301.5	3	2	3	3	3	2	2	-	-	-	-	2	-	3
PECP301.6	3	2	3	3	3	2	2	-	-	-	-	2	-	3

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List of Experiments			
Exp. No.	Name of Experiment	S/O	Hours
1	Study of basics of Image Processing	S	2
2	Implement a program to generate image histogram	O	2
3	Implement fundamental Steps in Digital Image Processing	O	2
4	Implement a program to convert Color image into gray Scale	O	2
5	Implement Image Sampling and Quantization is done to enhance the image.	O	2
6	Mention and explain in detail the mathematical tools used in digital image processing with an example.	O	2
7	Implement histogram equalization for image enhancement.	O	2
8	Apply smoothing and sharpening filters using spatial filtering.	O	2
9	Implement a model of image degradation/restoration.	O	2
10	Implement restoration of image in the presence of noise.	O	2
11	Apply different Edge Detection techniques on an image (Sobel, Prewitt, Canny)	O	2
12	Implement object recognition based on the decision-theoretic method.	O	2
13	Implement image segmentation techniques such as thresholding and region-based segmentation.	O	2
14	Develop and apply morphological image processing operations (Erosion, Dilation, Opening, Closing).	O	2
15	Write a case study report on sign language recognition or a similar real-world application	O	2

S-STUDY, O-OPERATIONAL

Note: A minimum of 12 experiments are to be performed from the above experiment list.

Text Books:

1. Digital Image Processing, Third Edition. Rafael C. Gonzalez. University of Tennessee. Richard E. Woods. NledData Interactive. Pearson International Edition.

Reference Books:

1. Principles of Digital Image Processing, Core Algorithms Wilhelm
2. Fundamentals of Digital Image Processing by Sanjay Sharma

Online Resources:

1. https://www.coursera.org/courses?query=image%20processing
2. https://onlinecourses.nptel.ac.in/noc19_ee55/preview

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (AI&ML) D. Y. PATIL COLLEGE OF ENGG. & TECH. KASABA BAWADA KOLHAPUR

Course Plan

Course Title: Big Data Laboratory	
Course Code: 231AIMLPECP302	Semester: V
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE+ MSE Marks: Not Applicable	INT Marks: 25

Course Description:

The Big Data Laboratory course provides third-year students with practical experience in managing and analyzing large datasets using modern Big Data technologies. Students will work with tools like Hadoop, Spark, Kafka, and NoSQL databases to perform data storage, processing, and real-time analytics. The lab emphasizes hands-on learning through experiments that involve distributed computing, data streaming, and machine learning, preparing students for real-world Big Data

Course Objectives:

1. To study the core concepts and frameworks used in Big Data processing (Hadoop, Spark, Kafka)
2. To study data storage, processing, and analytics using distributed systems like Hadoop and Spark
3. To configure and manage NoSQL databases like MongoDB and Cassandra for Big Data storage
4. To apply machine learning algorithms on Big Data platforms for predictive analytics and insights

Course Outcomes (COs):

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

PECP302.1	Demonstrate the setup of a Hadoop cluster, perform HDFS operations, and implement MapReduce programs for processing large datasets.
PECP302.2	Configure and execute CRUD operations on NoSQL databases (MongoDB/Cassandra) for efficient large-scale data management.
PECP302.3	Develop real-time data streaming applications using Apache Kafka and Spark for processing high-velocity data.
PECP302.4	Implement machine learning models using Apache Spark MLlib and analyze performance metrics for Big Data applications
PECP302.5	Utilize Big Data tools such as Apache Flink, Hive, and Zeppelin for real-time processing, querying, and interactive data visualization.

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PECP302.6	Integrate and automate Big Data workflows using cloud platforms (AWS, GCP, Azure) and Apache Airflow for ETL pipelines

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECP302.1	2	2	-	-	-	-	-	-	-	-	-	2	-	3
PECP302.2	3	3	3	-	-	-	-	-	-	-	-	2	-	3
PECP302.3	3	2	2	-	2	-	-	-	-	-	-	1	-	3
PECP302.4	3	3	3	-	-	-	-	-	-	-	-	2	-	3
PECP302.5	3	2	2	-	2	-	-	-	-	-	-	1	1	3
PECP302.6	3	3	3	-	2	-	-	-	-	-	-	2	-	3

Ex. No.	Title of Experiment	S/O
1	Set up a Hadoop cluster and perform basic operations on HDFS such as uploading, downloading, and viewing large datasets.	O
2	Implement a MapReduce program to process large datasets (e.g., word count) and analyze the output in a Hadoop environment.	O
3	Set up and configure a NoSQL database (MongoDB or Cassandra) and perform CRUD operations on large datasets.	O
4	Create a Kafka producer and consumer to handle real-time data streams and process the data in a Big Data environment.	O
5	Implement a Spark program to process large datasets using Apache Spark and analyze the performance and scalability.	O
6	Apply machine learning algorithms using Spark MLlib on large datasets and evaluate the model's performance using accuracy metrics.	O
7	Set up an Apache Flink environment and create a real-time stream processing application to analyze streaming data.	O

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8	Use Apache Zeppelin to perform interactive data analysis and visualization on large datasets stored in a Hadoop or Spark cluster.	O
9	Integrate Big Data processing with cloud platforms (AWS, GCP, Azure) to process large datasets stored in cloud storage.	O
10	Set up Apache Hive on a Hadoop cluster and perform data querying and analysis using HiveQL on large datasets.	O
11	Implement data ingestion using Apache Nifi to collect, process, and store real-time data from various sources into HDFS or a NoSQL database.	O
12	Set up a Hadoop YARN cluster and run various resource management configurations for efficient job scheduling in a distributed environment.	O
13	Implement a Spark Streaming application to process real-time data from Kafka, perform transformations, and store the results in a database.	O
14	Build a data pipeline using Apache Airflow to automate the workflow for extracting, transforming, and loading (ETL) large datasets.	O
15	Design and implement a machine learning pipeline using Apache Spark to preprocess, train, and evaluate models on a large dataset using parallel computing techniques.	O
16	Deployment and Configuration options in Microsoft Azure.	O

S-STUDY, O-OPERATIONAL

Note: A minimum of 12 experiments are to be performed from the above experiment list.

Text Books:

1. "Learning Spark: Lightning-Fast Big Data Analysis" by Holden Karau, Andy Konwinski, Patrick Wendell, and Matei Zaharia
2. "Data-Intensive Computing with Hadoop: The Ultimate Guide to Big Data Analytics with Hadoop" by Zikri Abdur Rahman

Reference Books:

1. "Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large-Scale Data Processing" by Mohammed Guller

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Course Plan

Course Title: DevOps and Kubernetes Laboratory	
Course Code: 231AIMLPECP303	Semester: V
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE + MSE Marks: Not Applicable	INT Marks: 25

Course Description:

This laboratory course provides hands-on experience with the tools and techniques commonly used in DevOps practices and Kubernetes orchestration. The course focuses on real-world application of continuous integration (CI), continuous deployment (CD), configuration management, containerization, and Kubernetes for scalable, automated software delivery. Students will work with tools such as Git, Jenkins, Docker, Ansible, Terraform, and Helm, along with Kubernetes for container orchestration. The course aims to bridge the gap between theory and practice, preparing students to implement modern DevOps pipelines and deploy applications in containerized environments.

Course Objectives:

1. To introduce students to DevOps practices, including version control, CI/CD, and automated configuration management.
2. To provide hands-on experience with tools such as Git, Jenkins, Ansible, and Terraform for automating software deployment and infrastructure provisioning.
3. To teach students how to manage application deployments, scaling, and monitoring in Kubernetes environments.

Course Outcomes (COs):

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

PECP303.1	Demonstrate proficiency in version control using Git and GitHub, and implement collaborative workflows like GitFlow in a DevOps environment.
PECP303.2	Develop and configure Jenkins pipelines for continuous integration and continuous deployment, incorporating automated testing and code analysis.
PECP303.3	Automate infrastructure provisioning and configuration management using tools like Ansible and Terraform in DevOps practices.
PECP303.4	Understand and apply Docker containerization for application packaging and deployment, and manage containerized applications on Kubernetes.
PECP303.5	Deploy and manage applications in a Kubernetes environment, including scaling, updating, and securing applications.

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PECP303.6	Implement GitOps practices using Helm charts and integrate Kubernetes-based CI/CD pipelines to streamline application deployment and monitoring in real-world projects.

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

COs	POs												PSOs		BTL
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	1	2	
PECP303.1	1	2	2	-	2	-	-	-	1	-	-	2	-	1	1
PECP303.2	2	2	2	2	2	-	-	-	2	-	-	2	2	2	2
PECP303.3	2	2	3	-	2	2	-	-	2	-	-	3	-	2	2
PECP303.4	2	3	3	-	3	2	-	-	3	2	-	-	3	3	2
PECP303.5	2	3	3	-	2	3	2	-	3	-	-	3	3	3	2
PECP303.6	3	3	3	-	3	3	3	-	3	3	-	-	3	3	3

List of Experiments

Exp. No.	**Name of Experiments**	**S/O**	**Hours**
1	**Version Control using Git and GitHub** Perform basic Git operations: init, add, commit, push, pull, clone, create branches, and merge.	**O**	**2**
2	**Collaborative Workflow with GitFlow or Trunk-Based Development** Simulate a team project using feature branches, pull requests, and conflict resolution.	**O**	**2**
3	**Setting Up Jenkins for Continuous Integration** Install and configure Jenkins. Create a freestyle project to automate build and test.	**O**	**2**

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4	**Building CI Pipeline with Jenkins and GitHub Integration** Trigger Jenkins build using GitHub webhooks and run test scripts on code push.	O	2
5	**Creating Declarative and Scripted Jenkins Pipelines** Write a Jenkinsfile for a multi-stage pipeline (build, test, deploy stages).	O	2
6	**DevSecOps: Integrate Static Code Analysis in CI Pipeline** Integrate tools like SonarQube or Trivy to scan for vulnerabilities in Jenkins pipeline.	O	2
7	**Automating Configuration with Ansible** Write and execute Ansible playbooks to install and configure web servers.	O	2
8	**Provisioning Infrastructure using Terraform** Use Terraform to create cloud infrastructure (e.g., AWS EC2 instance or local VMs using VirtualBox/Libvirt).	O	2
9	**Docker Basics and Containerization** Build, run, and manage Docker containers. Create a custom Dockerfile for a sample application.	O	2
10	**Kubernetes Cluster Setup (Minikube or Kind)** Install and start a single-node Kubernetes cluster. Verify using kubectl.	O	2
11	**Deploy Applications on Kubernetes** Create Kubernetes manifests to deploy a simple web application using Deployments, Services, and ReplicaSets.	O	2
12	**Kubernetes ConfigMaps and Secrets Management** Manage configuration data and sensitive information using ConfigMaps and Secrets in an application.	O	2
13	**Implement Rolling Updates, Rollbacks, and Health Probes** Perform rolling update to new version of an app, configure liveness and readiness probes.	O	2
14	**Helm Charts for Application Deployment** Install Helm, create a Helm chart, and deploy a templated app with Helm on Kubernetes.	O	2
15	**CI/CD with Kubernetes using ArgoCD or Jenkins X (Mini Project)** Set up a basic GitOps-style deployment pipeline to automatically deploy changes pushed to a Git repository.	O	2

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STUDY OPERATIONAL

Note: A minimum of 12 experiments are to be performed from the above experiment list.

Text Books:

1. "Kubernetes Up & Running: Dive into the Future of Infrastructure" by Kelsey Hightower, Brendan Burns, and Joe Beda
2. "Kubernetes Patterns: Reusable Elements for Designing Cloud-Native Applications" by Bilgin Ibryam, Roland Huß

Reference Books:

1. "Kubernetes: Up and Running: Dive into the Future of Infrastructure" by Kelsey Hightower, Brendan Burns, and Joe Beda
2. "Kubernetes Patterns: Reusable Elements for Designing Cloud-Native Applications" by Bilgin Ibryam and Roland Huß
3. "Kubernetes in Action" by Marko Lukša
4. *Accelerate: The Science of Lean Software and DevOps* by Nicole Forsgren, Jez Humble, and Gene Kim, IT Revolution Press
5. *Site Reliability Engineering: How Google Runs Production Systems* by Betsy Beyer, Chris Jones, Jennifer Petoff, and Niall Richard Murphy, O'Reilly Media
6. *Terraform: Up & Running: Writing Infrastructure as Code* by Yevgeniy Brikman, O'Reilly Media
7. *Ansible for DevOps: Server and Configuration Management for Humans* by Jeff Geerling, Independently Published
8. *Docker Deep Dive* by Nigel Poulton, Independently Published
9. Official Documentation:

   - Kubernetes Docs: https://kubernetes.io/docs/
   - Jenkins Docs: https://www.jenkins.io/doc/
   - Ansible Docs: https://docs.ansible.com/
   - Terraform Docs: https://developer.hashicorp.com/terraform/docs

Online Resources:

1. https://paperlive.in/devopstrainingonline?utm_source=google_search&utm_medium=cpc&utm_campaign=Devops_Exact)&gad_source=1&gclid=Cj0KCQiAqu9BhCjARIsANLjs0uWRT5RAltYtykPLtlDONQVMBVTnALLQgouSPlntDU56_WF01KbgaAmT0EALw_wcB

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Course Plan

Course Title: Liberal Learning Course- I Augmented Reality (AR) and Virtual Reality (VR) Club	
Course Code: 231AIMLCCAP301	**Semester: V**
Teaching Scheme: L-T-P: 2-0-0	**Credits: Audit**
Evaluation Scheme: ISE Marks: 50	**ESE Marks: NA**

Course Description:

This course provides an in-depth introduction to Augmented Reality (AR) and Virtual Reality (VR) technologies, exploring their fundamental principles, applications, and potential impact across various industries. Students will gain hands-on experience with creating AR/VR content and applications, using industry-standard software and development tools.

Aims:

1. To gain knowledge of historical and modern overviews and perspectives on virtual reality.
2. To learn the fundamentals of sensation, perception, and perceptual training.
3. To have the scientific, technical, and engineering aspects of augmented and virtual reality systems.
4. To learn the evaluation of virtual reality from the lens of design.
5. To learn the technology of augmented reality and implement it to gain practical knowledge.

Course Objectives:

1. Gain Knowledge of Virtual Reality: Acquire a comprehensive understanding of the historical development and modern perspectives of virtual reality.
2. Learn Fundamentals of Sensation and Perception: Understand the basic principles of sensation, perception, and the techniques used in perceptual training.
3. Understand Technical Aspects of AR and VR: Study the scientific, technical, and engineering principles that underpin augmented and virtual reality systems.
4. Evaluate VR Design: Develop the ability to assess virtual reality systems from a design perspective.
5. Implement Augmented Reality Technology: Gain practical experience by learning and applying the technology of augmented reality.

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Course Outcomes (COs):

At the end of the course, the student should be able to:

CCAP301.1	Demonstrate a comprehensive understanding of the historical development and contemporary perspectives on virtual reality.
CCAP301.2	Explain the basic principles of sensation and perception and apply techniques used in perceptual training.
CCAP301.3	Analyze and apply the scientific, technical, and engineering principles of augmented and virtual reality systems.
CCAP301.4	Evaluate and critique virtual reality systems from a design perspective.
CCAP301.5	Implement augmented reality technology in practical scenarios, demonstrating hands-on experience and knowledge.

