# *DevOps Project Report(Azure)*

**Project Title:** Flask-based Application Deployment using Jenkins, Docker, Kubernetes, and Terraform
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**Project Assigned By:** Hemanth Kumar
**Date:** 3 MAY

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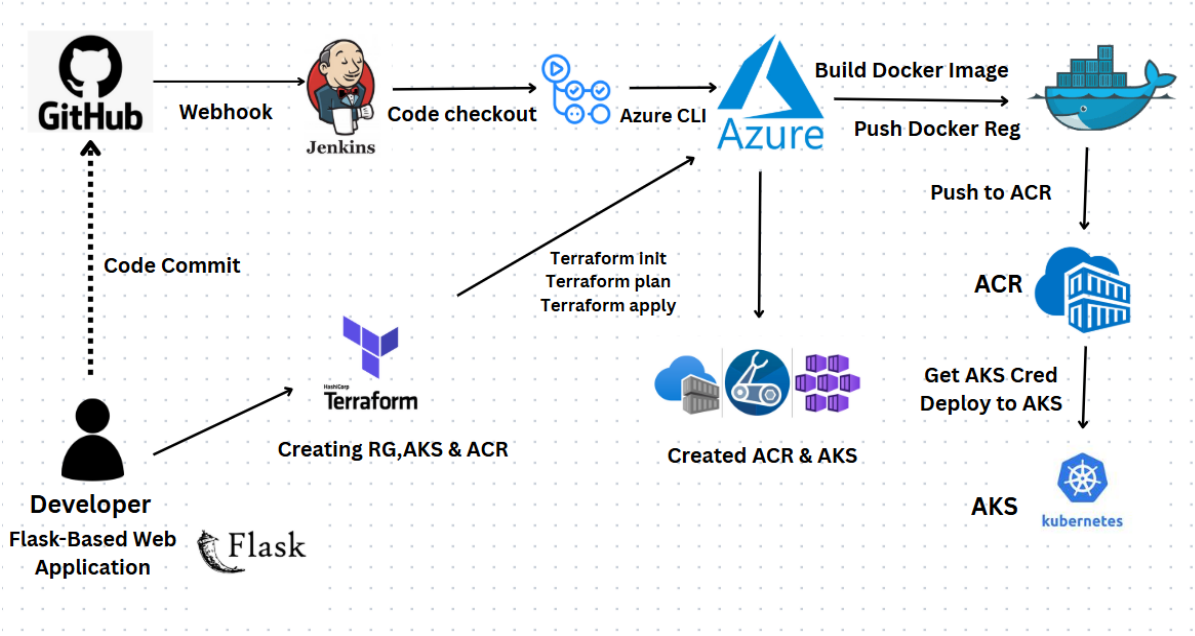
## 1. Project Overview :-

This project involves setting up a complete CI/CD pipeline to automate the deployment of a Flask-based web application using Jenkins, Docker, Azure Kubernetes Service (AKS), and Azure Container Registry (ACR). The infrastructure provisioning is handled via Terraform

## 2. Project Architecture :-




## 3. Project Objectives :-

- Automate code checkout, build, and deployment process.
- Containerize the Flask application using Docker.
- Push Docker images to Azure Container Registry.
- Deploy application to Azure Kubernetes Service.
- Manage infrastructure using Terraform scripts.

## 4. Project File Structure :-

| File/Folder | Description |
|---|---|
| app.py | Main Flask application file. |
| requirements.txt | Python dependencies for the application. |
| Dockerfile | Instructions to build Docker image for Flask app. |
| Jenkinsfile | Pipeline script defining stages like build, test, push, Deploy to the container |
| flask_app.sh | Optional shell script for managing or testing the app. |
| k8s/ | Contains Kubernetes YAML files (Deployment and Services) |
| terraform/ | Contains Terraform configuration files for AKS and ACR provisioning. |

