Project - Report

College Management System

Course Name: DevOps Foundation

Institution Name: Medicaps University – Datagami Skill Based Course

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Academic Year: 2026

Problem Statement & Objectives

1. **Problem Statement** –
   CI/CD for React.js College Management System app

2. **Project Objectives** –

- To design and develop a modular full-stack College Management System supporting Admin, Faculty, and Student roles.
- To implement secure authentication and role-based authorization using JWT.
- To design a normalized relational database (3NF) ensuring data integrity and consistency.
- To containerize the application using Docker for environment consistency.
- To implement a CI/CD pipeline using GitHub Actions for automated build, testing, and deployment.
- To deploy the system on AWS EC2 using Kubernetes (k3s) for orchestration and scalability.
- To ensure high availability, security, and automated rollback mechanisms.
- To demonstrate an enterprise-level DevOps workflow integrated with application architecture.

3. **Scope of the Project**-

- Full-stack web-based College Management System
- Student, Faculty, and Admin modules
- JWT-based authentication and RBAC
- Relational database schema design
- Docker containerization
- CI/CD automation using GitHub Actions
- Deployment on AWS EC2
- Kubernetes (k3s) orchestration
- Persistent volume configuration
- Secure secret management
- Automated deployment pipeline

Proposed Solution

The proposed solution is a **DevOps-enabled Full Stack College Management System** that integrates application development with infrastructure automation and container orchestration.

The system follows a layered architecture and uses CI/CD automation to transition from code commit to production deployment with minimal manual intervention.

1. Key features -

- Role-Based Access Control (Admin, Faculty, Student)
- Secure JWT Authentication
- Modular RESTful API Architecture
- Normalized Relational Database Design
- Docker Multi-Stage Containerization
- GitHub Actions CI/CD Automation
- Kubernetes (k3s) Orchestration
- Self-Healing Pods
- Rolling Updates with Zero Downtime
- Secure Secret Management
- Persistent Data Storage using Kubernetes Volumes
- Automated Build & Deployment Pipeline

2. Overall Architecture / Workflow

The CI/CD workflow follows a structured multi-stage process:

Stage 1 – Source Code Management

- Developer pushes code to Git repository.
- GitHub (or Jenkins) detects the push event.
- CI pipeline is automatically triggered.

Stage 2 – Continuous Integration

- Dependencies are installed.
- Automated unit tests are executed.
- React production build is generated.

If any test fails:

- Pipeline execution stops.
- Deployment is prevented.

If all tests pass:

- Pipeline proceeds to containerization stage.

Stage 3 – Containerization

- Docker image is built using a multi-stage Dockerfile.
- Optimized production image is generated.
- Image is tagged using version or commit hash.
- Image is pushed to Docker Hub (or private registry).

This ensures:

- Immutable artifact creation
- Environment consistency
- Easy rollback using version tags
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Stage 4 – Continuous Deployment

Upon merging code into the production branch:

- Deployment workflow is triggered.
- Kubernetes pulls the latest container image.
- Rolling update process begins.
- Old pods are gradually replaced with new pods.
- Zero downtime is maintained.

Stage 5 – Production Environment

- React CMS app is exposed via Kubernetes Service (NodePort/ClusterIP).
- Pods are monitored by Kubernetes.
- Failed pods are automatically restarted (self-healing).
- Application becomes accessible to end users.

3. Tools & Technologies Used-

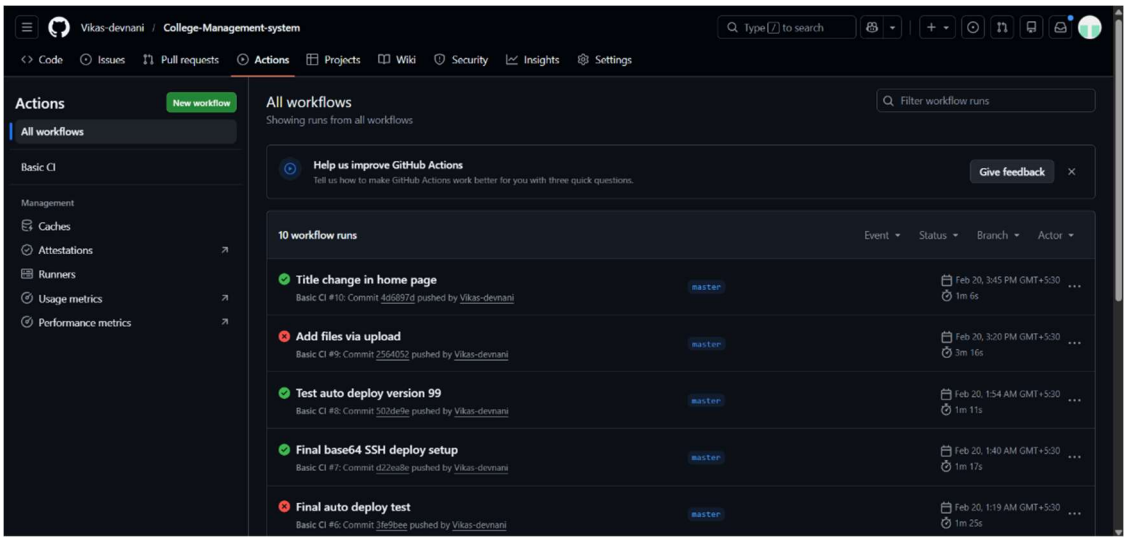
Category	Tools Used
Version Control	Git
Repository Hosting	GitHub
Frontend Framework	React.js
CI/CD Engine	GitHub Actions / Jenkins
Containerization	Docker
Container Registry	Docker Hub
Orchestration	Kubernetes (K8s)
Deployment Strategy	Rolling Update
Infrastructure	Cloud VM (AWS EC2)

