DevOps CI/CD Pipeline using Jenkins, Docker, and Kubernetes

Project Objective

Design and automate a robust CI/CD pipeline to deploy a multi-tier web application (frontend and backend) using:

1. **Jenkins** for Continuous Integration and Continuous Deployment
2. **Docker** for containerization
3. **Kubernetes** for orchestration (via **Minikube**)
4. **AWS EC2** (t2.medium) as the host environment
5. **GitHub** as the code repository

The goal is to build a reliable, production-ready DevOps workflow.

Hosting Environment

1. **Cloud Platform**: AWS EC2
2. **Instance Type**: t2.medium (2 vCPU, 4 GB RAM)
3. **Operating System**: Ubuntu 22.04 LTS
4. **Security Group Ports Opened**: 22 (SSH), 8080 (Jenkins), 30080 (Backend), 30081 (Frontend)
5. **Minikube Tunnel**: Enabled using minikube tunnel --bind-address 0.0.0.0

Tools & Technologies

Tool	Purpose
GitHub	Version Control
Docker	Containerize frontend/backend apps
Jenkins	Automate CI/CD pipeline
Kubernetes	Manage containerized workloads
Minikube	Local Kubernetes cluster
Nginx	Frontend static file server
Flask	Python backend web server

Project Structure

DevOps-CI-CD-Pipeline-Using-Jenkins-Docker-and-Kubernetes/

```
├── backend/
│   ├── Dockerfile
│   ├── app.py
│   └── requirements.txt
├── frontend/
│   ├── Dockerfile
│   └── index.html
├── k8s/
│   ├── backend-deployment.yaml
│   ├── frontend-deployment.yaml
│   └── service.yaml
├── Jenkinsfile
├── docker-compose.yml
└── README.md
```

Setup and Installation

Install Required Tools

→sudo apt update && sudo apt install -y git curl docker.io

→sudo usermod -aG docker $USER

Install Minikube:

→curl -LO https://storage.googleapis.com/minikube/releases/latest/minikube-linux-amd64

→sudo install minikube-linux-amd64 /usr/local/bin/minikube

Install kubectl:

→curl -LO "https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl"

→chmod +x kubectl && sudo mv kubectl /usr/local/bin/

Start Minikube:

→minikube start --driver=docker

→minikube tunnel --bind-address 0.0.0.0

Docker: Containerization

Backend Dockerfile

```
FROM python:3.9-slim

WORKDIR /app

COPY requirements.txt .

RUN pip install Flask==2.0.3 Werkzeug==2.0.3

COPY app.py .

EXPOSE 5000

CMD ["python", "app.py"]
```

Frontend Dockerfile

```
FROM nginx:alpine
COPY index.html /usr/share/nginx/html
EXPOSE 80
CMD ["nginx", "-g", "daemon off;"]
```

Build & Push Images

→docker build -t tpathak21/devops-backend:latest ./backend

→docker build -t tpathak21/devops-frontend:latest ./frontend

→docker push tpathak21/devops-backend:latest

→docker push tpathak21/devops-frontend:latest

Kubernetes Deployment

Backend Deployment

- **Kind**: Deployment
- **Name**: devops-backend
- **Replicas**: 2
- **Container Image**: tpathak21/devops-backend:latest
- **Container Port**: 5000
- **Label**: app: devops-backend

Purpose: Launches two backend container replicas managed by Kubernetes

Backend Service

- **Kind:** Service
- **Name:** devops-backend-service
- **Type:** NodePort
- **Selector:** app: devops-backend
- **Ports:**
  - Port: 5000
  - TargetPort: 5000
  - NodePort: 30080

Purpose: Exposes backend app outside the cluster on EC2 instance's IP:30080

Frontend Deployment

- **Kind**: Deployment
- **Name**: devops-frontend
- **Replicas**: 2
- **Container Image**: tpathak21/devops-frontend:latest
- **Container Port**: 80
- **Label**: app: devops-frontend
- **Purpose**: Launches two frontend container replicas