Prerequisite:	Discrete Mathematics, Sets, Cartesian Product and Functions

Evaluation Guidelines

- Attendance: Regular attendance in bootcamps, workshops, and club meetings focused on AR-VR technologies.
- Engagement: Active participation in discussions, Q&A sessions, and group activities related to AR-VR.
- Teamwork: Collaboration with peers on AR-VR projects and challenges.
- Technical Proficiency: Ability to operate AR-VR hardware, use relevant software (e.g., Unity, Unreal Engine, AR development kits), and troubleshoot common issues.
- Project Execution: Successful completion of assigned AR-VR projects and tasks within the given timeframe.
- Innovation: Demonstration of creativity and innovative thinking in AR-VR project design and implementation.
- Event Participation: Involvement in organizing and participating in AR-VR competitions, workshops, and awareness campaigns.
- Community Building: Contribution to building a supportive and collaborative AR-VR club environment.
- Competition Performance: Participation and performance in internal and external AR-VR competitions.
- Project Showcase: Presentation of completed AR-VR projects during club meetings or events.
- Awards and Accolades: Recognition received for outstanding work and contributions in the

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Certification Levels

Beginner Level Certification:

- Attendance: Attend at least 75% of the AR-VR bootcamps and workshops.
- Project Completion: Complete a basic AR-VR project (e.g., creating a simple AR experience or VR environment).
- Concept Understanding: Demonstrate understanding of basic AR-VR concepts and basic operation of AR-VR hardware and software.

Intermediate Level Certification:

- Project Completion: Successfully complete multiple AR-VR projects, including a complex design (e.g., an interactive VR simulation or a detailed AR application).
- Competition Participation: Participate in at least one internal AR-VR competition or challenge.
- Technical Proficiency: Show proficiency in troubleshooting and maintaining AR-VR hardware and software.

Advanced Level Certification:

- Leadership: Lead a team in a major AR-VR project or competition.
- Event Organization: Organize or contribute significantly to an AR-VR club event or workshop.
- Knowledge Sharing: Conduct a presentation or seminar on a specialized AR-VR topic. Publish a Research Article in Journal or Conference.

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Course Plan

Course Title: Liberal Learning Course- II Microsoft Developer Club	
Course Code: 231AIMLCCAP301	**Semester: V**
Teaching Scheme: L-T-P: 2-0-0	**Credits: Audit**
Evaluation Scheme: ISE Marks: 50	**ESE Marks: NA**

Course Description:

Microsoft Developer Club (MDC) is a distinguished global program specifically designed to empower students in their pursuit of knowledge, network expansion, and the application of technology for the betterment of their communities.

Aims:

1. Fostering a Community of Tech Enthusiasts
2. Enhancing Technical Proficiency.
3. Hosting Webinars and Microsoft Learn Challenges.
4. Technical Workshops and Training Sessions.
5. Participation in Microsoft Events and Competitions

Course Objectives:

1. Skill Growth: Enhance technical and soft skills in areas like coding, leadership, and community building.
2. Global Community: Connect with students from over 100 countries, fostering online communities and expanding influence.
3. Certifications: Receive training and earn certifications to validate expertise in various technologies.
4. Impact: Become agents of change, making a lasting impact on important projects and communities.
5. Career Boost: Boost resumes, personal growth, and online influence to kickstart careers.
6. Access to Technologies: Gain access to cutting-edge Microsoft technologies like Microsoft 365, Visual Studio Enterprise, and Azure.

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Course Outcomes (COs):

At the end of the course, the student should be able to:

CCAP301.1	Demonstrate heightened technical skills acquired through hands-on participation in coding challenges, webinars, and Microsoft Learn Challenges, providing them with a competitive edge in the job market.
CCAP301.2	Exhibit proficiency in organizing and hosting technical events, such as webinars, Microsoft Learn Challenges, showcasing their ability to plan and execute successful projects.
CCAP301.3	Contribute positively to the local community by leveraging their technical skills and knowledge gained through MLSA chapter involvement, fostering a culture of collaboration and making a tangible difference in the community.
CCAP301.4	Establish valuable connections within the tech industry, leading to mentorship opportunities, internships, and collaborative projects, thereby enhancing their career prospects and industry exposure.

Prerequisite:	Basic Knowledge of Programming

Content Unit **SQL & Microsoft Copilot**	**Hours**
Unit 1:SQL Fundamentals & Query Writing - DDL, DML, DCL, and TCL - SELECT, INSERT, UPDATE, DELETE - WHERE, ORDER BY, GROUP BY, HAVING - Joins and Subqueries	**6**
Unit 2: Database Design and Normalization - Schema and Relationships - 1NF, 2NF, 3NF, BCNF - Indexing and Performance Optimization - Transactions, ACID Properties, Locks	**6**

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Unit 3:Stored Procedures, Functions, and Triggers - Stored Procedures and their advantages - User-defined Functions - Triggers and their use cases - Error Handling and Exception Management	**6**
Unit 4: Introduction to Microsoft Copilot - Overview and AI-powered assistance - Integration with Microsoft 365 - Writing Emails, Reports, and Summaries - Ethical considerations and responsible AI usage	**6**
Unit 5: Copilot for Productivity Tools - Using Copilot in Word, Excel, PowerPoint - Automating content generation and formatting - AI-driven summarization and editing - Enhancing productivity in office applications	**6**
Unit 6: Copilot for Developers - Copilot in Visual Studio Code & GitHub - Writing and debugging code with AI assistance - Generating documentation and comments - Improving coding efficiency with AI suggestions	**6**

Evaluation Guidelines

1. Attendance (10 marks)
2. Collaboration and Teamwork (10 marks)
3. Practical Assignments (10 marks)
4. MSE (Member Self-Evaluation) (10 marks)
5. ESE (External Stakeholder Evaluation) (10 marks)

Certification Levels

Beginner Level Certification:

- Attendance: Attend at least 75% of the Microsoft Developer bootcamps and workshops.
- Project Completion: Complete a basic Microsoft project .
- Concept Understanding: Demonstrate understanding of basic concepts and basic operation related to Microsoft hardware and software.

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Intermediate Level Certification:

- Project Completion: Successfully complete multiple Github and PowerBI projects, including a complex design.
- Competition Participation: Participate in at least one internal Microsoft Developer Club competition.
- Technical Proficiency: Show proficiency in troubleshooting and maintaining Microsoft hardware and software.

Advanced Level Certification:

- Leadership: Lead a team in a major Microsoft Developer club project or competition.
- Event Organization: Organize or contribute significantly to an Microsoft Developer club event or workshop.
- Knowledge Sharing: Conduct a presentation or seminar on a specialized Microsoft Developer topic. Publish a Research Article in Journal or Conference

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Course Plan

Course Title: Machine Learning - II	
Course Code: 231AIMLPCCL304	Semester: VI
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE +MSE Marks: 20 + 30	ESE Marks: 50

Course Description:

This course provides an in-depth exploration of advanced machine learning techniques beyond fundamental concepts, equipping students with cutting-edge algorithms and real-world applications. The course covers Artificial Neural Networks (ANNs), Multilayer Perceptrons, Ensemble Learning, Evolutionary Algorithms, Reinforcement Learning, Clustering, and Dimensionality Reduction.

Students will learn to design, implement, and optimize complex machine learning models, including backpropagation, boosting techniques (AdaBoost, XGBoost), genetic algorithms, reinforcement learning strategies, and recommendation systems. Additionally, the course explores advanced clustering methods, feature selection techniques, and optimization approaches.

Through practical case studies in image processing, bioinformatics, digital forensics, retail, and text mining, students will develop theoretical understanding and hands-on skills to solve complex machine learning problems across diverse industries.

Course Objectives:

1. To study and implement advanced machine learning models, including artificial neural networks, ensemble learning, and reinforcement learning.
2. To apply and analyze evolutionary algorithms, clustering techniques, and dimensionality reduction methods for complex real-world problems.
3. To develop and optimize machine learning applications in domains like image processing, bioinformatics, digital forensics, and text mining.

Course Outcomes (COs):

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

PCCL304.1	Explain and implement perceptrons, multilayer networks, and gradient descent-based learning techniques for neural network training.
PCCL304.2	Apply and evaluate backpropagation algorithms in feedforward neural networks for optimizing learning performance.
PCCL304.3	Analyze and implement ensemble learning techniques like Boosting, Bagging,

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	and Gradient Boosting, and develop recommendation systems.
PCCL304.4	Demonstrate and apply genetic algorithms and reinforcement learning techniques for problem-solving in dynamic environments.
PCCL304.5	Compare and implement clustering techniques and dimensionality reduction methods like PCA and LDA for feature optimization.
PCCL304.6	Develop and apply machine learning models for real-world applications in image processing, bioinformatics, finance, and text mining.

Prerequisite:	Machine Learning-I

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

COs	**POs**											**PSOs**		**BTL**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	
PCCL304.1	3	2	2	2	1	-	-	-	-	-	-	2	-	3
PCCL304.2	3	3	2	3	2	-	-	-	-	-	-	1	-	3
PCCL304.3	2	3	3	2	2	1	-	-	-	-	-	2	-	3
PCCL304.4	2	2	3	2	3	-	1	-	-	-	-	1	-	3
PCCL304.5	3	3	3	3	2	1						2	-	3
PCCL304.6	3	2	3	3	2	1	1			2	2	1	-	4

Content	**Hours**
Unit 1: Artificial Neural Network : The brain and the Neuron- Hebb's rule, McCulloch and Pits Neurons, Perceptron – Representational Power of Perceptrons ,The Perceptron Training Rule, Gradient Decent and Delta Rule, Mutlilayer Perceptron algorithm	07
Unit 2: Multilayer Network Feed forward Network- Multilayer networks and Back Propagation algorithm : The Differentiable Threshold Unit, The Back propagation Algorithm	07
Unit 3: Ensemble learning and Recommendation System Boosting-AdaBoost, stumping, Bagging: subagging, Gradient Boosting, XGBoost, Introduction to Recommendation systems	07
Unit 4: Introduction to Evolutionary Learning and Reinforcement Learning	08

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Genetic Algorithms - Representing Hypothesis, Genetic Operators Fitness Function and Selection, Genetic Programming– Representing Programs, Illustrative Examples, Introduction of Reinforcement Learning	
Unit 5: Clustering and Dimensionality Reduction Introduction to Clustering, Types of Clustering, Partitioning Methods of Clustering, Hierarchical Methods. Linear Discriminant Analysis, Feature Selection Methods, Principal Component Analysis, Introduction of Optimization,	07
Unit 6: Applications of Machine Learning Introduction to application of Machine Learning, Image Processing and Pattern Recognition, Application in Bio- informatics, Application in Digital Forensics, Application in retails and finance, Introduction to text mining, Methods and techniques of text mining, Application of text mining.	08

Text Books:

1. Machine Learning – An Algorithmic Perspective by Stephen Marsland.

Reference Books:

1. Machine Learning by Tom M. Mitchell, International Edition 1997, McGraw Hill Education

Online Resources:

1. https://livebook.manning.com/book/machine-learning-in-action/about-this-book/
2. https://www.coursera.org/learn/machine-learning
3. https://nptel.ac.in/courses/106106139

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Course Plan

Course Title: Deep Learning	
Course Code: 231AIMLPCCL305	Semester: VI
Teaching Scheme: L-T-P: 2-0-0	Credits: 2
Evaluation Scheme: ISE+MSE Marks: Not Applicable	ESE Marks: 50

Course Description:

In this course, students will learn the fundamental principles, underlying mathematics, and implementation details of deep learning. This includes the concepts and methods used to optimize Applications ranging from computer vision to natural language processing and decision-making (reinforcement learning) will be demonstrated.

Course Objectives:

1. To introduce the fundamentals of deep learning.
2. To introduce different models of deep learning to work with various types of inputs with respect to various applications.
3. To learn architectures and optimization methods for deep neural network training.

Course Outcomes (COs):

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

PCCL305.1	Explain the fundamental concepts of artificial neurons, perceptrons, and the history of deep learning, including different learning types and workflows.
PCCL305.2	Apply various activation functions and training methods, including backpropagation, to multilayer perceptrons for effective learning in neural networks.
PCCL305.3	Implement convolutional neural networks (CNNs) by utilizing convolution, pooling, and pre-trained models to extract meaningful features from image datasets.
PCCL305.4	Develop and optimize recurrent neural networks (RNNs), including LSTMs, GRUs, and attention mechanisms, for sequence modeling applications.
PCCL305.5	Evaluate deep learning optimization techniques and generalization strategies, including reinforcement learning and computational neuroscience, to improve neural network performance.
PCCL305.6	Design and analyze deep learning models for real-world applications, including emotion recognition, NLP, speech recognition, and transformer-based architectures.

Prerequisite:	Machine Learning - I

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCL305.1	3	2	2	2	1	-	-	-	-	-	-	3	-	2
PCCL305.2	3	3	3	3	2	-	-	-	-	-	-	2	1	2
PCCL305.3	2	3	3	2	3	1	-	-	-	-	-	2	1	2
PCCL305.4	3	3	3	3	3	-	2	-	-	-	-	2	1	3
PCCL305.5	3	3	3	3	3	1-	2	-	-	-	-	2	-	3
PCCL305.6	3	3	3	3	3	1-	2	-	2	2	1	2	-	3

Content	Hours
Unit 1: Introduction Biological Neuron, Idea of computational units, McCulloch–Pitts unit History of Deep Learning, Deep learning workflow, Learning types McCulloch Pitts Neuron, Perceptron and Multilayer Perceptron	07
Unit 2: Activation Functions and Parameters Introduction to neural network and multilayer perceptrons (MLPs), Representation power of MLPs, sigmoid neurons, gradient descent, feed-forward neural networks representation, Back propagation.	07
Unit 3: Convolutional Neural Networks Deep learning techniques, The convolutional operation, The max pooling operation, Training a convnet from scratch on a small dataset, Using pre-trained convnet, Visualizing what convnet learn, CNN Architecture, Padding, Stride, CGNet, ResNet, and AlexNet	07

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Unit 4: Recurrent Neural Networks Introduction to RCNN, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs, Encoder-Decoder Models, Attention Mechanism.	07
Unit 5: Optimization and Generalization Optimization in Deep Learning–Non–convex optimization for deep networks-stochastic optimization Generalization in neural networks -spatial transformer networks-recurrent networks, LSTM-recurrent neural network language models-world-level RNNs & deep Reinforcement learning—computational & artificial neuroscience.	08
Unit 6: Case Study Emotion Recognition using human face and body language, Natural Language Processing, Speech Recognition, Transformers, and Sequence to Sequence Learning, Recent trends and Applications	07

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. Deep Learning, the MIT press, 2016.
2. Bengio, Yoshua. "Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1, Now Publishers, 2009
3. Deep Learning, Rajiv Chopra, Khanna Book Publishing, Delhi 2020.

