<Course Code>	MLOps	L	T	P	C
Owning School/Department	SCSET	2	0	2	3
Pre-requisites/Exposure	Elective				

Course Outcomes (COs)

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

CO1: Understand and articulate the fundamental principles of MLOps, including the integration of machine learning models in production environments, the different frameworks used for model development, and the design of coding environments.

CO2: Acquire practical skills in software development specific to machine learning applications, including the use of YAML language, understanding of OOP paradigms in ML contexts, and deployment techniques on cloud platforms like GCP and AWS.

CO3: Comprehend and apply the principles of containerization and orchestration in machine learning, focusing on Kubernetes architecture, container management, and the deployment of ML applications using Docker.

CO4: Develop proficiency in implementing and managing microservices and REST APIs for ML deployment, encompassing the use of Kubernetes and Docker, and the creation of CI/CD pipelines using tools like Jenkins and ArgoCD.

CO5: Gain expertise in designing and building automated machine learning pipelines, covering aspects from data collection to model production readiness, and effectively utilizing automation tools like Kafka and Airflow.

Course Contents:

Unit/Module I: **7 lecture hours**

Introduction to MLOps:

Introduction to MLOPS, frameworks used by the Developers and Operations team.Statistical ML Models for Data Streams: Classifcation, Regression,Unsupervised learning, AutoML: autosklearn, TPOT, Linear and non-Linear Models: linear regression, Random Forest, SVM, kNN, k-means, logistic Regression Visualization using D3, Tableau, Machine learning model and how it works, Machine learning model as a standalone entity and in production, different frameworks for model development, how the coding environments are designed.

Module 2: **7 lecture hours**

Software Development for Machine Learning Apps: Software Development Paradigms i.e. OOP, What is YAML language?, Useful for model development, software testings, code refactoring, and model optimization. ML API Development and Deployment on GCP and AWS: lask, FastApi, Tensorfow serving, TensorFlow Extended (TFX), Tensorfow lite for optimization latency

Module 3 **7 lecture hours**

Containerizing ML application: Concepts on the orchestration of developed containers, Kubernetes and its architecture, running a pod inside Kubernetes pod, describing load balancing and scalability offered by Kubernetes.ML Deployment: Data Pipelines, Model Pipelines, Deploy Pipelines, Docker Containers, Kubernetes, FluentD, Elk Stack

Module 4 **7 lecture hours**

Microservices and REST API for ML Deployment: Call developed model through a rest API, endpoint to access the model and get its outputs. Kubernetes , Docker, Docker image is run inside the pod in the Orchestration environment, the basic commands of Kubernetes, and some new CLI tools i.e. kubectl etc. CI/CD pipelines , Core components of the CI/CD pipelines , Core components such as Jenkins, ArgoCD and Github Action, CI/CD Pipelines, Gitlab, YAML/XML, Profler. Concept of Kafka, Airflow , Using frameworks to achieve the automation of the tasks i.e. Kafka, Airflow.

List of Experiments:

1. Implement a basic machine learning model (e.g., linear regression) and deploy it on a cloud platform.
2. Containerize a machine learning model using Docker and deploy it locally or on a cloud service.
3. Deploy and manage a containerized ML model using Kubernetes, focusing on scaling and load balancing.
4. Set up a Continuous Integration and Continuous Deployment (CI/CD) pipeline for automated testing and deployment of ML models.
5. Use an AutoML framework like TPOT or Auto-sklearn for automated model selection and training.
6. Implement monitoring for a deployed ML model using tools like Prometheus or Grafana to track its performance and health.
7. Develop a data pipeline using tools like Apache Kafka or Apache Airflow to manage the flow of data in ML applications.
8. Utilize tools like MLflow or Kubeflow for hyperparameter tuning of a deployed ML model.
9. Set up and use a feature store like Feast to manage and serve features for ML models.
10. Analyze a deployed ML model for biases and ethical implications, and implement strategies to mitigate these issues.
11. Group Project

Text Books :

1. E Ameisen, Building Machine Learning Powered Applications. O'Reilly Media, 2020.
2. N Lauchande, Machine Learning Engineering with MLflow: Manage the end-to-end machine learning life cycle with MLflow. Packt Publisher,2021

Reference Books :

1. N Gift, Practical Mlops. OReilly, 2023
2. S Pote, Machine Learning in Production: Master the art of delivering robust Machine Learning solutions with MLOps. BPB Publisher, 2023

Assessment Scheme:

Components	Internal Assessment	Mid Term Exam	End Exam	Total
Weightage (%)	50	15	35	100%