DEPARTMENT OF
COMPUTER
SCIENCE

FACULTY OF COMPUTING & ARTIFICIAL INTELLIGENCE

Course Guide

DevOps (IT)
2024
BSIT – VI

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Course Summary:

This course is designed as an introductory course on DevOps. The course introduces students to the concepts of infrastructure for continuous integration and continuous Delivery of IT services. The course covers the latest topics including but not limited to AWS, Maven, Dockers, Kubernetes, Jenkins, Ansible, Chef, Puppet, GitHub Actions, Tekton, and Travis. etc.

Course Objectives:

The goal of the course is to expose students to:

1. DevOps approach, practicing agile philosophy and Scrum methodology for developing and deploying cloud-native software
2. Understand application development, use APIs and libraries in Python
3. Develop application composed of microservices and deploy using containers and serverless technologies
4. Automation tools, continuous integration (CI), continuous deployment (CD) including Chef, Puppet, GitHub Actions, Tekton, and Travis.
5. Concepts of network programming and automation

Pre-requisites

Programming Fundamentals, Python, Computer Networks, Cloud Computing

Relevant Program Learning Outcome (PLO/S):

The course is designed so that students will achieve the PLO/s:
PLO1: Academic Education: To prepare graduates as computing professionals
PLO4: Design/ Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

Course Learning Outcomes:

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

1. **Understand** the principles and practices of DevOps.
2. **Explain** the designing and managing DevOps piplines to support agile and scrum methodology for cloud-native application.
3. **Identify** the automation tools for continuous integration (CI) and continuous deployment (CD).

Lab CLOs

1. **Utilize** containerization technologies like Docker and Kubernetes for building and deploying cloud-native applications.
2. **Implement** CI/CD pipelines for cloud-based deployments using platforms like AWS CodePipeline or GCP DevOps and serverless technologies.

Mapping of CLO to PLO:

Theory CLOs		
CLO	**Domain**	**PLO**
1	C2 (understand)	2
2	C2 (understand)	2
3	C3 (Apply)	4
Lab CLOs		
1	C3 (Apply)	4
2	C3 (Apply)	5

Course Outline with Week Breakdown:

Week	Contents	Activity	CLO
Week 1	**Introduction to DevOps** • DevOps Principles in detail • DevOps Engineer Skills in the market • Knowing DevOps Delivery Pipeline • Market trend of DevOps • DevOps Technical Challenges • Tools we use in DevOps		
	Understand Networking, Security and Protocols • HTTP, HTTPS, SSL and SSH • OSI Layer Model • TCP/IP and Networking Fundamentals		
	Server Administration • Apache, IIS, Tomcat, Linkerd, NGINX, Envoy, Istio and Caddy. • Reverse Proxy vs. Forward Proxy • Miniservices, Microservices architecture RESTful Microservices Using Node.js and Express	Quiz 01	
Week 2	**GIT – A Version controlling tool** • Knowing about Version control • Git – A CLI • Essentials of GIT in industry • How to setup GIT o Installing Git o First-Time Git • Setup o Getting a Git Repository • Working with various commands in GIT		
	Recording Changes to the Repository • How to check the Status of Your Files • How to track New Files • Staging our modified files • Ignoring Files from GIT • Viewing Your Unstaged and Staged Changes • How to commit Your Changes • Skipping the Staging Area and commit • Removing Files from GIT		
	Viewing the Commit History • Limiting Log Output • Using a GUI to Visualize History • Undoing Things • Changing Your Last Commit • Unstaging a Staged File • Unmodifying a Modified File		
Week 3	**Working with Remotes** • Showing Your Remotes • Adding Remote Repositories • Fetching and Pulling from Your Remotes • Pushing to Your Remotes • Inspecting a Remote • Removing and Renaming Remotes		
	Branching and Merging in Git • What a Branch Is • Basic in Branching and Merging • Branch Management in GIT • Branching Workflows and its usage • Remote Branches – create and delete o • Rebasing • **Git workflows** **Git cheat sheet**	Assignment 01 Quiz 02	
Week 4	**Docker** • Introduction • Real-world Shipping Transportation Challenges • Introducing Docker and its technology • Understanding of Docker images and containers		