Online Resources:

1. https://nptel.ac.in/courses/106/106/106106184/
2. https://www.coursera.org/specializations/deep-learning

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Course Plan

Course Title: Information Security	
Course Code: 231AIMLPCCL306	Semester: VI
Teaching Scheme: L-T-P: 3-0-0	Credits : 3
Evaluation Scheme: ISE+MSE Marks: 20+30	ESE Marks: 50

Course Description:

The Information Security course provides a comprehensive introduction to security principles, cryptographic techniques, authentication mechanisms, and network security protocols. It covers symmetric and asymmetric encryption, key management, digital signatures, and email security standards like PGP and S/MIME. The course also explores web security, firewalls, intrusion detection systems, and cybersecurity compliance frameworks such as Zero Trust Architecture and SASE. Additionally, it introduces software security vulnerabilities like buffer overflow, SQL injection, and malware threats. Through real-world case studies, students will learn to analyze security risks and implement protective measures.

Course Objectives:

1. To study fundamental concepts of cryptography, authentication, and secure communication to protect digital information.
2. To Analyze security threats, vulnerabilities, and defense mechanisms in network, web, and system security.
3. To Apply security protocols, encryption techniques, and compliance frameworks to design and implement secure systems.

Course Outcomes (COs):

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

PCCL306.1	Explain fundamental security concepts, cryptographic techniques, and symmetric encryption models.
PCCL306.2	Apply public-key cryptographic algorithms and key management techniques for secure communication.
PCCL306.3	Apply digital signature techniques and authentication protocols for secure communication.
PCCL306.4	Demonstrate the use of email security protocols and IP security mechanisms for data protection.
PCCL306.5	Illustrate web security concepts, intrusion detection techniques, and firewall principles.

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PCCL306.6	Identify cybersecurity compliance standards, software security threats, and secure software development practices.

Prerequisite:	Computer Networks, Operating Systems, Programming Fundamentals

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCL306.1	3	2	1	-	-	-	-	-	-	-	-	-	-	2
PCCL306.2	3	3	2	2	1	-	-	-	-	2	-	-	1	3
PCCL306.3	2	3	3	2	-	-	-	-	-	-	-	-	1	3
PCCL306.4	2	3	2	3	2	-	-	-	-	-	-	-	1	3
PCCL306.5	2	2	1	2	2	-	-	-	-	-	-	-	1	3
PCCL306.6	3	3	3	2	3	-	-	-	-	-	-	-	2	3

Content	Hours
Unit 1.Introduction The OSI Security Architecture, Symmetric Cipher Models: Substitution Techniques, Transposition Techniques, Steganography, Rotor Machines, Block Cipher Principles, The Data Encryption Standard.	7
Unit 2: Principles of Public-Key Crypto systems The RSA Algorithm, Key Management, Diffie-Hellman Key Exchange, Authentication requirements, Authentication functions, MAC and Hash functions and their requirements, Mathematical examples	7
Unit 3: Digital Signature Digital Signature Standard, DSS Approach, Authentication applications - Kerberos, X.509 Authentication services	7
Unit 4: Email Security PGP, S/MIME, IP Security - IP Security Architecture, Authentication Header and Encapsulating Security Payload, formats, working	7
Unit 5: Web and System Security Secure Socket Layer and Transport Layer Security, Secure Electronic Transactions, Intruders, Intruder Detection, Password Management, Firewall Design Principles, Trusted Systems.	8

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Unit 6: Key Cyber Security Compliance and Industry Standards Introduction to GTA, Zero Trust architecture, End Point Security-Introduction, types & examples, SASE: introduction & component of SASE Software Security Software Vulnerabilities: Buffer Overflow, Salami Attack, Format string, cross-site scripting, SQL injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Root kits Introduction to Secured Software Development Life Cycle. Case Study on Software Security.	8

Text Books:

1. William Stallings, "Cryptography and Network Security", Pearson Education, (Unit I to V)
2. Bernard Menezes, "Network Security and Cryptography", Cengage Learning, (Unit –VI)

Reference Books:

1. Atul Kahate, "Cryptography and network security", TMGH.
2. Forouzan, "Cryptography and Network Security ",TMGH.
3. Joshi et. al, "Network Security Know it All", Morgan Kaufmann Publisher

Online Resources:

1. https://www.classcentral.com/course/swayam-cyber-security-13978
2. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview
3. https://www.coursera.org/browse/computer-science/algorithms

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(An Autonomous Institute) B.Tech. Curriculum

T. Y. B. Tech. CSE(Artificial Intelligence Machine Learning)

SEM-VI (Academic Year - 2025-26)

Course Plan

Course Title: Machine Learning-II Laboratory	
Course Code: 231AIMLPCCP304	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE+ MSE Marks: Not Applicable	INT : 25 POE Mark:25

Course Description:

The Advanced Machine Learning Laboratory provides hands-on experience with cutting-edge machine learning techniques, including machine learning, ensemble learning, evolutionary algorithms, and reinforcement learning. This course enables students to implement, experiment with, and analyze advanced machine learning models using Python and industry-standard libraries such as TensorFlow, Scikit-learn, and Keras.

Students will explore artificial neural networks, multilayer perceptrons, and backpropagation for complex predictive modeling. They will also work on ensemble methods like AdaBoost, Bagging, and XGBoost to enhance model performance. Additionally, students will implement genetic algorithms and reinforcement learning techniques for optimization and decision-making.

The course covers clustering and dimensionality reduction using K-Means, Hierarchical Clustering, PCA, and LDA, providing a deeper understanding of data structuring and feature selection. Real-world applications such as image classification, text mining, recommendation systems, and fraud detection are explored to bridge the gap between theory and practice.

Course Objectives:

1. To implement and analyze advanced machine learning models such as artificial neural networks, ensemble learning, and reinforcement learning using Python and industry-standard libraries.
2. To develop and optimize machine learning algorithms for real-world applications, including recommendation systems, text mining, and image processing.
3. To apply clustering and dimensionality reduction techniques to enhance model efficiency and interpretability in high-dimensional datasets.

Course Outcomes (COs):

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

PCCP304.1	Implement and analyze Artificial Neural Networks and Feed Forward Networks for various machine learning tasks.
PCCP304.2	Develop and evaluate Backpropagation and Ensemble Learning techniques such as Boosting and Bagging to improve model performance.

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PCCP304.3	Design and implement a Recommendation System and Genetic Algorithm-based model for predictive analytics.
PCCP304.4	Apply and assess Reinforcement Learning and Optimization Algorithms for decision-making applications.
PCCP304.5	Design, implement, and evaluate Image Processing and Pattern Recognition techniques for feature extraction and classification.
PCCP304.6	Analyze and develop advanced applications in Digital Forensics and Bioinformatics using machine learning methodologies.

Prerequisite:	Basic Machine Learning concepts, Algorithms, Python programming

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PCCP304.1	3	2	1	1	-	-	-	-	-	-	-	3	-	L-3
PCCP304.2	3	3	2	2	2	-	-	-	-	-	-	2	-	L-3
PCCP304.3	3	3	3	2	2	2	-	-	-	-	-	2	-	L-3
PCCP304.4	3	3	3	3	2	2	2	-	-	-	-	2	-	L-3
PCCP304.5	3	3	2	3	2	2	2	2	-	-	-	2	1	L-3
PCCP304.6	3	3	3	2	3	3	2	2	2	2	2	2	1	L-4

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List of Experiments			
Exp. No.	**Name of Experiment**	**S/O**	**Hours**
1	Implement a Perceptron model to classify linearly separable data.	S	2
2	Implement a Multilayer Perceptron (MLP) with backpropagation using Python/TensorFlow.	O	2
3	Implement a Feedforward Neural Network and analyze its performance using different activation functions.	O	2
4	Implement the Backpropagation algorithm and visualize the learning process for classification tasks.	O	2
5	Implement the AdaBoost algorithm for binary classification.	O	2
6	Implement Bagging and Random Forest classifiers and compare their performance.	O	2
7	Build a movie recommendation system using Collaborative Filtering.	O	2
8	Implement a Genetic Algorithm for solving an optimization problem.	O	2
9	Implement a Reinforcement Learning model for a simple game.	O	2
10	Implement K-Means clustering and visualize on a dataset.	O	2
10	Apply Principal Component Analysis (PCA) for dimensionality reduction.	O	2
11	Implement a Hierarchical Clustering algorithm and compare its results with K-Means.	O	2
12	Design and Implement and Analyze Text Matching using String Matching Algorithm.	O	2
13	Design , Implement and Analyze Bio informatics with example.	O	2
14	Mini-Project	O	2

S-STUDY, O-OPERATIONAL

Note: Students should implement a minimum of 12 experiments from the above list.

Text Books:

1. Machine Learning – An Algorithmic Perspective by Stephen Marsland.

Reference Books:

1. Digital Image Processing Using MATLAB
2. Principles of Digital Image Processing, Core Algorithms Wilhelm

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3. Fundamentals of Digital Image Processing by Sanjay Sharma
4. Machine Learning by Tom M. Mitchell, International Edition 1997, McGraw Hill Education

Online Resources:

1. https://www.coursera.org/courses?query=image%20processing
2. https://onlinecourses.nptel.ac.in/noc19_ee55/preview
3. https://www.superdatascience.com/pages

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Course Plan

Course Title: Deep Learning Laboratory	
Course Code: 231AIMLPCCP305	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE+ MSE Marks: Not Applicable	INT:25 POE Mark:25

Course Description:

The Deep Learning Laboratory course provides hands-on experience in implementing and optimizing deep learning models using TensorFlow and Keras. Students will explore fundamental concepts such as data manipulation, preprocessing, and tensor operations, followed by the implementation of various neural network architectures, including fully connected networks (FCNN), convolutional neural networks (CNNs), and recurrent neural networks (RNNs).

Through case studies on real-world datasets like MNIST, CIFAR-10, and ImageNet, students will develop expertise in image classification, feature extraction, and sequence modeling. Additionally, the course covers the use of pre-trained networks, data augmentation, and optimization techniques to improve deep learning model performance.

Course Objectives:

1. To study fundamental deep learning concepts using TensorFlow and Keras, including data manipulation, tensor operations, and matrix arithmetic.
2. To develop and train various neural network architectures such as fully connected networks (FCNNs), convolutional neural networks (CNNs), and recurrent neural networks (RNNs) for real-world applications.
3. To analyze the performance of deep learning models through case studies on image classification, sequence modeling, and pre-trained networks to optimize model accuracy and efficiency.

Course Outcomes (COs):

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

PCCP305.1	Implement fundamental deep learning operations such as tensor arithmetic, matrix multiplication, and data preprocessing using NumPy and TensorFlow.
PCCP305.2	Develop basic artificial neural networks (ANNs) by implementing McCulloch-Pitts models and forward propagation using TensorFlow and Keras.

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PCCP305.3	Train and evaluate fully connected neural networks (FCNNs) for digit classification tasks such as MNIST, understanding the impact of hidden layers.
PCCP305.4	Design and implement convolutional neural networks (CNNs) for image classification tasks, including CIFAR-10, and analyze the effect of normalization and data shuffling.
PCCP305.5	Utilize pre-trained deep learning models such as ImageNet to classify images and enhance prediction accuracy in large-scale datasets.
PCCP305.6	Implement and analyze recurrent neural networks (RNNs) for sequential data applications like image captioning and text translation.

Prerequisite:	Machine Learning -I, Machine Learning-I Laboratory

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

COs	POs												PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
PCCP305.1	3	3	2	-	2	-	-	-	2	-	-	-	-	-	2
PCCP305.2	3	3	3	-	2	-	-	-	-	-	-	-	-	-	3
PCCP305.3	2	3	2	-	2	-	-	-	1	-	-	-	2	-	3
PCCP305.4	3	2	3	-	2	-	-	-	1	-	-	-	2	-	3
PCCP305.5	3	2	3	-	2	-	-	-	1	-	-	-	2	-	3
PCCP305.6	3	2	3	-	2	-	-	-	1	-	-	-	3	-	3

Exp. No.	Experiment List	S/O	Hours
1	Installation of Tensorflow & Keras (Tensorflow (v1.0.0), TFLearn, Keras, and many other pre-installed python libraries (Numpy, pandas)	S	2
2	Data Manipulation (Numpy library) Operations Broadcasting Indexing and slicing	S	2
3	Data Preprocessing Reading the Dataset Handling Missing Data Conversion to the Tensor Format	S	2

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4	Linear Algebra Tensors Tensor arithmetic Implementing matrix multiplication	O	2
5	Implement McCulloch Pitts neural network using Tensorflow	O	2
6	Forward pass with matrix multiplication Forward pass with hidden layer (matrix multiplication) Forward pass with matrix multiplication with Keras Forward passes with hidden layer (matrix multiplication) with Keras.	O	2
7	FCNN with only one neuron and plotting FCNN with one hidden layer and plotting Case study: MNIST digit classification with and without hidden layers.	O	2
8	A simple CNN Make a train and validation dataset of images with vertical and horizontal images Defining the CNN to predict the knowledge from image classification Visualizing the learned CNN Model	O	2
9	MNIST digit classification before and after shuffling Train CNN on Original Data Train CNN on shuffled data	O	2
10	Cifar10 classification with and without normalization CNN as classification model for the Cifar10 dataset CNN as classification model for the Cifar10 dataset	O	2
11	Using a pre-trained Imagenet network to predict images into one of the 1000 Imagenet classes	O	2
12	Implementation of Simple RNN and Implementation of Deep RNN	O	2
13	Case study of RNN shapes in image Captioning Case study of RNN shapes in Text Translation	S	2
14	Implement the concept of transfer learning using pretrained models	O	2

S-STUDY, O-OPERATIONAL

Note: Students should implement a minimum of 12 experiments from the above experiment list.

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Text Books:

1. Ian Goodfellow, YoshuaBengio, Aaron Courville. Deep Learning, the MIT press, 2016
2. Bengio, Yoshua. "Learning deep architectures for AI" Foundations and trends in Machine Learning 2.1, Now Publishers, 2009.
3. Deep Learning, Rajiv Chopra, Khanna Book Publishing, Delhi 2020.

Online Resources:

1. https://nptel.ac.in/courses/106/106/106106184/
2. https://www.coursera.org/specializations/deep-learning

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Course Plan

Course Title: Exploratory Data Analysis and Interpretation	
Course Code: 231AIMLMDML302	Semester: VI
Teaching Scheme: L-T-P: 2-0-0	Credits: 2
Evaluation Scheme: ISE Marks: NA	ESE : 50

Course Description:

This course provides a comprehensive introduction to data analysis and visualization using Power BI. Students will learn how to import, clean, transform, and model data from various sources. The course covers data visualization techniques, interactive dashboards, and DAX (Data Analysis Expressions) for advanced calculations. By the end of the course, students will be able to create insightful business reports, apply analytical techniques, and share interactive dashboards using Power BI Service. The course emphasizes hands-on experience through practical exercises, real-world datasets, and case studies.

Course Objectives:

1. To study and apply data analysis techniques using Power BI to clean, transform, and model data from various sources.
2. To create and design interactive visualizations, dashboards, and reports to derive meaningful business insights.
3. To utilize DAX functions for advanced calculations, time-based analysis, and performance tracking in Power BI.

