राष्ट्रीय प्रौद्योगिकी संस्थान पटना / **NATIONAL INSTITUTE OF TECHNOLOGY PATNA**
(शिक्षा मंत्रालय, भारत सरकार के अधीन एक राष्ट्रीय महत्व का संस्थान / An Institute of National Importance under Ministry of Education, Gov. of India)
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*CSXX02*77: MLOps

L-T-P-Cr: 2-0-2-3

Prerequisite: Python Programming, Machine Learning, DevOps Basics

Course Objectives

This course aims to impart foundational and practical knowledge on:

- To understand the principles of MLOps and the end-to-end machine learning lifecycle, including data preparation, model development, deployment, and monitoring.
- To apply tools and techniques for data and model versioning, experiment tracking, reproducibility, and collaboration using industry-standard platforms.
- To build and automate ML pipelines using CI/CD workflows and containerization technologies, enabling scalable and reliable model deployment.
- To implement cloud-native MLOps practices for model serving, monitoring, governance, and compliance, ensuring ethical and production-ready AI systems.

Course Outcomes

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

1. Explain the lifecycle and foundational concepts of MLOps.
2. Perform data and model versioning using standard toolsDeploy models
3. Implement CI/CD workflows for ML model training and deployment.
4. Deploy and monitor ML models in production environments.
5. Develop scalable ML pipelines using cloud-based MLOps solutions.

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2			2							2	2	1
CO 2	3	3	2	2	3						1	2	3	2
CO 3	3	3	3	2	3				2	1	2	2	3	3
CO 4	2	2	3	2	3	1	1	2	3	2	2	2	3	3
CO 5	3	2	2	2	3	2	2	3	2	2	2	3	3	3

Syllabus

Unit I – Introduction to MLOps   *Lectures: 05*

MLOps Fundamentals, comparison with DevOps, ML lifecycle vs software lifecycle, Key challenges in ML operations, Overview of MLOps platforms (MLflow, Kubeflow, TFX, Metaflow, Seldon).

Unit II – Data and Model Versioning   *Lectures: 05*

Data versioning tools (DVC, LakeFS, Pachyderm), Model versioning and experiment tracking (MLflow, Weights & Biases), Introduction to Feature stores and metadata management.

Unit III – CI/CD for ML system   *Lectures: 06*

Principles of Continuous Integration and Continuous Deployment*,* CI/CD tools for ML (GitHub Actions, Jenkins), Automated testing and retraining workflows, Managing reproducibility.

Unit IV – Model Deployment & Monitoring   *Lectures: 06*

 Model packaging: Docker, requirements.txt, conda env, Deployment strategies: REST APIs, batch, streaming, Monitoring performance, drift detection, Tools: Prometheus, Grafana, Evidently, WhyLogs.

Unit V – MLOps in the Cloud   *Lectures: 06*

MLOps on AWS, Azure, GCP, ML pipeline automation using Kubeflow or Airflow, Model governance, fairness, and security, AutoML and explainability (XAI).

Textbook

1. Emmanuel Raj, *Engineering MLOps*, Packt Publishing, 2021.
2. Mark Treveil et al., *Introducing MLOps*, O'Reilly Media, 2020.
3. Noah Gift, Alfredo Deza, *Practical MLOps*, O'Reilly Media, 2021.