	Working with container • How to Share and copy a container • Container Life Cycle • How to use Base Image and customize • Creation of Docker File • How to Publish Image on Docker Hub • **Use Docker Compose to create .net, python, php, wordpress, mysql** • How to Start Containers on a Cluster with Docker Swarm		
Week 5	**Introduction to Docker Networking** • Network Types in docker technology • Docker Container Networking • Docker Compose – An introduction • **Docker Swarm – An introduction** • Creating and Scaling an application in Docker swarm		
Week 6	**Cloud Infrastructure Components** • **Virtualization** Key concepts (VM, hypervisor) and its role in cloud infrastructure • **Compute** Understanding instances, types, and scaling practices (Vertical, Horizontal) • **Storage** Exploring various storage options (Object, Block, File) and their use cases	Assignment 02	
	• **Networking** Familiarizing with virtual networks, subnets, and security groups • **Management & Monitoring** Introducing tools for managing and monitoring cloud resources		
Week 7	**Cloud Security Considerations** • Shared responsibility model in the cloud (Provider vs. Customer responsibilities) Implementing access control mechanisms IAM, Identity, and Access Management • **Securing data in the cloud** Encryption, data residency, and compliance considerations Disaster recovery and backup strategies for cloud environments		
Week 8	**Cloud Deployment** • Different deployment models (IaaS, PaaS, SaaS) Introduction to AWS and its global infrastructure **Getting Started with AWS** • Setting up an AWS free tier account • Navigating the AWS Management Console • Understanding the AWS Global region and Availability Zone concept • Introduction to AWS billing and cost management	Quiz 03	
	Core AWS Services • Amazon EC2 (Elastic Compute Cloud): Launching virtual machines, instance types, and managing instances. • Amazon S3 (Simple Storage Service): Object storage, buckets, access control, and security.		
Week 9	**AWS Lambda** • Serverless compute service, creating and invoking functions. • Amazon SQS (Simple Queue Service): Messaging service for asynchronous communication between applications. • AWS IAM (Identity and Access Management): User roles, permissions, and access control in AWS.		
	Security and Cost Management in AWS • AWS Shared Responsibility Model • IAM best practices for secure access control • Monitoring AWS resources with Amazon CloudWatch • Optimizing costs with AWS Cost Management tools		
	Conclusion and Resources • Course Recap • AWS Certification overview • Additional learning resources and next steps		

Week 10	**Jenkins** • Essentials of Continuous Integration • An example scenario where CI is used • Know about Jenkins and its architecture in detail • Jenkins tool Management in detail • Know about User management in Jenkins	Assignment 03 Quiz 04	1
	Authentication • Jenkins own database user creation • Options to enable integration with LDA		
	Authorization • Matrix based authorization Project based authorization		
Week 11	**Overview of Maven** • Maven project structure • Maven plugins • Project Object Model (POM) – fundamental unit of work in Maven project • Maven build lifecycle o Adding external dependencies to maven pom.xml • Maven build and test project		2
	Creating jobs and automatic build settings • What is Jenkins Pipeline? • Why Pipeline? • Integration with GIT • How to enable project based authorization for a job • Source code management while creating jobs • Triggering automated build • Maven job setup • Know about post build options for jobs like notifications, trigger another build, publishing reports, etc		
	• Adding a slave node to Jenkins • Building Delivery Pipeline • Notification settings in Jenkins Plugin management in Jenkins		
Week 12	**Kubernetes** **Introduction to Containerization and Orchestration** • Explain containers and their advantages over traditional VMs. • Introduce Docker as a popular containerization platform. • Define container orchestration and its role in managing containers at scale. • Highlight the need for tools like Kubernetes.	Quiz 05	
	Demystifying Kubernetes • Introduce core Kubernetes components: Pods, Nodes, Services, Deployments. • Explain the Kubernetes cluster architecture (Master and Node).		
	• Demonstrate basic commands • Kubernetes CLI tool.		
Week 13	**Google Cloud Platform** **Introduction to GCP Environment** • GCP account and understanding billing concepts • Navigating the GCP Console and exploring available services • Familiarizing with basic GCP terminology (Project, Region, Zone, etc.)		
	Core GCP Services • Compute Engine Launching virtual machines (VMs), choosing instance types, and managing instances.		
Week 14	**Cloud Storage** • Creating and managing buckets, • Uploading/downloading objects • Access control.	Assignment 04 Quiz 06	
	• **Cloud Functions** • Introduction to serverless computing, creating and invoking simple functions. • **Cloud SQL** • Overview of managed database services on GCP.		