Course Outcomes (COs):

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

MDML302.1	Apply Power BI tools for importing, cleaning, and transforming data from various sources.
MDML302.2	Create data models and establish relationships between tables for better insights.
MDML302.3	Use advanced DAX functions to create custom metrics and perform time-based analysis.
MDML302.4	Create interactive dashboards and reports using Power BI to visualize business insights.
MDML302.5	Apply fundamental concepts of Power BI visualizations, including basic and advanced chart types, design principles, and interactive features.
MDML302.6	Apply DAX functions, calculated columns, and time intelligence for analysis.

Prerequisite:	Basic knowledge of databases, Excel, and data analysis concepts, Python Programming

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
MDML302.1	3	3	2	2	2	-	-	-	-	-	-	2	1	3
MDML302.2	3	3	3	3	2	-	-	-	1	-	-	2	1	4
MDML302.3	3	3	3	3	2	-	-	-	1	-	-	3	3	3
MDML302.4	3	3	3	3	3	-	-	-	1	2	-	1	1	4
MDML302.5	3	2	2	2	2	-	-	-	-	-	-	2	2	3
MDML302.6	3	3	3	3	2	-	-	-	1	-	-	1	1	3

Content	Hours
Unit 1. Introduction to Data Analysis and Power BI Importance of Data Analysis in various industries (Engineering, Business, Healthcare),Types of Data: Structured, Unstructured, Semi-structured ,Overview of Data Analysis Process: Collection, Cleaning, Exploration, and Visualization Overview of Power BI Components: Power BI Desktop, Power BI Service, Power BI Mobile, Power BI Workflow: Importing → Transforming → Visualizing → Publishing Data	5
Unit 2: Data Connectivity and Importing Data Importing data from various sources: Excel, CSV, Web, SQL Server, Cloud Services Import vs Direct Query vs Live Connection, Data Refreshing Mechanisms in Power BI Configuring Data Source Credentials and Privacy Levels	5
Unit 3: Data Transformation and Cleaning Power Query Editor, Introduction to Power Query Editor, Data Transformation Techniques: Filtering, Cleaning, Merging, Appending and Handling Missing Values, Duplicates, and Nulls, Data Shaping, Data Types, Removing Columns, Renaming Columns, Changing Data Types	5
Unit 4: Data Modeling in Power BI Data Models, Understanding Fact and Dimension Tables, Relationship Types: One-to-many, Many-to-many, Importance of Data Granularity Power BI Data Model View, Managing Relationships: Managing Primary and Foreign Keys, Normalization of Data, and Carnality of Relationships.	5

Unit 5: Visualizations in Power BI Types of Visualizations in Power Bi , basic Visualizations: Bar, Line, Pie, Table, Matrix ,Advanced Visualizations: Combo Charts, Tree maps, Waterfall, Best Practices for Visualization Design, Color Formatting, Conditional Formatting, and Interactivity, Slicers, Filters, Legends features	5
Unit 6: Using DAX for Data Analysis Basic DAX Functions: SUM, COUNT, AVERAGE, MIN, MAX ,Calculated Columns vs. Measures, Year-to-date, Quarter-to-Date, Month-to-Date Calculations, Using Date Tables in DAX	5

Exp. No.	List of Experiments	S/O	Hours
1	Importing Data from Multiple Sources	O	2
2	Clean a raw dataset by removing duplicates, handling missing values, and transforming data types using Power Query.	O	2
3	Establish relationships between multiple tables (Fact and Dimension) in a dataset to build a comprehensive data model.	O	2
4	Create different types of visualizations such as bar charts, line graphs, and pie charts to represent business data.	O	2
5	Write DAX formulas to create calculated columns and measures for sales metrics such as Year-to-Date (YTD) and Profit Margin.	O	2
6	Use DAX time intelligence functions to calculate monthly, quarterly, and yearly growth rates in a dataset.	O	2
7	Build a Power BI dashboard that includes slicers, filters, and interactive visualizations to explore business insights.	O	2
8	Use Power BI's What-If analysis feature to create scenarios and forecast future business outcomes based on historical data.	O	2
9	Publish a completed Power BI report to the Power BI Service and share it with other users, setting appropriate permissions.	O	2
10	Set up automatic data refresh for a report in Power BI Service to ensure real-time data updates.	O	2
11	Design and implement Key Performance Indicator (KPI) visuals to track business performance metrics such as sales growth or customer retention.	O	2
12	Import and integrate custom visuals from Power BI Marketplace to enhance the reporting experience and better represent data insights.	O	2

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13	Apply Power BI's built-in forecasting feature to predict future trends based on historical data, and visualize the forecast results with line charts.	O	2
14	Implement role-based security in Power BI to restrict data access based on user roles.	O	2
15	Perform sentiment analysis on textual data using Power BI and visualize the results using custom visualizations.	O	2

S-STUDY, O-OPERATIONAL

Note: Students should implement a minimum of 12 experiments from the above list.

Text Books:

1. "Power BI for the Excel Analyst" by Wynand Smit.
2. The Definitive Guide to DAX" by Marco Russo and Alberto Ferrari.
3. "Power BI: From Rookie to Rock Star" by Reza RadNoSQL for Mere Mortals-Dan Sullivan-1st Edition, Pearson Education

Reference Books:

1. "Analyzing Data with Power BI and Power Pivot for Excel" by Alberto Ferrari and Marco Russo
2. "Power BI Quick Start Guide" by Devin Knight, Adam Jorgensen, and Patrick LeBlanc.

Online Resources:

1. https://www.coursera.org/courses?query=microsoft%20power%20bi

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Professional Elective - II
Course Plan

Course Title: Soft Computing	
Course Code: 231AIMLPECL304	**Semester: VI**
Teaching Scheme: L-T-P: 3-0-0	**Credits:3**
Evaluation Scheme: ISE + MSE Marks : 20+30	**ESE Marks: 50**

Course Description:

This course introduces the fundamental concepts and methodologies of soft computing. It covers the core paradigms of fuzzy logic, artificial neural networks, genetic algorithms, and hybrid systems. Through both theoretical lectures and hands-on lab sessions (using Python and MATLAB Fuzzy Toolbox), students will learn to model, analyze, and solve real-world problems where conventional hard computing approaches fall short. The course emphasizes practical applications across domains such as control systems, pattern recognition, optimization, and data analysis.

Course Objectives:

1. To study the basic principles and differences between soft computing and traditional hard computing techniques.
2. To explore the mathematical and logical foundations of fuzzy logic, neural networks, and genetic algorithms.
3. To develop practical skills to implement soft computing models using programming tools like Python and MATLAB.
4. To apply soft computing techniques to design, simulate, and solve complex, real-world problems.
5. To evaluate the effectiveness and limitations of different soft computing methods in various application areas.

Course Outcomes (COs):

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

PECL304.1	Explain the core concepts of soft computing and its components, including fuzzy logic, neural networks, and evolutionary algorithms.
PECL304.2	Develop and implement fuzzy inference systems using the MATLAB Fuzzy Toolbox.
PECL304.3	Design, train, and evaluate artificial neural network models for classification, regression, and pattern recognition tasks using Python.
PECL304.4	Formulate and solve optimization problems using genetic algorithms and other

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	evolutionary techniques.
PECL304.5	Formulate and solve optimization problems using swarm intelligence algorithms and other evolutionary techniques.
PECL304.6	Critically assess the advantages, challenges, and limitations of various soft computing methods and their suitability for specific applications.

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

COs	POs												PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
PECL304.1	3	2	1	-	-	-	-	-	-	-	-	-	2	1	L-2
PECL304.2	2	3	2	2	3	-	-	-	-	-	-	-	3	2	L-2
PECL304.3	2	3	3	2	3	-	-	-	-	-	-	-	3	3	L-2
PECL304.4	3	2	3	3	2	-	-	-	-	-	-	-	3	2	L-3
PECL304.5	2	3	3	2	3	-	-	-	-	-	-	-	3	3	L-3
PECL304.6	3	2	3	3	3	2	-	-	-	-	-	-	3	3	L-3

Content	Hours
Unit 1:Introduction to Soft Computing Introduction to Soft Computing & its necessity, Difference between Hard Computing and Soft Computing, Components of Soft Computing: Fuzzy Logic, Neural Networks, and Evolutionary Algorithms, Applications of Soft Computing	7
Unit 2: Fuzzy Logic and Fuzzy Systems Fuzzy Sets and Membership Functions,Fuzzy Set Operations, Fuzzy Rules and Fuzzy Inference System (Mamdani & Sugeno), Defuzzification Techniques, Applications of Fuzzy Logic in Control Systems and Decision Making	7
Unit 3: Artificial Neural Networks (ANNs) Introduction to neural networks and deep learning, Convolutional neural networks (CNN) and recurrent neural networks (RNN), Applications in classification, regression, and pattern recognition	7
Unit 4: Introduction to Evolutionary Computing Introduction to Evolutionary Computing, Genetic Algorithm (GA): Representation, Selection, Crossover, Mutation Fitness Function and Convergence Criteria, Multi Objective Genetic Algorithm Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO)	7

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Applications of Genetic Algorithms in Optimization	
Unit 5: Swarm Intelligence and Optimization Particle Swarm Optimization (PSO): Concepts, behavior, and variations of PSO, algorithms, Ant Colony Optimization (ACO): Principles of ant colony optimization, pheromone trails, and solution construction, Bee Algorithms: Introduction to bee-inspired optimization algorithms, such as the artificial bee colony algorithm	7
Unit 6: Emerging Nature Inspired Soft Computing Research Emerging Nature Inspired Soft Computing research,Overview of artificial immune systems (AIS), Cellular Automata, DNA Computing Motivation, DNA Molecule, Adleman's experiment, Test tube programming language, Universal DNA Computers, Scope of DNA Computing.	7

Text Books:

1. D. K. Pratihar, Soft Computing, Narosa Publishing House, 2008.
2. S. Haykin, Neural Networks: A Comprehensive Foundation, 2nd Ed, Pearson Education, 1999.
3. G. Chen and T. T. Pham, Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems, CRC Press, 2001.

Reference Books

1. P. M. Dixit, U. S. Dixit, Modeling of metal forming and machining processes: by finite element and soft computing methods, 1st Ed, Springer-Verlag, 2008.
2. K. Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2006.
3. R. A. Aliev, R. R. Aliev, Soft Computing and its Applications, World Scientific Publishing Co. Pte. Ltd., 2001.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs54/preview
2. https://youtu.be/Op62ju1sOrQ?si=3O7PhRXHG8GCCLkb: Optimization by Prof Kalyanmoy Deb

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Course Plan

Course Title: Advanced Data Structures	
Course Code:231AIMLPECL305	**Semester :VI**
Teaching Scheme: L-T-P: 3-0-0	**Credits: 3**
Evaluation Scheme: ISE + MSE marks: 20+30	**ESE Marks: 50**

Course Description:

This course provides an in-depth understanding of advanced data structures and their applications in computational problem-solving. It covers hashing techniques for efficient data retrieval, priority queues for optimized task scheduling, and trees like AVL, B-Trees, and Red-Black trees for hierarchical data management. Students will explore graph algorithms for shortest path computation and topological sorting, along with disjoint set operations for efficient union-find operations. Additionally, the course includes string matching algorithms for text processing and pattern recognition. Through practical implementation and analysis, students will develop skills to design efficient and optimized algorithms for real-world applications.

Course Objectives:

1. To study and implement advanced data structures such as hash tables, priority queues, trees, and graphs for efficient data management and retrieval.
2. To analyze and apply graph algorithms and disjoint set operations for solving complex computational problems.
3. To explore and implement string matching algorithms for pattern recognition and text processing applications.

Course Outcomes (COs):

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

PECL305.1	Apply hashing techniques to design efficient data retrieval mechanisms.
PECL305.2	Implement and analyze priority queues using binary heaps and binomial queues.
PECL305.3	Demonstrate various tree structures like AVL, B-Trees, and Red-Black trees for efficient data organization
PECL305.4	Implement and apply graph algorithms for shortest path and topological sorting
PECL305.5	Apply disjoint set operations and path compression techniques for efficient data structure operations
PECL305.6	Implement and analyze string matching algorithms for pattern recognition.

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Prerequisite:	Basic Data Structure concepts, OOP concepts.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL305.1	3	2	1	-	-	-	-	-	-	-	-	2	1	2
PECL305.2	3	3	2	2	-	-	-	-	-	-	-	1	2	3
PECL305.3	3	2	3	2	-	-	-	-	-	-	-	1	2	3
PECL305.4	3	3	3	3	2	-	-	-	-	-	-	1	3	3
PECL305.5	3	2	2	2	-	-	-	-	-	-	-	1	2	3
PECL305.6	3	2	2	2	-	-	-	-	-	-	-	1	2	3

Content	Hours
Unit 1: Hashing Techniques General Idea, Hash Function, Separate Chaining, Hash Tables without linked lists: Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Hash Tables in the Standard Library, Universal Hashing, Extendible Hashing.	07
Unit 2: Priority Queues Basic model of priority queue, Binary Heap: Structure Property, Heap Order Property, Basic Heap Operations: insert, delete, Percolate down, Other Heap Operations .Binomial Queues: Binomial Queue Structure, Binomial Queue Operations,	07
Unit 3: Trees AVL: Single Rotation, Double Rotation, B-Trees, Multi-way Search Trees – 2-3 Trees: Searching for an Element in a 2-3 Tree, inserting a New Element in a 2-3 Tree, Deleting an Element from a 2-3 Tree. Red-Black Trees– Properties of red-black trees, Rotations, Insertion, Deletion	08
Unit 4: Graphs Algorithms Elementary Graph Algorithms: Single Source Shortest Path Algorithms: Dijkstra's, Bellman-Ford, All-Pairs Shortest Paths: Floyd-Warshall's Algorithm	08

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Unit 5: Disjoint Set Class Equivalence relation, Basic Data Structure, Simple Union and Find algorithms, Smart Union and Path compression algorithm.	06
Unit 6: String Matching – The naive string- matching algorithm, The Rabin-Karp algorithm, The Knuth- Morris –Pratt algorithm.	06

Text Books:

1. Data Structures and Algorithm Analysis in C++, Mark Allen Weiss, 4 th Edition, 2014 Pearson.
2. Introduction to Algorithms, Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 3rd Edition, 2009, The MIT Press.

Reference Books:

1. Advanced Data Structures, Reema Thareja, S. Rama Sree, Oxford University Press, 2018.
2. Fundamentals of Computer Algorithms, Ellis Horowitz, Satraj Sahani and Rajase kharam, 2nd Edition, 2009, University Press Pvt. Ltd.

Online Resources:

1. https://nptel.ac.in/courses/106102064
2. Easy to Advanced Data Structures (Simpliv) | MOOC List (mooc-list.com)
3. https://www.coursera.org/learn/data-structures-algorithms-4

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Course Plan

Course Title: Reinforcement Learning	
Course Code: 231AIMLPECL306	Semester: VI
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE+MSE Marks: 20+30	ESE Marks: 50

Course Description:

This course introduces the fundamentals of reinforcement learning (RL), focusing on key algorithms like UCB, Policy Gradient, and bandit algorithms. Topics include Markov Decision Processes (MDPs), Bellman Optimality, Dynamic Programming, Temporal Difference (TD) Learning, and Eligibility Traces. Advanced concepts such as function approximation, least squares methods, and hierarchical RL are also covered. By the end, students will be equipped to apply RL techniques to complex decision-making tasks and optimize strategies.