Frontend Service

- **Kind**: Service
- **Name**: devops-frontend-service

- **Type**: NodePort
- **Selector**: app: devops-frontend
- **Ports**:
    - **Port**: 80
    - **TargetPort**: 80
    - **NodePort**: 30081

Purpose: Exposes frontend app outside the cluster on EC2 instance's IP:30081

Apply Resources

→kubectl apply -f k8s/

→kubectl get pods -o wide

→kubectl get svc

Jenkins CI/CD Pipeline

Agent Declaration

- **Type**: any
- **Purpose**: Allows pipeline to run on any available Jenkins agent (node)

Environment Setup

- **DOCKERHUB_CREDENTIALS**:
- Secure Jenkins credentials (ID: dockerhub-creds) used for DockerHub login

Stages

Stage 1: Checkout Code from GitHub

Clones the main branch from your GitHub repository: https://github.com/TejPATHAK/DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes

Stage 2: Build Backend Docker Image

- Builds Docker image:
- **Image**: tpathak21/devops-backend:latest
- **Context**: ./backend

Stage 3: Build Frontend Docker Image

- Builds Docker image:
    - **Image**: tpathak21/devops-frontend:latest
    - **Context**: ./frontend

Stage 4: Login to DockerHub

- Authenticates Jenkins with DockerHub using securely stored credentials
- **Stage 5:** Push Docker Images
- Pushes both frontend and backend images to DockerHub:
    - tpathak21/devops-backend:latest
    - tpathak21/devops-frontend:latest

Stage 6: Deploy to Kubernetes

- Uses kubectl to apply manifests for:
    - **Backend Deployment**
    - **Frontend Deployment**
    - **NodePort Services**
- Uses the Kubeconfig file located at: /var/lib/jenkins/.kube/config

End Result

- Fully automated CI/CD pipeline from GitHub to DockerHub to a live Kubernetes cluster
- Runs seamlessly inside an AWS EC2 instance with Jenkins managing every stage