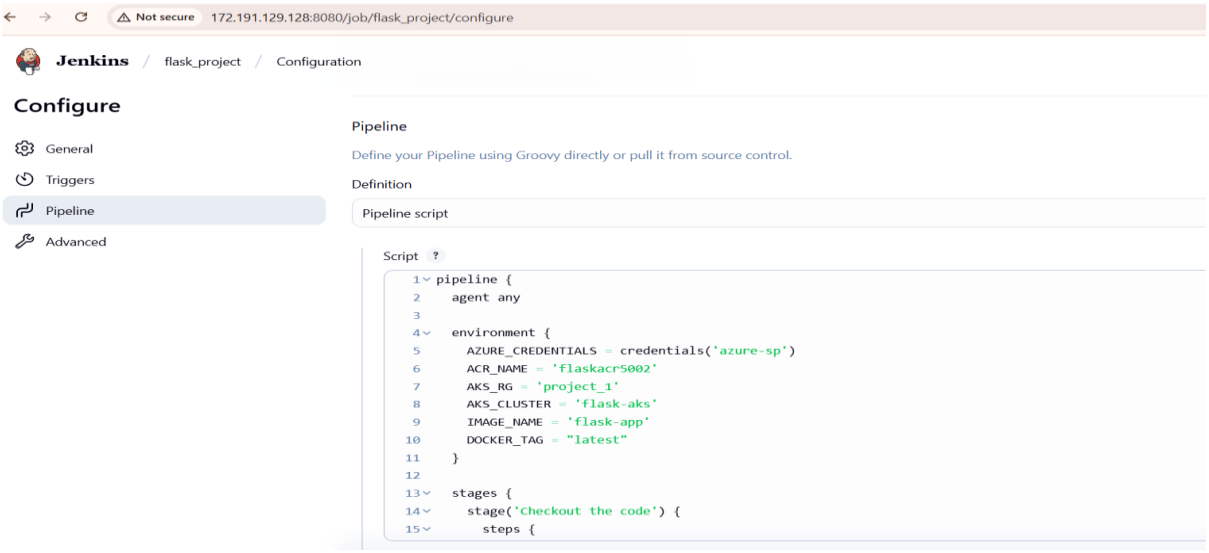
## 5. Technologies and Tools Used

- **Programming Language:** Python (Flask)
- **CI/CD Tool:** Jenkins
- **Containerization:** Docker
- **Container Registry:** Azure Container Registry (ACR)
- **Orchestration:** Azure Kubernetes Service (AKS)
- **Infrastructure as Code:** Terraform
- **Version Control:** GitHub

## 6.Pipeline Workflow

1. **Code Checkout** – Jenkins pulls the code from GitHub.
2. **Azure Login** – Authenticate using a Service Principal.
3. **Docker Build** – Build a Docker image of the Flask app.
4. **Push to ACR** – Push the built image to Azure Container Registry.
5. **Get AKS Credentials** – Fetch cluster context.
6. **Deploy to AKS** – Apply Kubernetes manifests to deploy the app.