Course Objectives:

1. To provide a solid foundation in both theoretical and practical aspects of RL.
2. To cover key topics like multi-armed bandit problems, Markov Decision Processes (MDPs), and Bellman Optimality.
3. To explore Dynamic Programming, Temporal Difference methods, and Hierarchical Reinforcement Learning.

Course Outcomes (COs):

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

PECL306.1	Understand the fundamentals of Reinforcement Learning (RL)
PECL306.2	Apply bandit algorithms such as UCB and PAC to solve decision-making problems in uncertain environments.
PECL306.3	Identify and demonstrate the use of Markov Decision Processes (MDPs) and Bellman Optimality for problem-solving.
PECL306.4	Implement least squares methods (LSTD) to approximate value functions.
PECL306.5	Use dynamic programming techniques such as value iteration and policy iteration to solve RL problems.
PECL306.6	Use dynamic programming techniques such as value iteration and policy iteration to solve RL problems.

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Prerequisite:	A basic understanding of machine learning, probability theory, and linear algebra

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL306.1	3	2	1	-	-	-	-	-	-	2	-	3	2	L-2
PECL306.2	3	3	3	2	2	-	-	-	-	2	-	3	3	L-3
PECL306.3	3	3	3	3	2	-	-	-	-	2	-	3	3	L-3
PECL306.4	3	2	3	3	3	-	-	-	-	2	-	3	3	L-3
PECL306.5	3	2	3	3	3	-	-	-	-	2	-	3	3	L-3
PECL306.6	3	3	3	3	3	2	-	-	-	2	-	3	3	L3

Content	Hours
Unit 1: Overview of Reinforcement Learning (RL) Basic concepts: Agent, Environment, Actions, Rewards ,Types of learning: Supervised vs. Reinforcement Learning	07
Unit 2: Bandit Algorithms – UCB, PAC Multi-Armed Bandit Problem, Upper Confidence Bound (UCB) Algorithm ,PAC (Probably Approximately Correct), Median Elimination Algorithm, Policy Gradient Methods: Understanding and Optimizing Polic	07
Unit 3: Markov Decision Processes (MDPs) States, Actions, Rewards, and Transition Functions ,Value Functions and Bellman Equations Full Overview of Reinforcement Learning	07
Unit 4: Bellman Optimality and Dynamic Programming Bellman Equation and Optimality, Solving for Optimal Policies, Dynamic Programming: Policy Evaluation, Policy Improvement, and Value Iteration	07
Unit 5: Temporal Difference (TD) Methods and Eligibility Traces Introduction to TD Learning , Understanding Eligibility Traces, Combining Monte Carlo and TD Methods (e.g., SARSA(λ), Q(λ))	07
Unit 6: Function Approximation and Least Squares Methods Function Approximation in RL, Linear Function Approximation and Generalization, Least Squares Temporal Difference (LSTD) for Value Function Approximation	07

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Text Books:

1. R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

Reference Books:

1. Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc19_cs55/preview

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Professional Elective-III

Course Plan

Course Title: Applied AIML	
Course Code: 231AIMLPECL307	Semester: VI
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE + MSE Marks: 20+30	ESE Marks: 50

Course Description:

This course explores the real-world applications of Artificial Intelligence (AI) and Machine Learning (ML) across various domains. It covers AI integration with IoT and cloud computing, AI-based object detection and recognition, and advanced image processing techniques for healthcare and bioinformatics. The course also introduces text mining methods and their role in natural language processing. Additionally, students will explore AI applications in business, finance, and social problem-solving. Practical case studies such as handwriting detection, digital forensics, and disease prediction provide hands-on experience in applying AI & ML solutions to real-world challenges.

Course Objectives:

1. To study the integration of AI with IoT, cloud computing, and big data for real-world applications.
2. To apply AI and ML techniques for object detection, image processing, and text mining in various domains.
3. To explore AI-driven solutions in business, healthcare, and digital forensics through case studies and practical implementations.

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Course Outcomes (COs):

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

PECL307.1	Explain the integration of AI with IoT and cloud computing, including AI-based platforms and industry standards for data mining
PECL307.2	Implement AI-based object detection and recognition techniques for real-world applications such as emotion recognition and biometric systems.
PECL307.3	Apply image processing and pattern recognition techniques in healthcare and bioinformatics.
PECL307.4	Analyze various text mining techniques and their applications in natural language processing.
PECL307.5	Examine the role of AI and ML in business, finance, and social problem-solving
PECL307.6	Explain To understand the ethical considerations and societal implications of AI and ML applications

Prerequisite:	Machine Learning

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL307.1	3	2	2	1	2	-	-	-	-	-	-	2	-	L-2
PECL307.2	3	3	2	2	2	-	-	-	-	-	-	1	-	L-3
PECL307.3	3	3	2	2	3	2	-	-	-	-	-	2	-	L-3
PECL307.4	3	2	3	2	2	1	-	-	-	-	-	2	-	L-3
PECL307.5	3	3	3	2	3	2	1	-	-	-	-	2	-	L-3
PECL307.6	3	2	2	1	2	-	-	-	-	-	-	-	-	L-3

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Contents	Hours
Unit 1: AI with IoT & Cloud IOT reference model – IOT platforms – IOT verticals – Big data and IOT- Infusion of AI, industry standard for data mining – AI and IOT platforms. AI Platforms-Azure ML, Google AI, Swift AI.	07
Unit 2: AI based Object Detection & Recognition Emotion Recognition using human face, AI based system to predict diseases early, AI based biometric system.Case study on Application in Digital Forensics.	07
Unit 3: Image Processing Image Processing and Pattern Recognition, Application in Bioinformatics, Applications in healthcare,Case study on Heart/Cancer disease detection.	07
Unit 4: Text Mining Introduction to text mining, methods and techniques of text mining, Application of text mining, Linguistic aspects of natural language processing.Case study on Handwriting detection.	07
Unit 5: AIML For business Applications of Artificial Intelligence (AI) in business, ML in Social Problems handling, Application in retails and finance.	07
Unit 6: Ethical and Societal Impacts of AI/ML: To understand the ethical considerations and societal implications of AI and ML applications, including fairness, bias, transparency, and accountability in AI systems.	07

Text Books:

1. Dr. Nilakshi Jain, Artificial Intelligence: Making a System Intelligent, John Wiley &Sons.
2. Anindita Das, Artificial Intelligence & Soft Computing for Beginners, 3rd Edition-2018, Shroff Publisher
3. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, 2010, Prentice Hall of India.
4. Sunila Gollapudi, Practical Machine Learning, Packt Publishing Ltd

Reference Books:

1. Dan W. Patterson, Introduction to Artificial Intelligence, Pearson Education India, 6 January 2015.
2. Tom M. Mitchell, Machine Learning, International Edition 1997, McGraw Hill Education

Online Resources:

1. https://nptel.ac.in/courses/106/102/106102220/
2. https://onlinecourses.nptel.ac.in/noc21_ge20/preview
3. https://www.coursera.org/learn/machine-learning
4. https://nptel.ac.in/courses/106106139

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Course Plan

Course Title: Pattern Recognition	
Course Code: 231AIMLPECL308	Semester: VI
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE+MSE Marks: 20+30	ESE Marks: 50

Course Description:

This course provides a comprehensive introduction to mathematical, statistical, and computational techniques used in pattern recognition. Students will explore fundamental concepts, classification methods, feature selection, and feature extraction techniques. The course also covers advanced algorithms, including Bayesian decision theory, clustering techniques, deep learning-based recognition, and recent advancements in pattern recognition. Through practical applications and real-world datasets, students will develop skills to design and implement intelligent recognition systems.

Course Objectives:

1. To know the basics of different mathematical and statistical techniques commonly used in pattern recognition.
2. To study different pattern recognition algorithms.
3. To learn various preprocessing algorithms.
4. To introduce various algorithms for image classification.

Course Outcomes (COs):

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

PECL308.1	Explain the fundamental principles of pattern recognition, including mathematical preliminaries, classification, clustering, and Bayesian rules.
PECL308.2	Apply Bayesian decision theory, discriminant functions, parameter estimation methods, and clustering algorithms for pattern classification.
PECL308.3	Analyze different feature selection techniques, including branch and bound, sequential selection, and Cauchy Schwartz inequality.
PECL308.4	Apply and evaluate various feature extraction methods based on probabilistic separability and interclass distance criteria.
PECL308.5	Analyze different visual recognition techniques, including segmentation, high-level reasoning, and human-in-the-loop systems.
PECL308.6	Evaluate and compare recent advancements in pattern recognition, including classifier performance, data visualization, and soft computing techniques.

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Prerequisite:	Probability & Statistics

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL308.1	3	2	3	-		-	-	-	-	-	-	2	-	L-2
PECL308.2	3	3	2	2	2	-	-	-	-	-	-	2	1	L-2
PECL308.3	3	2	3	2	2	-	-	-	-	-	-	2	-	L-2
PECL308.4	3	2	3	2	2	-	-	-	-	-	-	2	1	L-3
PECL308.5	3	2	2	3	2	-	-	-	-	-	-	2	1	L-3
PECL308.6	3	2	3	2	3	-	-	-	-	-	-	2	1	L-3

Content	**Hours**
Unit 1: Introduction and mathematical Preliminaries Principles of pattern recognition: Uses, mathematics, Classification and Bayesian rules, Clustering vs classification, Basics of linear algebra and vector spaces, Eigen values and eigen vectors, Rank of matrix and SVD.	7
Unit 2: Pattern Recognition basics Bayesian decision theory, Classifiers, Discriminant functions, Decision surfaces, Parameter estimation methods, Hidden Markov models, dimension reduction methods, Fisher discriminant analysis, Principal component analysis, non-parametric techniques for density estimation, nonmetric methods for pattern classification, unsupervised learning, algorithms for clustering: K -Means, Hierarchical and other methods	7
Unit 3: Feature Selection Problem statement and uses, Branch and bound algorithm, Sequential forward and backward selection, Cauchy Schwartz inequality.	7
Unit 4: Feature Extraction Feature extraction criteria function: Probabilistic separability based and Interclass distance based, Feature Extraction: principles	7
Unit 5: Visual Recognition Sources Human visual recognition system, Recognition methods: Low-level modelling (e.g., features), Midlevel abstraction (e.g., segmentation), High-level reasoning (e.g., scene understanding); Detection/Segmentation methods; Context and scenes, Importance and	7

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saliency, Large-scale search and recognition, Egocentric vision, systems, Human-in-the-loop interactive systems, 3D scene understanding.	
Unit 6: Recent advancements in Pattern Recognition Comparison between performance of classifiers, Basics of statistics, covariance and their properties, Data condensation, feature clustering, Data visualization, Probability density estimation, Visualization and Aggregation, FCM and soft-computing techniques, Examples of real-life datasets.	7

Text Books:

1. Pattern Recognition and Machine Learning by Christopher M. Bishop, Springer, 2006.
2. O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
3. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

Reference Books:

1. Pattern Classification by Richard O. Duda , Peter E. Hart, David G. Stork, Wiley, 1973.
2. P.A Devijver and J. Kittler, Pattern Recognition: A Statistical Approach, Prentice-Hall International, Englewood Cliffs, NJ, 1980.
3. K. Fukunaga, Introduction to Statistical Pattern Recognition, 2nd Ed. Academic Press, New York, 1990.

Online Resources:

1. https://nptel.ac.in/courses/106/106/106106046/

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Course Plan

Course Title: Advanced Database Systems	
Course Code: 231AIMLPECL309	Semester: VI
Teaching Scheme: L-T-P: 3-0-0	Credits: 3
Evaluation Scheme: ISE + MSE Marks: 20+30	ESE Marks: 50

Course Description:

This course delves into advanced database systems, focusing on Parallel and Distributed Databases, Object-Relational Databases (ORDBMS), and NoSQL systems. It explores the architecture and processing techniques in distributed environments, leveraging structured and unstructured data models. Students will learn Business Intelligence and Decision Support systems, including OLAP and data warehousing, to enhance decision-making capabilities. Additionally, the course covers Data Mining and Information Retrieval techniques, equipping students with skills in pattern discovery, clustering, and indexing. It also introduces Web Mining, enabling the extraction of meaningful insights from web data.

Course Objectives:

1. To understand the architecture and processing techniques of Parallel and Distributed Databases.
2. To explore Object-Relational Databases (ORDBMS) and utilize structured data types for advanced database operations.
3. To analyze and implement NoSQL databases for handling unstructured data with high scalability.
4. To learn Business Intelligence and Decision Support techniques for effective data analysis and decision-making.
5. To apply Data Mining and Information Retrieval techniques for knowledge discovery and efficient text processing.
6. To explore Web Mining methods to extract valuable insights from web content, structure, and usage data.

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Course Outcomes (COs):

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

PECL309.1	Understand parallel and distributed databases, including query processing and commit protocols.
PECL309.2	Implement object-relational databases with structured data and inheritance.
PECL309.3	Compare NoSQL databases with RDBMS, focusing on MongoDB and case studies like Cassandra.
PECL309.4	Apply business intelligence and decision support using OLAP and tools like Power BI.
PECL309.5	Use data mining techniques and information retrieval methods like TF/IDF.
PECL309.6	Implement web mining techniques, including PageRank and HITS algorithms.

Prerequisite:	Database engineering

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECL309.1	3	-	1	-	-	-	-	-	-	-	-	-	-	L-2
PECL309.2	3	-	-	-	-	-	-	-	-	-	-	-	-	L-3
PECL309.3	2	2	2	-	-	-	-	-	-	-	-	-	2	L-4
PECL309.4	3	2	-	-	-	-	-	-	-	-	-	-	2	L-3
PECL309.5	2	2	2	-	-	-	-	-	-	-	-	-	2	L-3
PECL309.6	3	2	2	-	-	-	-	-	-	-	-	-	2	L-3

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Content	Hours
Unit 1: Parallel and Distributed Databases Parallel Systems, Parallel Database Architectures, Parallel Databases --I/O Parallelism, Design of Parallel Systems, Distributed Systems, Distributed Database Concepts, Distributed Data Storage, Distributed Transactions, Commit Protocols, Distributed Query Processing, Case Study-Distributed Databases in Oracle.	07
Unit 2: Object Relational Databases Motivating example, Structured data types, Operations on structured data, Encapsulation and ADTs, Inheritance, Objects, OIDS and Reference types, Database design for an ORDBMS, Object identity, Nested collections, Storage and access methods, Query processing and optimization, Comparison of RDBMS and ORDBMS. Case Study: Multimedia databases, spatial databases	07
Unit 3: NoSQL Database Introduction, Need, Features. Types of NoSQL Databases: Key-value store, document store, graph, wide column stores, BASE Properties, Data Consistency model, ACID Vs BASE, Comparative study of RDBMS and NoSQL. MongoDB (with syntax and usage): CRUD Operations, Indexing, Aggregation, MapReduce, Replication, Sharding Case Study: Cassandra, DynamoDB	08
Unit 4: Business Intelligence and Decision Support The Need for Data Analysis, Business Intelligence, Business Intelligence Architecture, Introduction to decision support, Data Warehousing, OLAP, Implementation Techniques for OLAP, Star Schemas, Views and decision support, View materialization, Maintaining materialized views. Case Study: Introduction to Business Intelligence tool- Power BI	08
Unit 5: Data Mining and Information Retrieval Introduction, Basic Data Mining Tasks, Data Mining Versus Knowledge Discovery in Databases, Data Mining Issues, Counting Co-occurrences, Mining for rules, Tree structured rules, Clustering: K-Means algorithm and BIRCH algorithm, Similarity search over sequences, Introduction to Information Retrieval: Vector space model, TF/IDF weighting of terms, indexing for text search	08
Unit 6: Web Mining Introduction, Web Content Mining, Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining, PageRank, HITS algorithm, Clever, Web Usage Mining, Preprocessing, Data Structures, Pattern Discovery, Pattern Analysis	07

Text Books:

1. A. Silberschatz, H.F. Korth, S. Sudarshan, "Database System Concepts", 6th Edition, McGraw Hill Education. (Unit 1)
2. Raghu Ramkrishnan, Johannes Gehrke, "Database Management System", Fourth Edition, McGraw Hill Education.(Unit 2, 4,5)

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3. Pramod J. Sadalage and Marin Fowler "NoSQL Distilled: A brief guide to merging world of Polyglot persistence", Addison Wesley, 2012. (Unit 3)
4. NoSQL for Mere Mortals- Dan Sullivan- 1st Edition, Pearson Education (Unit 3)
5. Margaret H. Dunham "Data Mining" Pearson Education (Unit 5, 6)

Reference Books:

1. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More", Emereo Pty Limited, 2011,ISBN 1743045743, 9781743045749
2. Ralph Kimball, "The Data Warehouse Lifecycle toolkit', 2nd edition, Wiley India.