Output Validation

curl Test

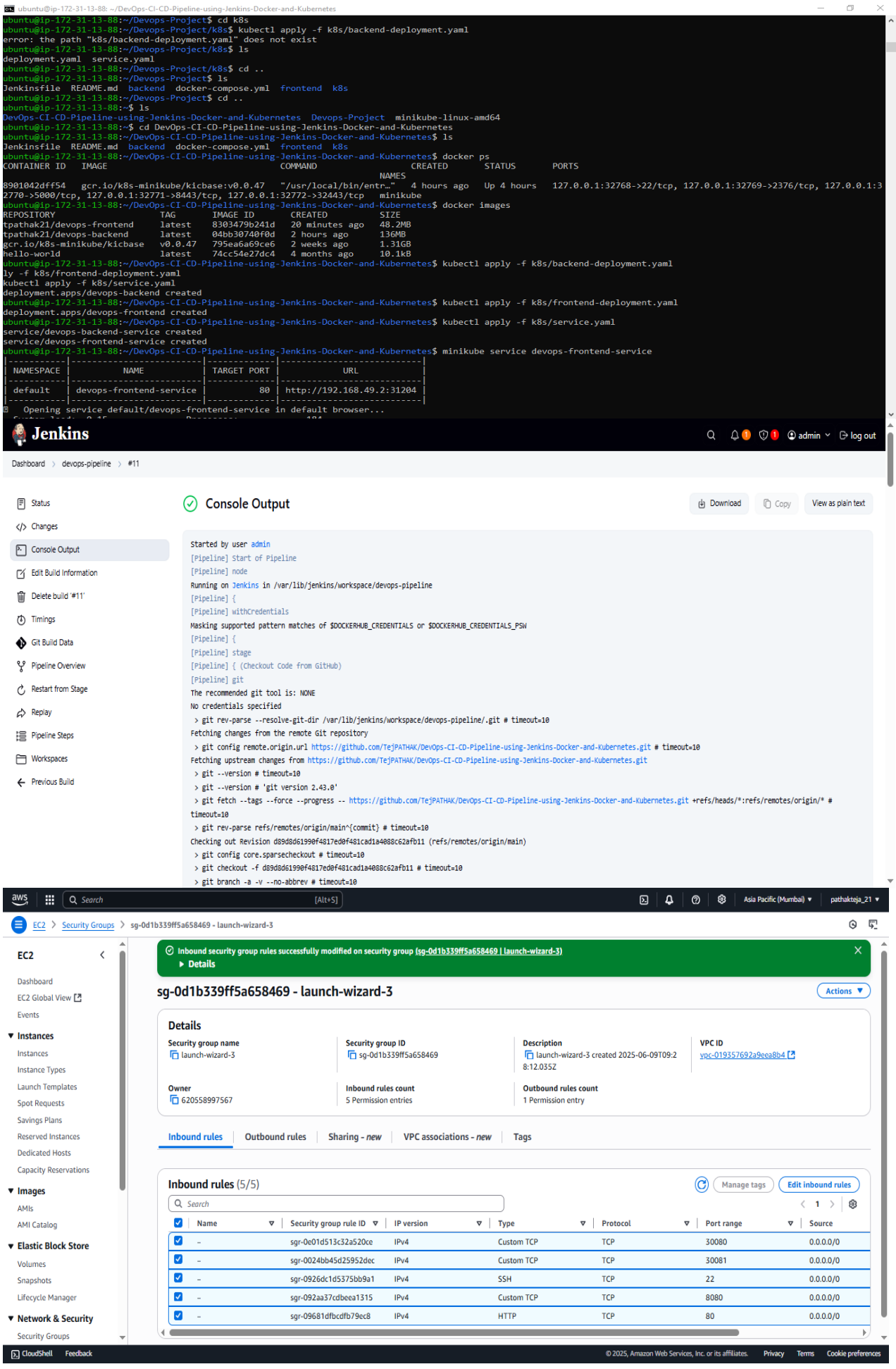
→curl http://<EC2-PUBLIC-IP>:30080 # Backend