Results & Output

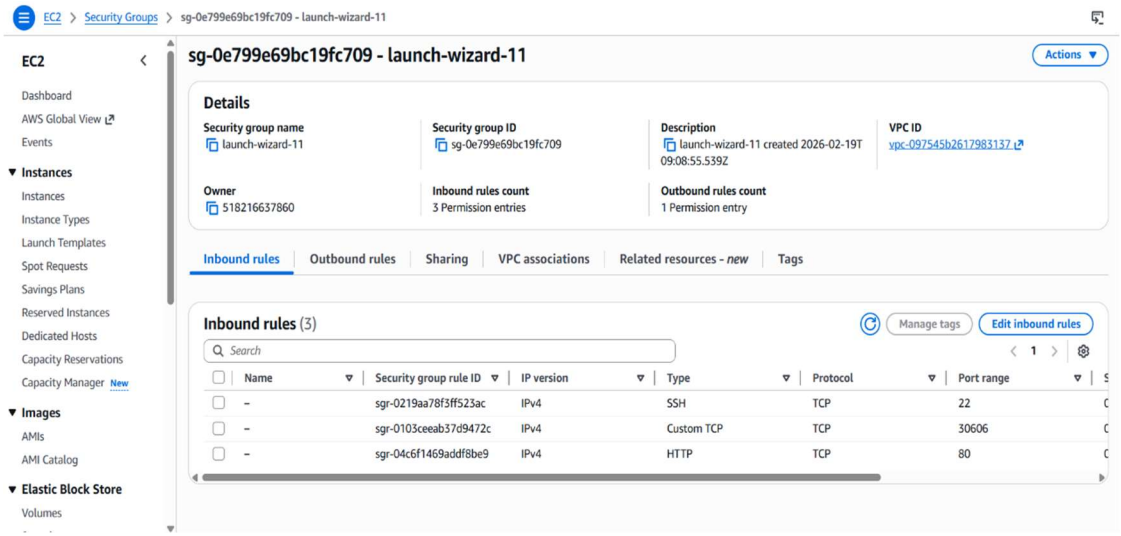
1. Screenshots / Outputs-

The following outputs were generated during project execution:

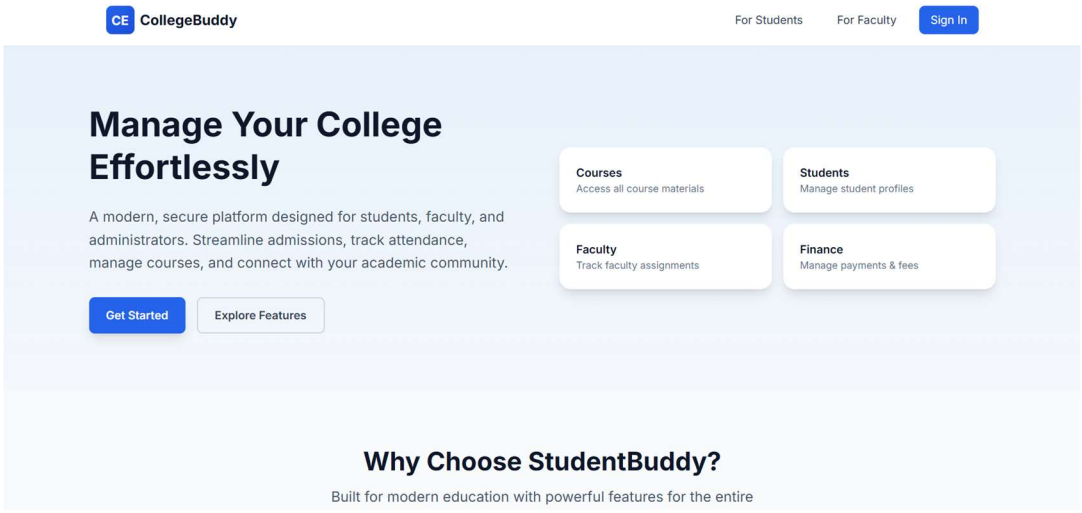
- Git commit triggering CI workflow

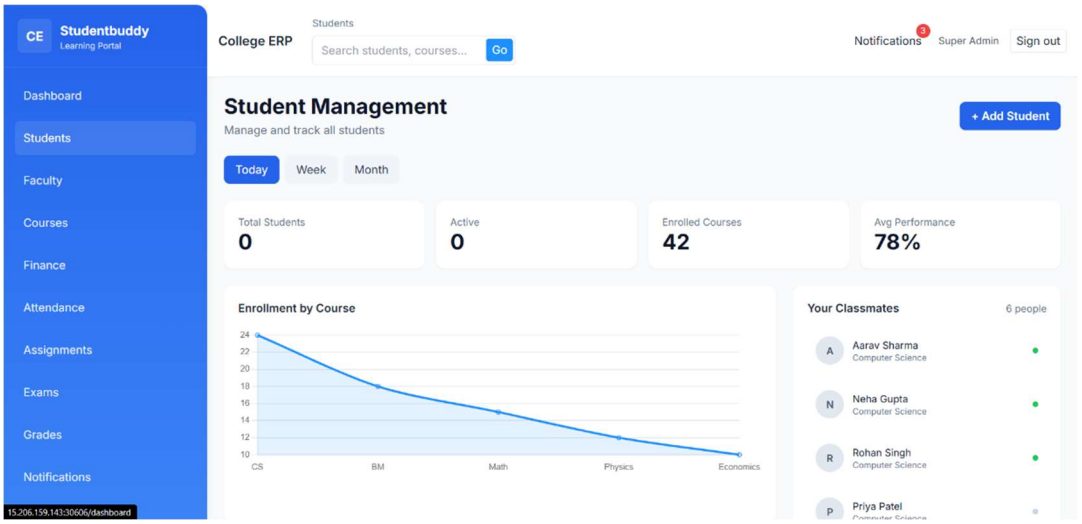


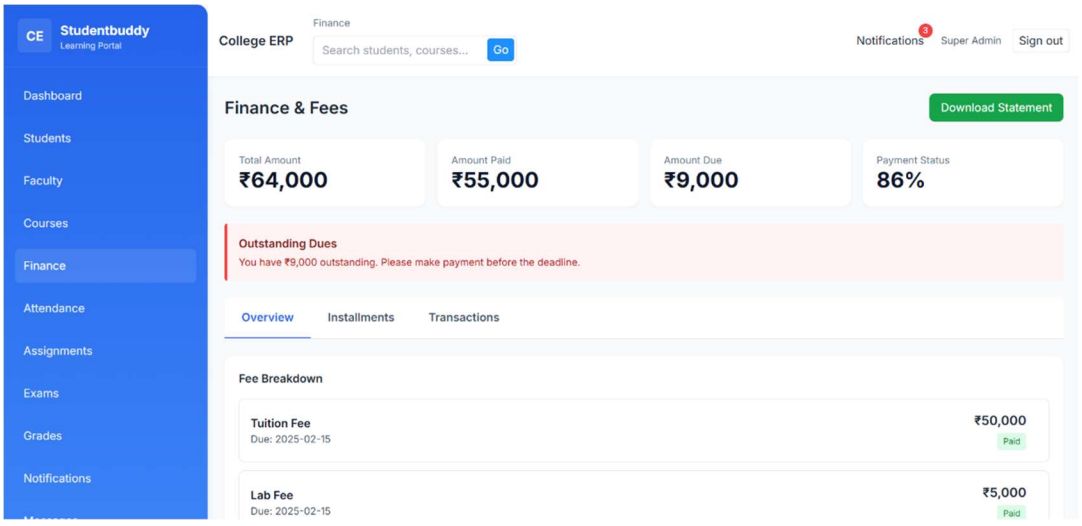
- AWS EC2 Security Group Inbound Rules Configuration



- Live React CMS application in browser







3. Key Outcomes

- Successfully automated build and deployment lifecycle.
- Reduced deployment time significantly.
- Eliminated manual deployment steps.
- Ensured consistent production environments.
- Achieved automated test validation on every commit.
- Implemented version-controlled container artifacts.
- Enabled zero-downtime rolling deployments.
- Demonstrated scalable Kubernetes-based architecture.
- Achieved enterprise-level CI/CD automation for the College Management System.

Conclusion

The project successfully implemented a professional CI/CD pipeline for the React.js College Management System application using Git, Docker, GitHub Actions, and Kubernetes.

By automating testing, build, containerization, and deployment processes, the system ensures:

- High code quality
- Faster release cycles
- Reliable and repeatable deployments
- Reduced human errors
- Scalable enterprise-grade infrastructure

This project provided hands-on experience in implementing modern DevOps practices and demonstrated how automation enhances reliability, efficiency, and scalability in real-world applications.

Future Scope & Enhancements

- Integration of Prometheus and Grafana for monitoring
- Horizontal Pod Autoscaler (HPA)
- Blue-Green deployment strategy
- Canary deployments
- Automated vulnerability scanning in CI pipeline
- Advanced logging using ELK stack
- Multi-environment staging pipelines
- Infrastructure as Code using Terraform
- Advanced security hardening