Online Resources:

1. NoSQL- https://nptel.ac.in/courses/106104189

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Professional Elective – II Laboratory
Course Plan

Course Title: Soft Computing Laboratory	
Course Code: 231AIMLPECP304	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE +MSE Marks: N/A	INT Marks: 25

Course Description:

This laboratory course provides hands-on experience in soft computing techniques such as artificial neural networks, fuzzy logic, and genetic algorithms. The course emphasizes the practical implementation of algorithms and applications in real-world problems.

Course Objectives:

1. To study the fundamental concepts of soft computing techniques.
2. To implement and analyze various neural network architectures.
3. To apply fuzzy logic principles for decision-making systems.
4. To utilize genetic algorithms for optimization problems.

Course Outcomes (COs):

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

PECP304.1	Apply fundamental soft computing techniques, including artificial neural networks, fuzzy logic, and genetic algorithms.
PECP304.2	Differentiate various neural network architectures and their learning processes.
PECP304.3	Construct fuzzy logic-based systems for decision-making applications.
PECP304.4	Utilize genetic algorithms for solving optimization problems.
PECP304.5	Combine multiple soft computing techniques to address complex problems.
PECP304.6	Assess the performance of soft computing models in real-world applications.

Prerequisite:	AI, ML Basics

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

COs	POs												PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
PECP304.1	3	3	3	-	3	-	-	-	-	-	-	1	1	-	L3
PECP304.2	3	2	3	-	3	-	-	-	-	-	-	2	3	-	L3
PECP304.3	3	2	3	-	3	-	-	-	-	2	-	-	3	-	L3
PECP304.4	3	2	3	-	3	-	-	-	-	-	-	2	3	-	L3
PECP304.5	3	3	3	-	3	-	-	-	2	2	-	3	3	-	L3
PECP304.6	3	3	3	-	-	3	3	3	-	2	-	3	3	-	L3

Sr. No.	List of Experiments	S/O	Hours
1	Use MATLAB's Fuzzy Logic Toolbox to design a simple FIS. Define input variables, membership functions, and output decisions.	O	2
2	Design Fuzzy Membership Functions like triangular and trapezoidal.	O	2
3	Implement Backpropagation Algorithm in a simple neural network.	O	2
4	Implement a fuzzy system to determine washing time based on dirt level and fabric type.	O	2
5	Develop a fuzzy system to predict weather conditions based on temperature, humidity, and wind speed	O	2
6	Simulate Hopfield Network for pattern recognition.	O	2
7	Develop a Fuzzy Logic Controller for temperature control.	O	2
8	Implement a Fuzzy Inference System for risk assessment.	O	2
9	Implementation optimization using genetic algorithm.	O	2
10	Implement a rule-based fuzzy system to diagnose diseases based on patient symptoms.	O	2
11	**Case Study 1:** Genetic Algorithms in Stock Market Prediction.	S	2
12	**Case Study 2:** Using Neural Networks and Fuzzy Logic for Traffic Control.	S	2
13	**Mini Project 1:** Disease Prediction using Neural Networks.	O	2
14	**Mini Project 2:** Fuzzy Toolbox and Soft Computing Techniques for Prediction	O	2

S-STUDY, O-OPERATIONAL

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Note: Students should implement a minimum of 12 experiments from the above experiment list.

Text Books:

1. D. K. Pratihar, Soft Computing, Narosa Publishing House, 2008.
2. S. Haykin, Neural Networks: A Comprehensive Foundation, 2nd Ed, Pearson Education, 1999.
3. G. Chen and T. T. Pham, Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems, CRC Press, 2001.

Reference Books

1. P. M. Dixit, U. S. Dixit, Modeling of metal forming and machining processes: by finite element and soft computing methods, 1st Ed, Springer-Verlag, 2008.
2. K. Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice Hall, 2006.
3. R. A. Aliev, R. R. Aliev, Soft Computing and its Applications, World Scientific Publishing Co. Pte. Ltd., 2001.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs54/preview
2. https://youtu.be/Qp62ju1sOrQ?si=3O7PhRXHG8GCCLkb:Optimization by Prof Kalyanmoy Deb

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Course Plan

Course Title: Advanced Data Structures Laboratory	
Course Code: 231AIMLPECP305	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE+MSE Marks: Not Applicable	INT Marks: 25

Course Description:

This lab course provides hands-on experience with advanced data structures such as binary search trees, AVL trees, heaps, Segment Trees, and Graphs. Students will implement and analyse algorithms for efficient data manipulation, optimization, and problem-solving. Through practical experiments, they will explore applications in areas like graph traversal, range queries, and string matching, building a strong foundation in algorithmic efficiency and performance optimization.

Course Objectives:

1. To gain practical knowledge in implementing and applying advanced data structures.
2. To study underlying algorithms and performance analysis of data structures like AVL trees, heaps, tries, and segment trees.
3. To develop problem-solving skills through hands-on implementation of algorithms for real-world applications.
4. To enhance understanding of advanced topics like graph traversal, minimum spanning trees, and range queries.

Course Outcomes (COs):

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

PECP305.1	Implement fundamental tree-based data structures, including Binary Search Trees (BST), AVL Trees, Red-Black Trees, B-Trees, and Segment Trees, to efficiently store and retrieve data.
PECP305.2	Design and analyze heap-based priority queues (Min-Heap, Max-Heap, Fibonacci Heap) and use them for efficient sorting and scheduling applications.
PECP305.3	Construct and represent graph structures using adjacency matrices and adjacency lists, and implement algorithms such as Dijkstra's and Kruskal's to solve shortest path and Minimum Spanning Tree problems.
PECP305.4	Apply Union-Find algorithms with path compression and rank heuristics to solve problems in network connectivity and graph partitioning.
PECP305.5	Develop and compare advanced sorting algorithms (including inversion counting techniques) to evaluate their time complexities in different scenarios.

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PECP305.6	Implement and apply Suffix Arrays and Longest Common Prefix (LCP) Arrays for efficient string processing and pattern matching.

Prerequisite :	data structures, algorithms, complexity analysis, and programming skills in languages like C/C++ or Java.

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

COs	POs												PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
PECP305.1	3	2	3	2	2	-	-	-	-	-	-	-	-	2	3
PECP305.2	3	3	3	2	2	-	-	-	-	-	-	-	-	2	4
PECP305.3	3	3	3	3	2	-	-	-	-	-	-	-	-	3	4
PECP305.4	3	3	3	2	2	-	-	-	-	-	-	-	-	2	3
PECP305.5	3	3	3	2	2	-	-	-	-	-	-	-	-	2	4
PECP305.6	3	3	3	2	2	-	-	-	-	-	-	-	-	2	3

Sr. No.	List of Experiments	S/O	Hours
1	Implement and perform operations (insertion, deletion, traversal) on a Binary Search Tree (BST).	O	2
2	Implement an AVL tree and perform rotations to maintain balance.	O	2
3	Implement Min-Heap and Max-Heap data structures.	O	2
4	Implement graph data structures using adjacency matrix and adjacency list	O	2
5	Implement Dijkstra's algorithm to find the shortest path in a weighted graph.	O	2
6	Implement a Red-Black Tree and understand its balancing properties.	O	2
7	Implement a Tree data structure and use it for dictionary operations.	O	2
8	Implement a Segment Tree to perform range queries (sum, minimum, maximum).	O	2
9	Implement the Union-Find data structure with path compression and union by rank.	O	2
10	Implement Suffix Arrays and Longest Common Prefix (LCP) Arrays.	O	2
11	Implement a B-Tree to maintain balanced multi-level indexes.	O	2
12	Implement Kruskal's algorithm to find the Minimum Spanning Tree	O	2

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13	Implement a Fibonacci heap to perform priority queue operations efficiently.	O	2
14	Implement an algorithm to count the number of inversions in an array.	O	2
15	Implement various advanced sorting algorithms and compare their performances.	O	2

S-STUDY, O-OPERATIONAL

Note: Students should implement a minimum of 12 experiments from the above list.

Text Books:

1. "Data Structures and Algorithms in Java" by Robert Lafore
2. "Advanced Data Structures" by Peter Brass
3. "Algorithms, Part I & II" by Robert Sedgewick and Kevin Wayne

Reference Books:

1. "Data Structures and Algorithms in C++" by Adam Drozdek
2. "The Art of Computer Programming, Volume 1: Fundamental Algorithms" by Donald E. Knuth
3. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
4. "Algorithms and Data Structures" by Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman

Online Resources:

1. https://nptel.ac.in/courses/106102064
2. https://archive.nptel.ac.in/courses/106/106/106106127/

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Course Plan

Course Title: Reinforcement Learning Laboratory	
Course Code: 231AIMLPECP306	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE+ MSE Marks: Not Applicable	INT Marks: 25

Course Description:

The Reinforcement Learning (RL) Laboratory is designed to provide students with hands-on experience in implementing and experimenting with reinforcement learning algorithms. Students will explore a range of RL algorithms, including Q-learning, SARSA, policy gradients, Deep Q-Networks (DQN), and actor-critic methods. This course emphasizes the application of RL in real-world scenarios like game playing, robotics, and autonomous systems. The lab aims to give students practical skills in designing and testing RL models while also understanding theoretical concepts like exploration-exploitation trade-offs and reward-based learning.

Course Objectives:

1. To introduce students to core reinforcement learning algorithms and their applications.
2. To help students understand the exploration-exploitation dilemma and strategies to balance them.
3. To provide hands-on experience with RL methods for problem-solving in domains such as robotics and game playing..
4. To train students to evaluate and compare the performance of different RL techniques.
5. To implement and experiment with deep reinforcement learning methods for complex tasks.

Course Outcomes (COs):

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

PECP306.1	Describe reinforcement learning algorithms such as Q-learning, SARSA, and Policy Gradient for solving practical problems.
PECP306.2	Analyze and differentiate various RL algorithms and their hyperparameters to assess their effectiveness.
PECP306.3	Illustrate and model decision-making problems using Markov Decision Processes (MDPs).
PECP306.4	Implement and apply deep reinforcement learning algorithms like DQN and actor-critic models for high-dimensional problems

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PECP306.5	Demonstrate and utilize reinforcement learning techniques in real-world applications such as robotics, gaming, and autonomous systems
PECP306.6	Analyze and interpret the performance and limitations of RL models in practical scenarios.

Prerequisite:	Data structures, algorithms, probability theory, programming (Python/C++), and Machine Learning

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

COs	POs												PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
PECP306.1	3	2	3	3	2	-	-	-	-	1	-	2	3	2	1
PECP306.2	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PECP306.3	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PECP306.4	3	3	3	3	3	2	-	-	-	2	-	2	3	3	3
PECP306.5	3	3	3	3	3	2	1	-	2	2	-	2	3	3	3
PECP306.6	3	3	3	3	3	2	1	-	2	2	-	2	3	3	3

Sr. No.	List of Experiments	S/O	Hours
1	Implement Q-learning to navigate an agent from the start to the goal in a grid environment.	O	2
2	Implement the SARSA algorithm to solve the Frozen Lake environment using exploration-exploitation strategies.	O	2
3	Train a policy gradient-based agent to balance the CartPole system.	O	2
4	Implement the epsilon-greedy algorithm for solving the multi-armed bandit problem.	O	2
5	Use DQN to train an agent to play the Atari Pong game.	O	2
6	Compare the performance of epsilon-greedy and Upper Confidence Bound (UCB) in a simple environment.	O	2
7	Implement the actor-critic algorithm to control a pendulum in the continuous action space.	O	2
8	Implement Monte Carlo Tree Search to develop an optimal strategy for Tic-Tac-Toe.	O	2
9	Train a DDPG-based agent to control a robotic arm for a simple task.	O	2

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10	Use a deep neural network to approximate Q-values and solve a Grid World task with larger state and action spaces.	O	2
11	. Implement an RL agent (using Q-learning or SARSA) to solve the Frozen Lake or Tic-Tac-Toe game.	O	2
12	Design an RL experiment where an agent learns to navigate through a simulated maze or obstacle course	O	2
13	Modify an RL model implementation (e.g., adjust hyperparameters or introduce controlled errors) to observe failure modes.	O	2
14	Simulate a real-world scenario (e.g., noisy sensor data in robotics) and evaluate the robustness of an RL model under these conditions.	O	2
15	Case Study – Real-World Performance Benchmarking Analyze and interpret the performance differences between two RL algorithms (e.g., Q-learning and SARSA) in a practical application scenario.	S	2

S-STUDY, O-OPERATIONAL

Note: Students should implement a minimum of 12 experiments from the above list.

Text Books:

1. "Data Structures and Algorithms in Java" by Robert Lafore
2. "Advanced Data Structures" by Peter Brass
3. "Algorithms, Part I & II" by Robert Sedgewick and Kevin Wayne

Reference Books:

1. "Data Structures and Algorithms in C++" by Adam Drozdek
2. "The Art of Computer Programming, Volume 1: Fundamental Algorithms" by Donald E. Knuth
3. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
4. "Algorithms and Data Structures" by Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman

Online Resources:

1. https://nptel.ac.in/courses/106102064
2. https://archive.nptel.ac.in/courses/106/106/106106127/

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Professional Elective – III Laboratory
Course Plan

Course Title: Applied AIML Laboratory	
Course Code: 231AIMLPECP307	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE+MSE Marks: Not Applicable	INT Marks: 25

Course Description:

The Applications of Artificial Intelligence and Machine Learning (AIML) Laboratory course provides students with hands-on experience in designing, implementing, and evaluating AI and machine learning models. The course complements theoretical learning by offering practical sessions on key algorithms and techniques, including supervised and unsupervised learning, neural networks, and deep learning. Students will work with industry-standard tools such as TensorFlow, PyTorch, and Scikit-learn to solve real-world problems in domains like computer vision, natural language processing, and data analytics.