**Figure *1:*Jenkins dashboard showing the configured pipeline for the Flask application.**




## Jenkinsfile

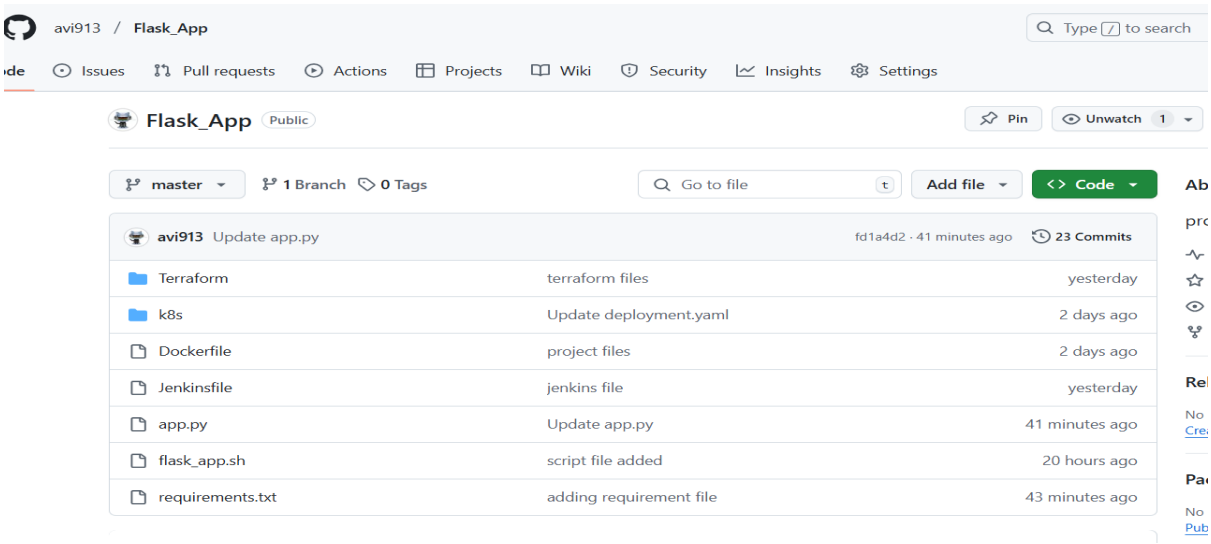
```
pipeline {
 agent any
 environment {
  AZURE_CREDENTIALS = credentials('azure-sp')
  ACR_NAME = 'flaskacr5002'
  AKS_RG = 'project_1'
  AKS_CLUSTER = 'flask-aks'
  IMAGE_NAME = 'flask-app'
  DOCKER_TAG = "latest"
 }
 stages {
  stage('Checkout the code') {
   steps {
    git branch: 'master', url: 'https://github.com/avi913/Flask_App.git'
   }
  }
  stage('Login to Azure') {
   steps {
    withCredentials([string(credentialsId: 'azure-sp', variable: 'AZ_CREDS')]) {
```

```
        sh '''
        echo $AZ_CREDS > azure.json
        az login --service-principal --username $(jq -r .clientId azure.json) \
              --password $(jq -r .clientSecret azure.json) \
              --tenant $(jq -r .tenantId azure.json)
        az account set --subscription $(jq -r .subscriptionId azure.json)
        '''}}}
    stage('Build Docker Image') {
      steps {
        sh '''
        az acr login --name $ACR_NAME
        docker build -t $ACR_NAME.azurecr.io/$IMAGE_NAME:$DOCKER_TAG .
        '''}}
    stage('Push to ACR') {
      steps {
        sh '''
        docker push $ACR_NAME.azurecr.io/$IMAGE_NAME:$DOCKER_TAG
        '''}}
    stage('Get AKS Credentials') {
      steps {
        sh '''
        az aks get-credentials --resource-group $AKS_RG --name $AKS_CLUSTER --
overwrite-existing''  }  }
    stage('Deploy to AKS') {
      steps {
        sh '''
        kubectl apply -f k8s/deployment.yaml
        kubectl apply -f k8s/service.yaml
        '''}}}
   post {
    success {
```

```
    echo 'Deployed successfully to AKS!'
  }
  failure {
    echo 'Deployment failed!'}}}
```