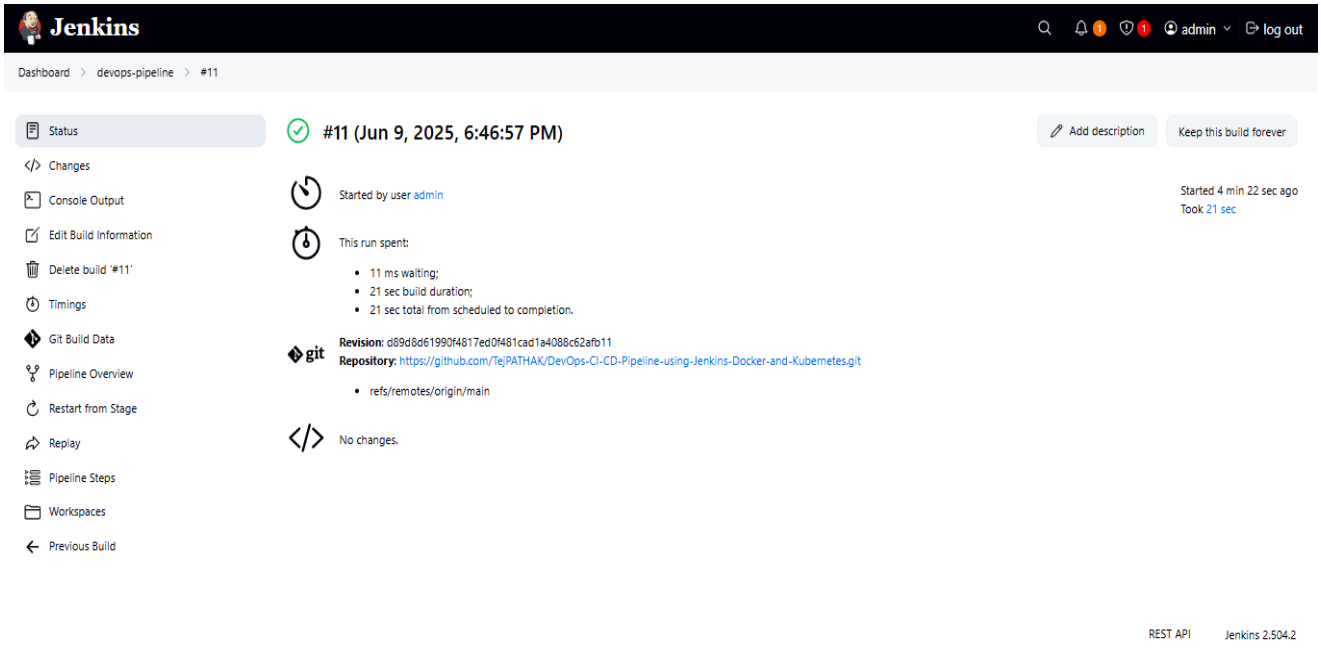
→curl http://<EC2-PUBLIC-IP>:30081 # Frontends

