

Name of the Programme: MCA

Course Code: CSA-612

Title of the Course: MLOps

Number of Credits: 4 (2L+2T+0P)

Effective from AY: 2022-23

<u>Prerequisites for the course</u>	Familiarity with linear algebra, probability theory, machine learning , familiarity with python.	
<u>Objectives:</u>	This course is aimed at any one who wishes to explore deep learning from scratch. This course offers a practical hands on exploration of deep learning, avoiding mathematical notation, preferring instead to explain quantitative concepts through programming using python API	
<u>Content:</u>	Unit 1. Introduction to MLOps Rise of the Machine Learning Engineer and MLOps-What Is MLOps?-DevOps and MLOps-An MLOps Hierarchy of Needs-Implementing DevOps-Configuring-Continuous Integration with GitHub Actions-DataOps and Data Engineering-Platform Automation-MLOps	3 hours
	Unit 2. MLOps Foundations-Bash and the Linux Command Line-Cloud Shell Development Environments-Bash Shell and Commands-List Files Run CommandsFiles and Navigation-Input/Output-Configuration-Writing a Script-Cloud Computing Foundations and Building Blocks-Getting Started with Cloud Computing- minimalistic python revision- Descriptive Statistics and Normal Distributions-Optimization-Machine Learning Key Concepts-Doing Data Science-Build an MLOps Pipeline from Zero	3 hours
	Unit 3. MLOps for Containers and Edge Devices Containers-Container Runtime-Creating a Container Running a Container-Best Practices-Serving a Trained Model Over HTTP-Edge Devices-Coral Azure Percept-TFHub-Porting Over Non-TPU Models-Containers for Managed ML Systems-Containers in Monetizing MLOps-Build Once, Run Many MLOps Workflow	3 hours
	Unit 4. Continuous Delivery for Machine Learning Models-Packaging for ML Models-Infrastructure as Code for Continuous Delivery of ML Models-Using Cloud Pipelines-Controlled Rollout of Models-Testing Techniques for Model Deployment	3 hours
	Unit 5. AutoML and KaizenML-AutoML-MLOps Industrial Revolution- Kaizen Versus KaizenML-Feature Stores-Apple's Ecosystem-Apple's AutoML: Create ML-Apple's Core ML Tools orGoogle's AutoML and Edge Computer Vision or Azure's AutoMLor AWS AutoML-Open Source AutoML Solutions-Ludwig-FLAML-Model Explainability	3 hours
	Unit 6. Monitoring and Logging-Observability for Cloud MLOps- Introduction to Logging-Logging in Python-Modifying Log Levels- Logging Different Applications-Monitoring and Observability-Basics of Model Monitoring-Monitoring Drift with AWS SageMaker-Monitoring Drift with Azure ML	3 hours
	Unit 7. MLOps for AWS-Introduction to AWS-Getting Started with AWS Services-MLOps on AWS-MLOps Cookbook on AWS-CLI Tools- Flask Microservice-AWS Lambda Recipes-AWS Lambda-SAM Local- AWS Lambda-SAM Containerized Deploy-Applying AWS Machine Learning to the Real World	3 hours
	Unit 8. Machine Learning Interoperability-Why Interoperability Is Critical-ONNX: Open Neural Network Exchange-ONNX Model Zoo- Convert PyTorch into ONNX -Convert TensorFlow into ONNX-Deploy ONNX to Azure-Apple Core ML-Edge Integration	3 hours
	Unit 9: Building MLOps Command Line Tools and Microservices-	3 hours

	Python Packaging-The Requirements File-Command Line Tools-Creating a Dataset Linter Modularizing a Command Line Tool-Microservices-Creating a Serverless Function-Authenticating to Cloud Functions-Building a Cloud-Based CLI-Machine Learning CLI Workflows Unit 10. Machine Learning Engineering and MLOps Case Studies-Unlikely Benefits of Ignorance in Building Machine Learning Models-MLOps Projects at Sqor Sports Social Network-Mechanical Turk Data Labeling-Influencer Rank-Athlete intelligence (AI product)-The perfect techniques versus the real world-critical challenges in MLOps- Ethical and unintended consequences-lack of operational excellences- focus on prediction accuracy vs the big picture	3 hours
	Assignments to be done during Tutorial Slots: 1. Perfect Project Structure – Cookiecutter & readme.so 2. Speed Exploratory Data Analysis to Minutes – Pandas Profiling, SweetViz 3. Track Data Science Projects with CI, CD, CT, CM –Data Version Control (DVC) 4. Explainable AI / XAI – SHAP, LIME, SHAPASH 5. Deploy ML Projects in minutes – Docker, FastAPI 6. End to End Machine Learning – MLflow 7. Building Production Ready ML Pipelines - Model Registry, Feature Store (Feast, ButterFlow) 8. Big Data using Python, instead of PySpark – DASK 9. Build a Chatbot and Deploy it (open-source) 10. FaaS Framework implementation – Apache OpenWhisk, OpenFaas	10 * 3 = 30 hours
<u>Pedagogy:</u>	lectures/ tutorials/lab assignments/self-study	
<u>References/ Readings</u>	Main Reading :- Practical MLOps – Noah Gift and AlfredoDeza Introduction to MLOps – Noah Gift and AlfredoDeza 1 Machine Learning Engineering By Andriy Burkov 2.ML Ops: Operationalizing Data Science By David Sweenor, Dev Kannabiran, Thomas Hill, Steven Hillion, Dan Rope and Michael O’Connell-O’Reilly 3. Building Machine Learning Pipelines By Hannes Hapke, Catherine Nelson 4. Practical MLOps by Noah Gift, Alfredo Deza. O’Reilly 5. Introducing MLOps By Mark Treveil & Dataiku Team 6.Beginning MLOps with MLFlow: Deploy Models in AWS SageMaker, Google Cloud, and Microsoft Azure By Sridhar Alla, Suman Kalyan Adari, O’Reilly	
<u>Course Outcomes</u>	Students will be able to – 1. handle deployment challenges in ML projects 2. develop technical competence to deploy the ML projects.	