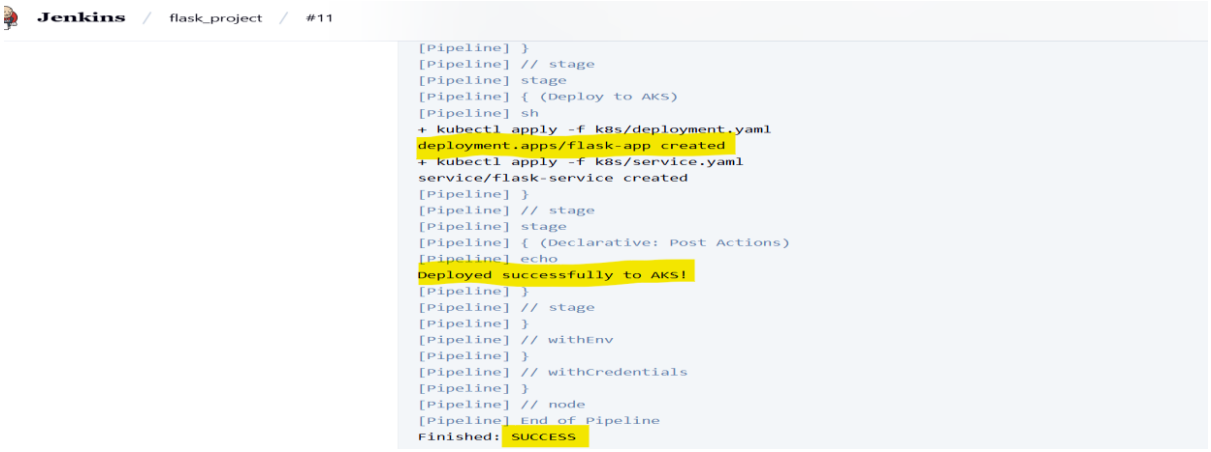
## GitHub Repository :-

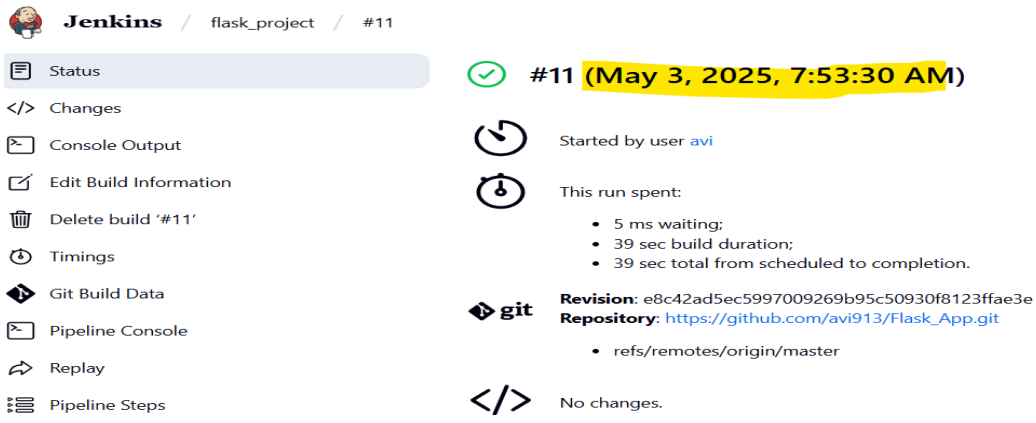
**Figure: GitHub repository containing the source code and deployment files.**




## Jenkins Pipeline Execution :-

***Figure:*** **Jenkins pipeline execution log displaying successful code checkout and build steps.**






## Docker Image Build Stage :-

**Figure 3: Docker image being built from the Dockerfile using Jenkins."**

Flask_App / Dockerfile

avinash project files

Code Blame 15 lines (11 loc) · 264 Bytes Code 55% faster with GitHub Copilot

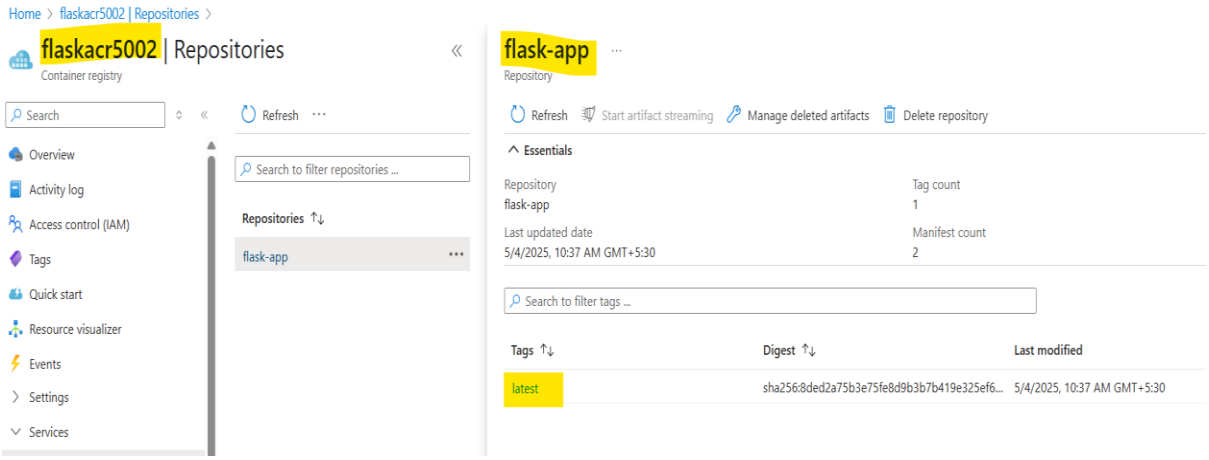
```
1   # Used official Python image
2   FROM python:3.9-slim
3
4   # Set working directory
5   WORKDIR /app
6   COPY requirements.txt .
7   RUN pip install -r requirements.txt
8
9   COPY . .
10
11  # Expose port
12  EXPOSE 5000
13
14  # Run the app with gunicorn
15  CMD ["gunicorn", "-b", "0.0.0.0:5000", "app:app"]
```