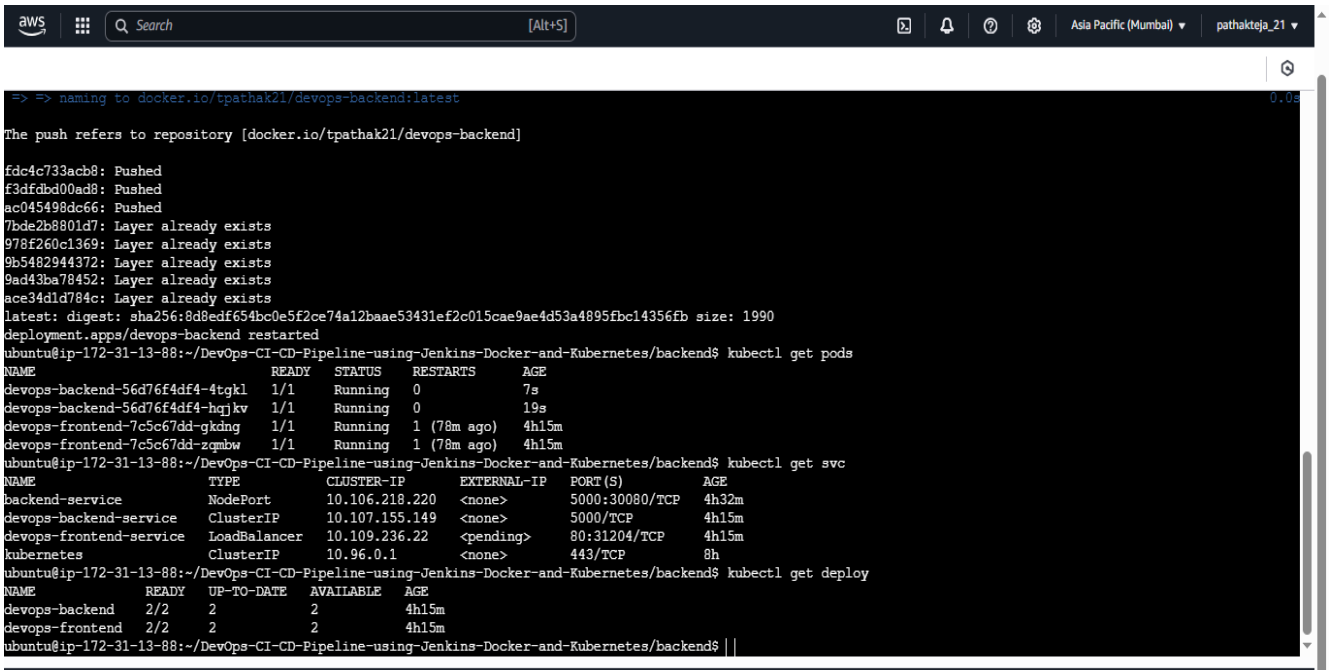
Jenkins Pipeline

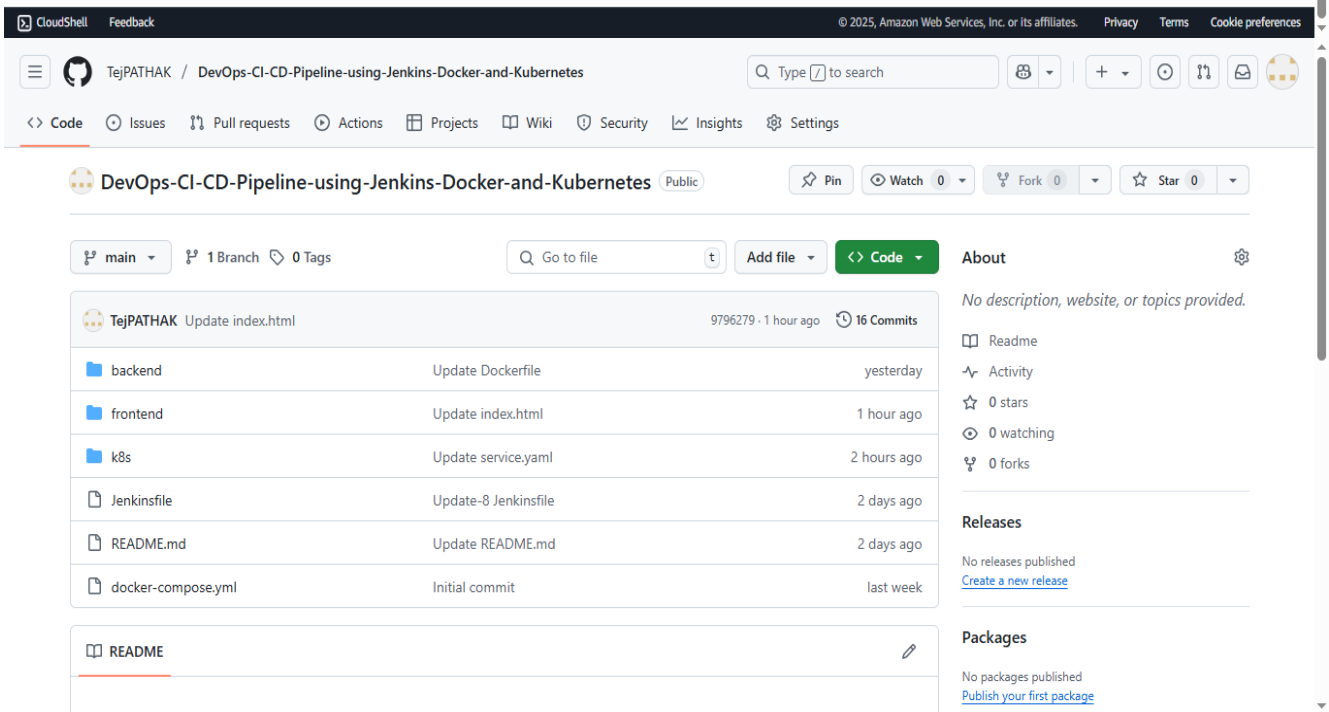
All stages: Clone > Build > Push > Deploy should show as green