Course Objectives:

1. To develop professional skills that prepare them to recognize emotions using human face and body language.
2. To emphasize model development, testing, performance evaluation, and optimization, equipping students with the skills required to build and deploy machine learning models in various applications.
3. To prepare students to apply AIML concepts in industries such as healthcare, finance, robotics, and more, developing their ability to tackle complex challenges using AI-driven solutions.

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Course Outcomes (COs):

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

PECP307.1	Implement machine learning models for classification, regression, and clustering tasks using appropriate datasets and evaluation metrics.
PECP307.2	Develop AI-based applications in domains such as computer vision, natural language processing (NLP), and predictive analytics using deep learning frameworks.
PECP307.3	Integrate trained AI/ML models into web and mobile applications using Flask, React.js, and Android, ensuring seamless deployment and real-world applicability.
PECP307.4	Analyze and optimize AI/ML models by performing data preprocessing, hyperparameter tuning, and model performance evaluation using standard techniques.
PECP307.5	Apply AI techniques for automation and decision-making, developing solutions like chatbots, recommendation systems, and AI-powered analytics tools.
PECP307.6	Deploy AI models on cloud platforms or edge devices, ensuring scalability, accessibility, and efficiency in real-world AI applications.

Prerequisite:	Machine Learning

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECP307.1	3	2	3	-	-	-	-	-	-	-	-	2	-	L-2
PECP307.2	3	2	3	-	-	-	-	-	-	-	-	1	-	L-2
PECP307.3	3	3	3	-	-	-	-	-	-	-	-	2	-	L-3
PECP307.4	3	3	3	-	-	-	-	-	-	-	-	2	-	L-3
PECP307.5	3	3	3	-	-	-	-	-	-	-	-	2	-	L-3
PECP307.6	3	3	3	-	-	-	-	-	-	-	-	2	-	L-3

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Sr. No.	List of Experiments	S/O	Hours
1	Write a program to predict the user's next location.	O	2
2	Write a program to detectYouTube comments as spam or not	O	2
3	Write a program to predict the genre of a song.	O	2
4	Write a Program For Shock Front Classification	O	2
5	Write a program to develop a human face recognition system.	O	2
6	Write a Program To develop a Speech Recognition System	O	2
7	Write a program for the developer system For Email Spam And malware filtering.	O	2
8	Building and training a model for medical image diagnosis.	O	2
9	Implement path-finding algorithms for AI agents.	O	2
10	Study of virtual personal assistants.	O	2
11	Implement AI Application for Medical Diagnosis	O	2
12	Implement AI algorithms to develop intelligent robots.	O	2
13	Build a classifier to detect spam emails using NLP	O	2
14	Create a simple AI-based chatbot using NLP	O	2
15	Mini Project	O	2

S-STUDY, O-OPERATIONAL

Note: Students should implement a minimum of 12 experiments from the above list.

Text Books:

1. Dr. Nilakshi Jain, Artificial Intelligence: Making a System Intelligent, John Wiley &Sons.
2. Anindita Das, Artificial Intelligence & Soft Computing for Beginners, 3rd Edition-2018, Shroff Publisher
3. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, 2010, Prentice Hall of India.
4. Sunila Gollapudi, Practical Machine Learning, Packt Publishing Ltd

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Reference Books:

1. Dan W. Patterson, Introduction to Artificial Intelligence, Pearson Education India, 6 January2015.
2. Tom M. Mitchell, Machine Learning, International Edition 1997, McGraw Hill Education

Online Resources:

1. https://nptel.ac.in/courses/106/102/106102220/
2. https://onlinecourses.nptel.ac.in/noc21_ge20/preview
3. https://www.coursera.org/learn/machine-learning
4. https://nptel.ac.in/courses/106106139

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Kasaba Bawada, Kolhapur-416 006

Course Plan

Course Title: Pattern Recognition Laboratory	
Course Code: 231AIMLPECP308	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE+ MSE Marks: Not Applicable	INT Marks: 25

Course Description:

The Pattern Recognition Laboratory provides hands-on experience in implementing and analyzing various pattern recognition techniques using mathematical, statistical, and machine learning approaches. The course covers fundamental concepts such as dimensionality reduction, feature selection, classification, clustering, and deep learning-based recognition systems. Students will work with real-world datasets and apply advanced data visualization techniques to interpret results effectively.

This lab is designed to bridge the gap between theoretical understanding and practical implementation by engaging students in experiments that include Bayesian classification, Hidden Markov Models (HMM), Gaussian Mixture Models (GMM), Principal Component Analysis (PCA), Decision Trees, Support Vector Machines (SVM), and deep learning-based object recognition. Students will also explore clustering algorithms, feature extraction methods like Fisher Discriminant Analysis, HOG, and SIFT, and real-world applications such as biometrics, medical diagnosis, and fraud detection.

Course Objectives:

1. To implement and analyze fundamental pattern recognition techniques, including Bayesian classifiers, Hidden Markov Models (HMM), Gaussian Mixture Models (GMM), and clustering algorithms to classify and recognize patterns in real-world data.
2. To apply dimensionality reduction and feature extraction techniques such as Principal Component Analysis (PCA), Fisher Discriminant Analysis, and deep learning-based CNN models to improve classification accuracy and computational efficiency.
3. To develop real-world pattern recognition applications in areas like biometrics, handwriting recognition, medical diagnosis, and cybersecurity, while utilizing data visualization tools (Power BI, Tableau) for insightful interpretation.

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Course Outcomes (COs):

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

PECP308.1	Implement fundamental mathematical techniques such as eigenvalues, eigenvectors, SVD, covariance, and Bayesian classification for pattern recognition.
PECP308.2	Develop and apply feature selection and feature extraction methods, including PCA, Fisher Discriminant Analysis, and probabilistic separability-based techniques.
PECP308.3	Implement and compare clustering techniques such as K-Means, Hierarchical Clustering, DBSCAN, and Fuzzy C-Means for data analysis.
PECP308.4	Design and evaluate classification models using Hidden Markov Models (HMM), Gaussian Mixture Models (GMM), and deep learning-based CNN models.
PECP308.5	Develop pattern recognition applications using real-world datasets, including handwriting recognition, biometric analysis, and fraud detection.
PECP308.6	Create interactive dashboards and perform data visualization using Power BI for pattern recognition insights.

Prerequisite:	Image processing, Machine learning

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECP308.1	3	2	2	-	-	-	-	-	-	-	-	1	-	L-3
PECP308.2	3	3	2	2	-	-	-	-	-	-	-	2	-	L-3
PECP308.3	3	3	3	2	1	-	-	-	-	-	-	2	1	L-3
PECP308.4	3	3	3	2	-	-	-	-	-	-	-	2	1	L-3
PECP308.5	3	3	3	3	1	-	-	-	-	-	-	2	-	L-3
PECP308.6	3	3	3		-	-	-	-	-	-	-	2	-	L-3

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Exp. No.	List of Experiments	S/O	Hours
1	Computation of Eigenvalues and Eigenvectors – Implement the calculation of Rank of a Matrix and Singular Value Decomposition (SVD) from Scratch.	O	2
2	Bayesian Classifiers Implementation – Develop Naïve Bayes Classifier and Bayes Optimal Classifier for text classification tasks.	O	2
3	Hidden Markov Model (HMM) Implementation – Train and test an HMM using a sample dataset for speech or sequence modeling.	O	2
4	Principal Component Analysis (PCA) Implementation – Reduce dimensionality and visualize high-dimensional data.	O	2
5	Clustering Algorithms – Implement K-Means, Hierarchical Clustering, and DBSCAN to analyze data distribution.	O	2
6	Implementation of Feature Selection Algorithms – Compare Branch and Bound Algorithm, Sequential Forward Selection, and Backward Selection.	O	2
7	Feature Extraction Techniques – Implement Fisher Discriminant Analysis and Probabilistic Separability-Based Feature Extraction.	O	2
8	Implementation of Cauchy-Schwartz Inequality – Apply Vector Norms and Inequalities for feature transformation.	O	2
9	Implementation of Covariance Matrix – Calculate covariance, covariance matrix, and their properties for different datasets.	O	2
10	Implementation of Gaussian Mixture Models (GMMs) – Apply GMM for density estimation and classification.	O	2
11	Image-Based Pattern Recognition – Implement HOG (Histogram of Oriented Gradients) and SIFT (Scale-Invariant Feature Transform) for object recognition.	O	2
12	Deep Learning for Pattern Recognition – Use a pre-trained CNN model for feature extraction and classification.	O	2
13	Power BI for Data Visualization – Create an interactive dashboard and visualize classification/clustering results.	O	2
14	Implementation of Fuzzy C-Means (FCM) Algorithm – Compare FCM with K-Means clustering for pattern classification.	O	2
15	Real-World Pattern Recognition Case Study – Choose a dataset (e.g., biometrics, handwriting recognition, fraud detection) and apply pattern recognition techniques.	O	2

S-STUDY, O-OPERATIONAL

Note: Students should implement a minimum of 12 experiments from the above experiment list.

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Text Books:

1. Pattern Recognition and Machine Learning by Christopher M. Bishop, Springer, 2006.
2. O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001.
3. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

Reference Books:

1. Pattern Classification by Richard O. Duda , Peter E. Hart, David G. Stork, Wiley, 1973.
2. P.A Devijver and J. Kittler, Pattern Recognition: A Statistical Approach, Prentice-Hall International, Englewood Cliffs, NJ, 1980.
3. K. Fukunaga, Introduction to Statistical Pattern Recognition, 2nd Ed. Academic Press, New York, 1990.

Online Resources:

1. https://nptel.ac.in/courses/106/106/106106046/

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(An Autonomous Institute) B.Tech. Curriculum

T. Y. B. Tech. CSE(Artificial Intelligence Machine Learning)

SEM-VI (Academic Year - 2025-26)

Course Plan

Course Title: Advanced Database Systems Laboratory	
Course Code: 231AIMLPECP309	Semester: VI
Teaching Scheme: L-T-P: 0-0-2	Credits: 1
Evaluation Scheme: ISE + MSE Marks: Not Applicable	INT Marks: 25

Course Description:

This course explores advanced database systems, including parallel and distributed databases, Object-Relational Databases (ORDBMS), and NoSQL systems. It covers MongoDB operations, OLAP functionalities, data mining algorithms, and information retrieval techniques, equipping students with practical skills in modern data management and analytics.

Course Objectives:

1. To apply partitioning, fragmentation, and semi-join techniques in parallel and distributed databases for efficient data processing.
2. To create and operate ORDBMS with structured data types and advanced query functionalities.
3. To perform CRUD operations, aggregation, and MapReduce tasks using MongoDB.
4. To conduct OLAP operations and implement data mining algorithms like A-priori and K-means clustering.
5. To implement information retrieval techniques using vector space models, TF/IDF weighting, and inverted indexes.

Course Outcomes (COs):

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

PECP309.1	Implement partitioning and fragmentation techniques in parallel and distributed databases.
PECP309.2	Design and operate Object-Relational Databases with structured data types.
PECP309.3	Utilize NoSQL databases for CRUD operations, aggregation, and MapReduce tasks.
PECP309.4	Demonstrate OLAP operations and cube operator functionalities.
PECP309.5	Implement data mining algorithms for association and clustering.
PECP309.6	Implement information retrieval models and techniques for efficient text processing.

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
PECP309.1	3	2	2	-	-	-	-	-	-	-	-	2	-	L-3
PECP309.2	3	-	2	-	-	-	-	-	-	-	-	-	2	L-4
PECP309.3	3	2	2	-	-	-	-	-	-	-	-	-	2	L-3
PECP309.4	2	2	2	-	-	-	-	-	-	-	-	2	-	L-3
PECP309.5	3	3	2	-	-	-	-	-	-	-	-	-	2	L-4
PECP309.6	3	3	2	-	-	-	-	-	-	-	-	2	-	L-4

Sr. No.	List of Experiments	S/O	Hours
1	Implement partitioning techniques on parallel databases.	O	2
2	Implement vertical or horizontal fragmentation in distributed DBMS.	O	2
3	Implement semi join in distributed DBMS.	O	2
4	Implementation of 2 Phase Commit protocol for distributed databases.	O	2
5	Create structured data types of ORDBM Sand per form operations-create table using structured data types, insert data and solve queries.	O	2
6	Study of Open Source NOSQL Database: MongoDB (Installation, Basic CRUD operations, Execution)	O	2
7	Design and Develop MongoDB Queries using CRUD operations. (Use CRUD operations, SAVE method, logical operators)	O	2
8	Implement aggregation with suitable example using MongoDB	O	2
9	Implement Map Reduce operation with suitable example using MongoDB	O	2
10	Demonstrate all OLAP operations and cube operator in OLAP.	O	2
11	Implement A-priori algorithm in data mining.	O	2
12	Implement K-Means clustering algorithm.	O	2
13	Implement Vector space model Information Retrieval.	O	2
14	Implement TF/IDF weighting of terms for Information Retrieval.	O	2
15	Implement Inverted index.	O	2

S-Study, O-Operational

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Note: Students should implement a minimum of 12 experiments from the above experiment list.

Text Books:

1. A. Silberschatz, H.F. Korth, S. Sudarshan, "Database System Concepts", 6th Edition, Mc Graw Hill Education.
2. Raghu Ramkrishnan, Johannes Gehrke," Database Management System ", Fourth Edition, McGraw Hill Education.
3. Pramod J. Sadalage and Marin Fowler " NoSQL Distilled: A brief guide to merging world of Poly glotpe rsistence", Addison Wesley, 2012.
4. NoSQL for Mere Mortals-Dan Sullivan-1st Edition, Pearson Education
5. Margaret H. Dunham "Data Mining " Pearson Education

Reference Books:

1. Kevin Roebuck ," Storing and Managing Big Data-NoSQL, HADOOP and More ", Emereo Pty Limited, 2011,ISBN1743045743, 9781743045749
2. Ralph Kimball, " The Data Warehouse Lifecycle toolkit ',2nd edition,Wiley India.

Online Resources:

1. NoSQL-https://nptel.ac.in/courses/106104189

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Course Plan

Course Title: Application Development	
Course Code: 231AIMLVSECP301	Semester: VI
Teaching Scheme: L-T-P: 1-0-2	Credits: 2
Evaluation Scheme: ISE Marks: 25 Marks	INT Marks: 25 Marks

Course Description:

This course provides hands-on experience in developing modern web and mobile applications using industry-standard technologies. Students will explore full-stack development with the MERN stack (MongoDB, Express.js, React.js, Node.js) and learn how to build dynamic and interactive web applications. The course also introduces Angular for front-end development and covers the creation of RESTful APIs with Express.js and Node.js.

Additionally, students will learn to embed machine learning models into web applications using Flask and SQLite and perform API endpoint testing with Postman. The course further delves into Android application development, covering activity lifecycle, UI components, intents, multi-threading, and database management with SQLite.

By the end of this course, students will be able to design, develop, and deploy scalable applications for both web and mobile platforms, equipping them with essential skills for the modern software development industry.