Week 15	**Project and Presentations**		
Week 16	**Project and Presentations Exam**		

Lab Outline:

Week	Contents	Activity	CLO
Lab 1	**Git and GitHub** • Introduction to Git and GitHub • Setting up Git and GitHub accounts • Creating a new repository • Basic Git commands (clone, add, commit, push)		
Lab 2	• Branching and Merging • Creating and switching branches • Merging branches • Resolving merge conflicts		
Lab 3	• Collaboration with GitHub • Forking and cloning repositories • Pull requests and code reviews • Collaborative workflows • Advanced Git Features • Tagging and releasing versions • Rebasing • Cherry-picking		
Lab 4	**Docker** • Installing Docker • Running containers • Docker commands (docker ps, docker run, docker stop)		
Lab 5	• Docker Images • Building Docker images • Dockerfile basics • Docker Hub and image repositories • Docker Networking • Container networking		
Lab 6	• Docker network commands • Linking containers • Docker Volumes and Data Management • Persistent data with volumes • Bind mounts • Docker volume commands		
Lab 7	**AWS** • Creating an AWS account • Navigating the AWS Management Console • Basic AWS services overview		
Lab 8	• EC2 Instances • Launching EC2 instances • Connecting to instances via SSH • Instance management (start, stop, terminate)		
Lab 10	• S3 Storage • Creating S3 buckets • Uploading and downloading objects • Bucket policies and permissions • AWS CLI and Automation • Installing and configuring AWS CLI • Scripting AWS tasks with CLI • Automating tasks with AWS Lambda and CloudWatch Events		
Lab 11	**Jenkins** • Installing Jenkins • Setting up Jenkins jobs • Building a simple pipeline		

	• Jenkins Plugins • Installing and configuring plugins • Using plugins for source code management, notifications, etc. • Customizing Jenkins pipelines		
Lab 12	• Jenkins Security • User authentication and authorization • Role-based access control • Securing Jenkins with SSL • Jenkins Integration • Integrating Jenkins with Git/GitHub • Integrating Jenkins with Docker • Integrating Jenkins with AWS services		
Lab 13	**Maping All DevOps** Casestudy 2 • Maping CI/CD with Git, Docker, Jenkins, and AWS		
Lab 14	**Maping All DevOps** Casestudy 2 • Maping CI/CD with Git, Docker, Jenkins, and AWS		
Lab 15	**Creating a GCP account** • Overview of GCP services • Accessing GCP console and Cloud Shell **Compute Engine** • Creating virtual machines with Compute Engine • Managing VM instances • SSH access and instance metadata		
Lab 16	**Cloud Storage** • Creating buckets in Cloud Storage • Uploading and downloading objects • Bucket permissions and access control		

Please note: This is a proposed schedule only and may be varied at the discretion of the instructor to give a greater or lesser degree of emphasis to particular topics.

Books / Reference Materials:

Reference Books:

- "Python for DevOps: Learn Ruthlessly Effective Automation" by Noah Gift, Kennedy Behrman, Alfredo Deza . 2020
- "Effective DevOps: Building a Culture of Collaboration" by Jennifer Davis, Ryn Daniels · 2016

Online Sources:

- IBM DevOps and Software Engineering Professional Certificate
  https://www.coursera.org/professional-certificates/devops-and-software-engineering#courses

General Grading Policy:

There will be 45 lectures (50 minutes each) during the semester. The tentative assessment's weightage are as under

Item	Assessment Task	Weightage
1.	Quizzes	12%
2.	Assignments	18%
3.	Midterm	30%
4.	Final	40%

Grading and General Course Policies:

- Assignments and/or grade percentages are subject to change.
- Quiz is usually conducted every week except the 1st week. The quiz cover contents from the last three lectures i.e. lectures delivered last week. Therefore, always keep yourself prepared for the quiz in the first lecture of the week.
- There will be no makeup quizzes / assignments
- No late assignments will be accepted.
- All assignments and projects submitted should be the outcome of individual work only. Group work is explicitly prohibited (severe penalties for violation).
- **An 'F' grade will be allotted if projects/Assignments are found copied from the internet or any other sources**