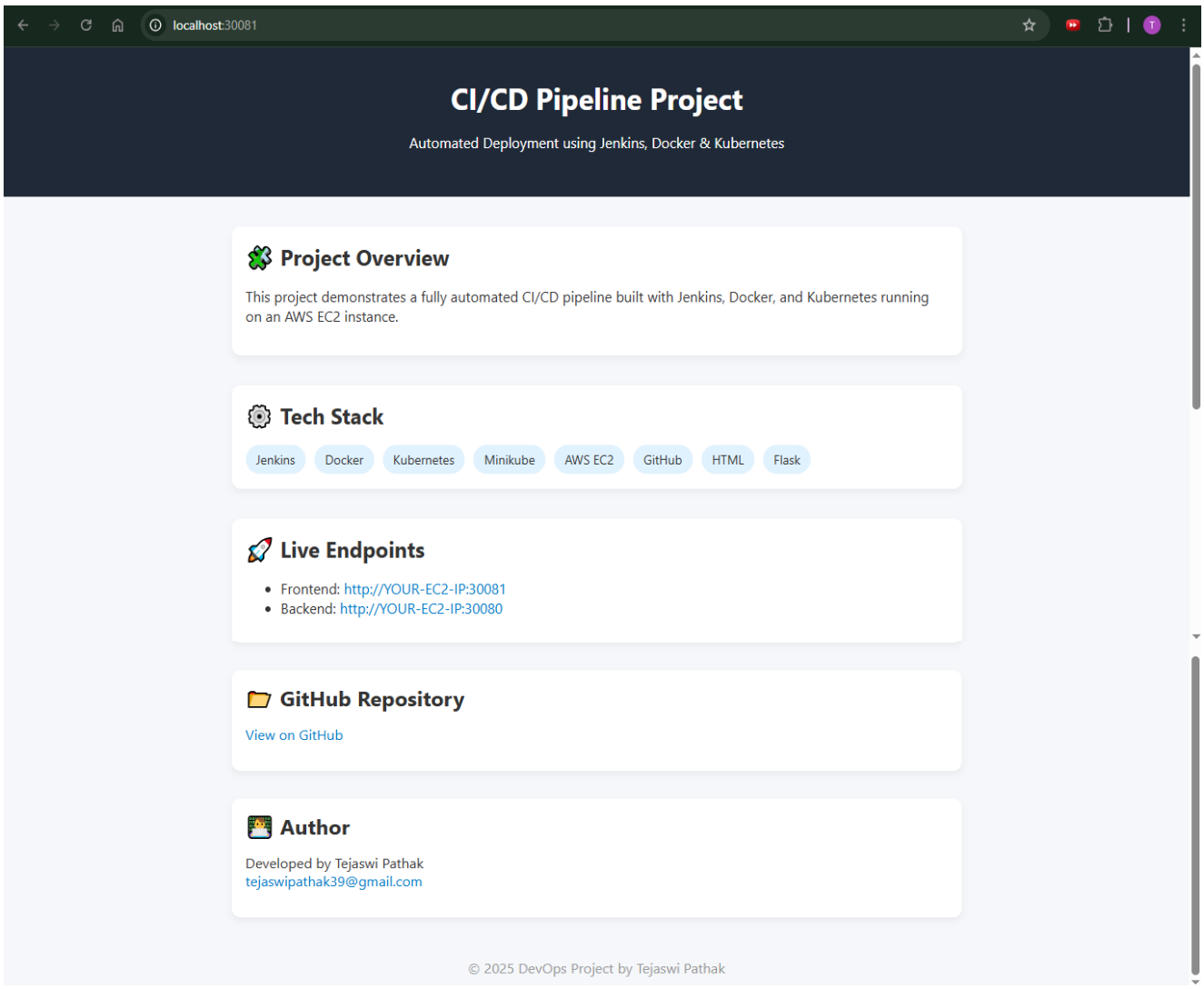
Outputs Images




Jenkins
admin
log out
Dashboard
devops-pipeline
#11
Status
Changes
Console Output
Edit Build Information
Delete build '#11'
Timings
Git Build Data
Pipeline Overview
Restart from Stage
Replay
Pipeline Steps
Workspaces
Previous Build
#11 (Jun 9, 2025, 6:46:57 PM)
Add description
Keep this build forever
Started by user admin
Started 4 min 22 sec ago
Took 21 sec
This run spent:
11 ms waiting;
21 sec build duration;
21 sec total from scheduled to completion.
Revision: d89d8d61990f4817ed0f481cad1a4088c62afb11
Repository: https://github.com/TejPATHAK/DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes.git
refs/remotes/origin/main
No changes.
REST API
Jenkins 2.504.2