Course Objectives:

1. To equip students with the skills to design, develop, and deploy full-stack web applications using modern frameworks such as MERN (MongoDB, Express.js, React.js, Node.js) and Angular, ensuring proficiency in front-end and back-end development.
2. To enable students to integrate machine learning models into web applications using Flask and SQLite, while mastering API development, testing, and deployment strategies for scalable solutions.
3. To provide hands-on experience in Android application development, covering UI design, activity lifecycle, multi-threading, and database management with SQLite, enabling students to build functional mobile applications.

Course Outcomes (COs):

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

VSECP301.1	Develop full-stack web applications using the MERN stack (MongoDB, Express.js, React.js, Node.js) and understand the role of each component in modern web development.

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VSECP301.2	Implement front-end applications using React.js and Angular, applying concepts such as component-based architecture, state management, routing, and form handling to build interactive user interfaces.
VSECP301.3	Design and develop RESTful APIs using Node.js and Express.js, incorporating asynchronous programming, middleware functions, and API testing with Postman.
VSECP301.4	Integrate and deploy machine learning models into web applications using Flask, SQLite for data storage, and deployment strategies for public access.
VSECP301.5	Build and deploy Android applications by implementing activity lifecycle, intents, layouts, UI components, and multi-threading, while managing databases using SQLite.
VSECP301.6	Perform API endpoint testing and debugging using Postman, ensuring secure and efficient communication between client and server applications.

Prerequisite:	Programming, Basics of HTML and CSS, Web Technology

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

COs	POs											PSOs		BTL
	1	2	3	4	5	6	7	8	9	10	11	1	2	
VSECP301.1	3	3	3	1	2	-	-	-	-	-	-	2	-	L-3
VSECP301.2	2	3	3	1	2	-	-	-	-	-	-	-	-	L-3
VSECP301.3	3	3	3	-	2	-	-	-	2	-	-	2	-	L-3
VSECP301.4	3	2	3	-	2	-	-	-	2	-	-	2	-	L-3
VSECP301.5	3	2	3	1	2	-	-	-	2	-	-	2	-	L-3
VSECP301.6	3	2	3	1	2	-	-	-	-	-	-	2	-	L-3

Contents	Hours
Unit 1: Introduction to MERN Full Stack: Introduction to modern full-stack development and the role of the MERN stack,MERN Components,Introduction to MongoDB, Express.JS, React.JS, Node.JS. Applications os MERN,Overview of TypeScript	3

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Unit 2: Basics of Angular and React JS: Angular - Web Application Architecture, MVC and MVVM design pattern, Angular architecture, Angular building blocks, Forms implementation. **React.js:** Introduction to React and its component-based architecture,JSX: JavaScript XML syntax for creating UI components,React hooks:UseState and UseEffect, etc., for managing component state and lifecycle, React Router for navigation and creating a single-page application (SPA)	3
Unit 3: Basics of Node.JS, Express.JS: **Node JS:** Introduction to Node.js and its non-blocking, event-driven architecture,Setting up a basic Node.js server, Asynchronous programming in Node.js using callbacks, promises, and async/await, integrating with Express.js. **Express.JS**: Introduction to Express.js and its role in handling HTTP requests and routing,Setting up a basic Express server,Middleware functions in Express,Creating RESTful APIs using Express	3
Unit 4: Embedding a Machine Learning Model into a Web Application Serializing fitted scikit-learn estimator, Setting up an SQLite database for data storage, Developing a web applications with Flask, Deploying the web application to a public server API Endpoint Testing with Postman: Installation, create request, import request, exporting request as code, API Endpoint Testing, Create, Modify and delete the contents, Inspecting and using header information. Overview of Stremlit.	3
Unit 5: Android Overview: Overview of Android, History, Android Versions, Android OS stack: Linux kernel, Native Libraries/DVM, Application Framework, Applications, Activity, Fragments, Process and Threads. Android Development Environment Introduction to Android SDK, Android Emulator, Creating a Project, Project Directory Structure, DDMS, Android Manifest File, Permissions. Intents and Layouts: XML, Android View Hierarchies. What Is Intent? Android Intent Messaging via Intent Objects, Types of Intents, Using Intents with Activities, Sending Intents (Telephony, SMS), Broadcast Receivers	3
Unit 6: Input Controls, Input Events, Dialogs: Input Controls, Menus, Notification and Action Bar, Android Database and App Market: Installing SQLite plugin, DbHelper, The Database Schema and Its Creation, Four Major Operations, Cursors, Example, publish app to the Android Market.	3

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List of Experiments			
Exp. No.	Name of Experiments	S/O	Hours
1	Create a web application that allows users to create, read, update, and delete data using the MERN stack.	O	2
2	Develop a task manager with user authentication where users can create and manage their tasks. Front-end will be built with React, and the back-end will handle tasks using MongoDB and Express.	O	2
3	Build a basic user authentication system that allows users to register and log in. **Tools/Technologies:** • Front-end: React.js • Back-end: Express.js, Node.js • Database: MongoDB (to store user data)	O	2
4	Create a web application that fetches and displays real-time weather data for a city entered by the user. **Tools/Technologies:** • Front-end: React.js • API: OpenWeatherMap API (or any public weather API)	O	2
5	Create a simple Testing Angular application	O	2
6	Write a program demonstrating NodeJs application	O	2
7	Create simple application using Flask	O	2
8	Write a program to create, modify, and delete the contents using Postman.	O	2
9	Deploying the web application to a public server	O	2
10	Creating a simple project and study of android project structure and installing apk on mobile device/tablet, configuring mobile device/tablet in Android Studio with developer option and running app directly on mobile device/tablet.	O	2

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11	Write a program to use different layouts.	O	2
12	Write a program to use intents for SMS and telephony.	O	2
13	Program to demonstrate Buttons, Text Fields, Checkboxes, Radio Buttons, and Toggle Buttons with their events handler.	O	2
14	Program to demonstrate Touch Mode and Menus with their events handler.	O	2
15	Implement an application that implements Multi-threading.	O	2
16	Write a program to study and use the SQLite database.	O	2

S-STUDY, O-OPERATIONAL
Note: A minimum of 12 experiments are to be performed from the above list.

Text Books:

1. Michael Bowers, DionysiosSynodinos and Victor Sumner, "Pro HTML5 and CSS3 Design Patterns", Apress edition (Unit I & II)
2. Amos Q. Haviv, "MEAN Web Development", PACKT PUBLISHING LTD (Unit III)
3. Sebastian Raschka & Vahid Mirjalili, "Python Machine Learning", Packt Publication (Unit IV)
4. Wei-Mag Lee, "Beginning Android application development", (Unit V & VI)

Reference Books:

1. Michael Bowers, DionysiosSynodinos and Victor Sumner, "Pro HTML5 and CSS3 Design Patterns", Apress edition
2. Ethan Brown, "Web Development with Node and Express", Published by O'Reilly Media
3. W. Jason Gilmore, "Learning Android by Marko Gargenta Publisher", O'Reilly Media
4. Wallace Jackson "Android Apps for Absolute Beginners",

Online Resources:

1. https://onlinecourses.swayam2.ac.in/ugc19_lb05/preview
2. https://www.udemy.com/course/machine-learning-learn-by-building-web-apps-in-python

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Course Plan

Course Title: Liberal Learning Course- I Augmented Reality (AR) and Virtual Reality (VR) Club	
Course Code: 231AIMLCCAP302	Semester: VI
Teaching Scheme: L-T-P: 2-0-0	Credits: Audit
Evaluation Scheme: ISE Marks: 50	ESE Marks: NA

Course Description:

This course provides an in-depth introduction to Augmented Reality (AR) and Virtual Reality (VR) technologies, exploring their fundamental principles, applications, and potential impact across various industries. Students will gain hands-on experience with creating AR/VR content and applications, using industry-standard software and development tools.

Course Objectives:

1. Gain Knowledge of Virtual Reality: Acquire a comprehensive understanding of the historical development and modern perspectives of virtual reality.
2. Learn Fundamentals of Sensation and Perception: Understand the basic principles of sensation, perception, and the techniques used in perceptual training.
3. Understand Technical Aspects of AR and VR: Study the scientific, technical, and engineering principles that underpin augmented and virtual reality systems.
4. Evaluate VR Design: Develop the ability to assess virtual reality systems from a design perspective.
5. Implement Augmented Reality Technology: Gain practical experience by learning and applying the technology of augmented reality.

Course Outcomes (COs):

At the end of the course, the student should be able to:

CCAP302.1	Demonstrate a comprehensive understanding of the historical development and contemporary perspectives on virtual reality.
CCAP302.2	Explain the basic principles of sensation and perception and apply techniques used in perceptual training.
CCAP302.3	Analyze and apply the scientific, technical, and engineering principles of augmented and virtual reality systems.

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CCAP302.4	Evaluate and critique virtual reality systems from a design perspective.
CCAP302.5	Implement augmented reality technology in practical scenarios, demonstrating hands-on experience and knowledge.

Prerequisite:	Discrete Mathematics, Sets, Cartesian Product and Functions

Evaluation Guidelines

- Attendance: Regular attendance in bootcamps, workshops, and club meetings focused on AR-VR technologies.
- Engagement: Active participation in discussions, Q&A sessions, and group activities related to AR-VR.
- Teamwork: Collaboration with peers on AR-VR projects and challenges.
- Technical Proficiency: Ability to operate AR-VR hardware, use relevant software (e.g., Unity, Unreal Engine, AR development kits), and troubleshoot common issues.
- Project Execution: Successful completion of assigned AR-VR projects and tasks within the given timeframe.
- Innovation: Demonstration of creativity and innovative thinking in AR-VR project design and implementation.
- Event Participation: Involvement in organizing and participating in AR-VR competitions, workshops, and awareness campaigns.
- Community Building: Contribution to building a supportive and collaborative AR-VR club environment.
- Competition Performance: Participation and performance in internal and external AR-VR competitions.
- Project Showcase: Presentation of completed AR-VR projects during club meetings or events.
- Awards and Accolades: Recognition received for outstanding work and contributions in the field of AR-VR.

Certification Levels

Beginner Level Certification:

- Attendance: Attend at least 75% of the AR-VR bootcamps and workshops.
- Project Completion: Complete a basic AR-VR project (e.g., creating a simple AR experience or VR environment).
- Concept Understanding: Demonstrate understanding of basic AR-VR concepts and basic

operation of AR-VR hardware and software.

Intermediate Level Certification:

- Project Completion: Successfully complete multiple AR-VR projects, including a complex design (e.g., an interactive VR simulation or a detailed AR application).
- Competition Participation: Participate in at least one internal AR-VR competition or challenge.
- Technical Proficiency: Show proficiency in troubleshooting and maintaining AR-VR hardware and software.

Advanced Level Certification:

- Leadership: Lead a team in a major AR-VR project or competition.
- Event Organization: Organize or contribute significantly to an AR-VR club event or workshop.
- Knowledge Sharing: Conduct a presentation or seminar on a specialized AR-VR topic. Publish a Research Article in Journal or Conference.

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Course Plan

Course Title: Liberal Learning Course- II Microsoft Developer Club	
Course Code: 231AIMLCCAP302	Semester: V
Teaching Scheme: L-T-P: 2-0-0	Credits: Audit
Evaluation Scheme: ISE Marks: 50	ESE Marks: NA

Course Description:

Microsoft Developer Club (MDC) is a distinguished global program specifically designed to empower students in their pursuit of knowledge, network expansion, and the application of technology for the betterment of their communities.

Aims:

1. Fostering a Community of Tech Enthusiasts
2. Enhancing Technical Proficiency.
3. Hosting Webinars and Microsoft Learn Challenges.
4. Technical Workshops and Training Sessions.
5. Participation in Microsoft Events and Competitions

Course Objectives:

1. Skill Growth: Enhance technical and soft skills in areas like coding, leadership, and community building.
2. Global Community: Connect with students from over 100 countries, fostering online communities and expanding influence.
3. Certifications: Receive training and earn certifications to validate expertise in various technologies.
4. Impact: Become agents of change, making a lasting impact on important projects and communities.
5. Career Boost: Boost resumes, personal growth, and online influence to kickstart careers.
6. Access to Technologies: Gain access to cutting-edge Microsoft technologies like Microsoft 365, Visual Studio Enterprise, and Azure.

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Course Outcomes (COs):

At the end of the course, the student should be able to:

CCAP302.1	Graduates will demonstrate heightened technical skills acquired through hands-on participation in coding challenges, webinars, and Microsoft Learn Challenges, providing them with a competitive edge in the job market.
CCAP302.2	Students will exhibit proficiency in organizing and hosting technical events, such as webinars, Microsoft Learn Challenges, showcasing their ability to plan and execute successful projects.
CCAP302.3	Graduates will contribute positively to the local community by leveraging their technical skills and knowledge gained through MLSA chapter involvement, fostering a culture of collaboration and making a tangible difference in the community.
CCAP302.4	Students will establish valuable connections within the tech industry, leading to mentorship opportunities, internships, and collaborative projects, thereby enhancing their career prospects and industry exposure.

Prerequisite:	Basic Knowledge of Programming

Content Unit **Microsoft Azure**	**Hours**
Unit 1:Introduction to Microsoft Azure - Cloud Computing Basics: IaaS, PaaS, SaaS - Azure Compute, Storage, Networking - Azure Portal Resource Management - Virtual Machines and Cloud Storage	**6**
Unit 2: Azure Identity and Access Management - Azure Active Directory (Azure AD) - Role-Based Access Control (RBAC) - Basic Security Measures in Azure - Compliance and Governance	**6**

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Unit 3:Azure Database Services - Azure SQL Database Overview - Basics of Azure Cosmos DB - Backup and Recovery - Managing Cloud Databases	6
Unit 4: Azure Storage and Networking - Azure Blob Storage Basics - File Storage and Access Management - Virtual Networks and Firewalls - Managing Cloud Storage Resources	6
Unit 5:Deploying Applications on Azure - Introduction to Azure App Services - Hosting Web Applications - Basics of Azure Functions & Serverless Computing - Monitoring and Management	6
Unit 6: Security and Compliance in Azure - Azure Security Center Overview - Security Policies and Data Encryption - Backup Strategies - Compliance Standards in Azure	6

Evaluation Guidelines

1. Attendance (10 marks)
2. Collaboration and Teamwork (10 marks)
3. Practical Assignments (10 marks)
4. MSE (Member Self-Evaluation) (10 marks)
5. ESE (External Stakeholder Evaluation) (10 marks)

Certification Levels

Beginner Level Certification:

- Attendance: Attend at least 75% of the Microsoft Developer bootcamps and workshops.
- Project Completion: Complete a basic Microsoft project .
- Concept Understanding: Demonstrate understanding of basic concepts and basic operation related to Microsoft hardware and software.

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Intermediate Level Certification:

- Project Completion: Successfully complete multiple Github , PowerBI projects, including a complex design .
- Competition Participation: Participate in at least one internal Microsoft Developer club competition.
- Technical Proficiency: Show proficiency in troubleshooting and maintaining Microsoft hardware and software.

Advanced Level Certification:

- Leadership: Lead a team in a major Microsoft Developer club project or competition.
- Event Organization: Organize or contribute significantly to an Microsoft Developer club event or workshop.
- Knowledge Sharing: Conduct a presentation or seminar on a specialized Microsoft Developer topic. Publish a Research Article in Journal or Conference.

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(Dr. B. A. Jitkar)
Dean Academics

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