aws
Search
[Alt+S]
Asia Pacific (Mumbai)
pathakteja_21
=> => naming to docker.io/tpathak21/devops-backend:latest
The push refers to repository [docker.io/tpathak21/devops-backend]
fdc4c733acb8: Pushed
f3dfdbd00ad8: Pushed
ac045498dc66: Pushed
7bde2b8801d7: Layer already exists
978f260c1369: Layer already exists
9b5482944372: Layer already exists
9ad43ba78452: Layer already exists
ace34d1d784c: Layer already exists
latest: digest: sha256:8d8edf654bc0e5f2ce74a12baae53431ef2c015cae9ae4d53a4895fbc14356fb size: 1990
deployment.apps/devops-backend restarted
ubuntu@ip-172-31-13-88:~/DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes/backend$ kubectl get pods
NAME READY STATUS RESTARTS AGE
devops-backend-56d76f4df4-4tgkl 1/1 Running 0 7s
devops-backend-56d76f4df4-hqjkv 1/1 Running 0 19s
devops-frontend-7c5c67dd-gkdng 1/1 Running 1 (78m ago) 4h15m
devops-frontend-7c5c67dd-zqmbw 1/1 Running 1 (78m ago) 4h15m
ubuntu@ip-172-31-13-88:~/DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes/backend$ kubectl get svc
NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE
backend-service NodePort 10.106.218.220 <none> 5000:30080/TCP 4h32m
devops-backend-service ClusterIP 10.107.155.149 <none> 5000/TCP 4h15m
devops-frontend-service LoadBalancer 10.109.236.22 <pending> 80:31204/TCP 4h15m
kubernetes ClusterIP 10.96.0.1 <none> 443/TCP 8h
ubuntu@ip-172-31-13-88:~/DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes/backend$ kubectl get deploy
NAME READY UP-TO-DATE AVAILABLE AGE
devops-backend 2/2 2 2 4h15m
devops-frontend 2/2 2 2 4h15m
ubuntu@ip-172-31-13-88:~/DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes/backend$
CloudShell
Feedback
© 2025, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences


TejPATHAK / DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes
Type / to search
Code
Issues
Pull requests
Actions
Projects
Wiki
Security
Insights
Settings
DevOps-CI-CD-Pipeline-using-Jenkins-Docker-and-Kubernetes
Public
Pin
Watch 0
Fork 0
Star 0
main
1 Branch
0 Tags
Go to file
Add file
Code
About
No description, website, or topics provided.
Readme
Activity
0 stars
0 watching
0 forks
TejPATHAK Update index.html
9796279 · 1 hour ago
16 Commits
backend Update Dockerfile yesterday
frontend Update index.html 1 hour ago
k8s Update service.yaml 2 hours ago
Jenkinsfile Update-8 Jenkinsfile 2 days ago
README.md Update README.md 2 days ago
docker-compose.yml Initial commit last week
README
Releases
No releases published
Create a new release
Packages
No packages published
Publish your first package


localhost:30081
CI/CD Pipeline Project
Automated Deployment using Jenkins, Docker & Kubernetes
Project Overview
This project demonstrates a fully automated CI/CD pipeline built with Jenkins, Docker, and Kubernetes running on an AWS EC2 instance.
Tech Stack
Jenkins
Docker
Kubernetes
Minikube
AWS EC2
GitHub
HTML
Flask
Live Endpoints
Frontend: http://YOUR-EC2-IP:30081
Backend: http://YOUR-EC2-IP:30080
GitHub Repository
View on GitHub
Author
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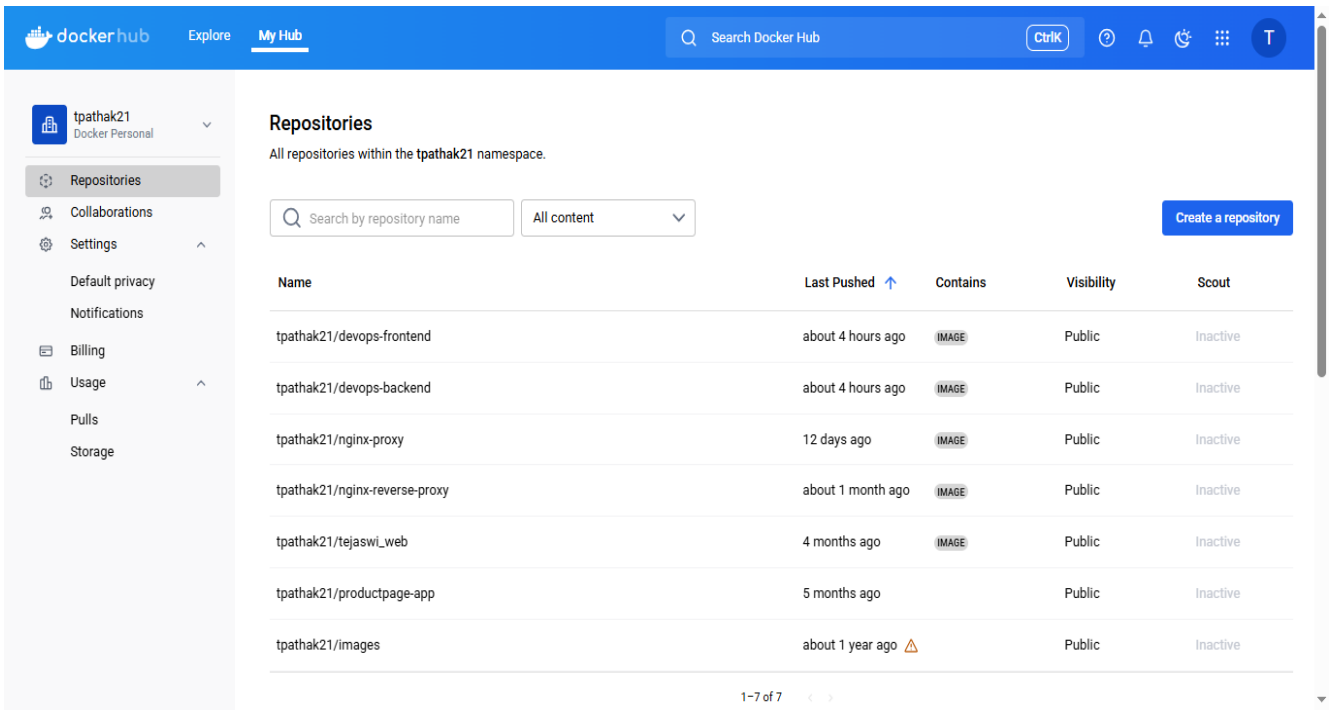
dockerhub
Explore
My Hub
Search Docker Hub
CtrlK
tpathak21
Docker Personal
Repositories
Collaborations
Settings
Default privacy
Notifications
Billing
Usage
Pulls
Storage
Repositories
All repositories within the tpathak21 namespace.
Search by repository name
All content
Create a repository
Name
Last Pushed
Contains
Visibility
Scout
tpathak21/devops-frontend
about 4 hours ago
IMAGE
Public
Inactive
tpathak21/devops-backend
about 4 hours ago
IMAGE
Public
Inactive
tpathak21/nginx-proxy
12 days ago
IMAGE
Public
Inactive
tpathak21/nginx-reverse-proxy
about 1 month ago
IMAGE
Public
Inactive
tpathak21/tejaswi_web
4 months ago
IMAGE
Public
Inactive
tpathak21/productpage-app
5 months ago
Public
Inactive
tpathak21/images
about 1 year ago
Public
Inactive
1–7 of 7

Links

GitHub Repository: DevOps-CI-CD-Pipeline

LinkedIn Profile: Tejaswi Pathak

DockerHub Profile: tpathak21

Conclusion

This project is a full-fledged demonstration of how to containerize applications, automate deployments using Jenkins, and orchestrate containers via Kubernetes - all deployed on an AWS EC2 instance. It proves your ability to integrate multiple DevOps tools in a production-like setup.