**Cmd :[docker images ]**

```
Last login: Sun May  4 04:47:52 2025 from 103.215.237.162
avi@master-vm:~$ docker images
REPOSITORY                          TAG       IMAGE ID       CREATED          SI
flaskacr5002.azurecr.io/flask-app   latest    9e0db6734110   51 minutes ago   13
sonarqube                           latest    e3614eb70b40   3 weeks ago      1.
mcr.microsoft.com/azure-cli         latest    4119f014521e   5 weeks ago      74
hello-world                         latest    74cc54e27dc4   3 months ago     10
```

## Image Pushed to ACR :-

### Docker image successfully pushed to Azure Container Registry




## AKS Deployment via Kubectl :-

### Figure 4: Application deployed to AKS using Kubernetes manifests.

- **Deployment.yaml and service.yaml files**

Flask_App / k8s / deployment.yaml

avi913 Update deployment.yaml

Code | Blame | 19 lines (19 loc) · 326 Bytes | Code

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: flask-app
spec:
  replicas: 2
  selector:
    matchLabels:
      app: flask
  template:
    metadata:
      labels:
        app: flask
    spec:
      containers:
      - name: flask
        image: avinashaka3/flaskapp:latest
        ports:
        - containerPort: 5000
```

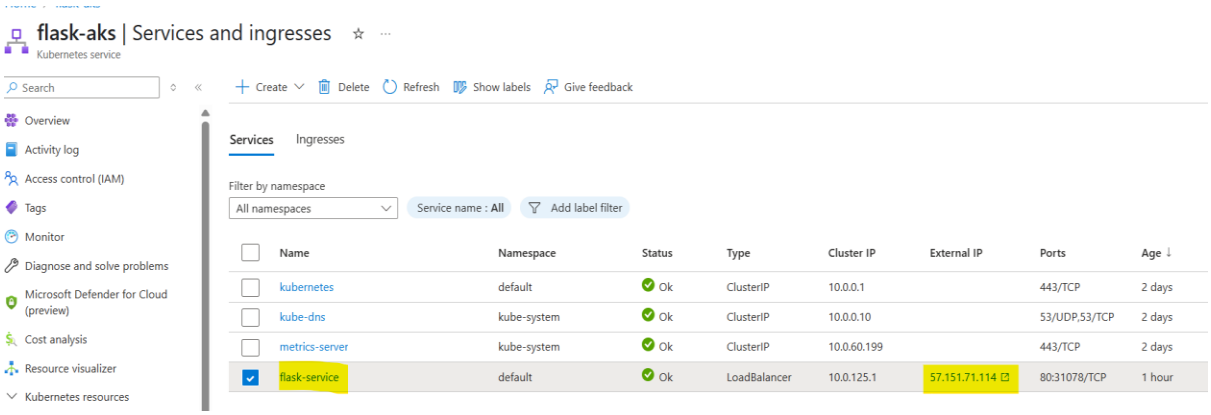
Flask_App / k8s / service.yaml

avinash modified deployment and service

Code | Blame | 14 lines (14 loc) · 207 Bytes

```yaml
apiVersion: v1
kind: Service
metadata:
  name: flask-service
  labels:
    app: flask
spec:
  type: LoadBalancer
  selector:
    app: flask
  ports:
    - protocol: TCP
      port: 80
      targetPort: 5000
```

**When we hit that url http:// 57.151.71.114:80 it will open our web-app**

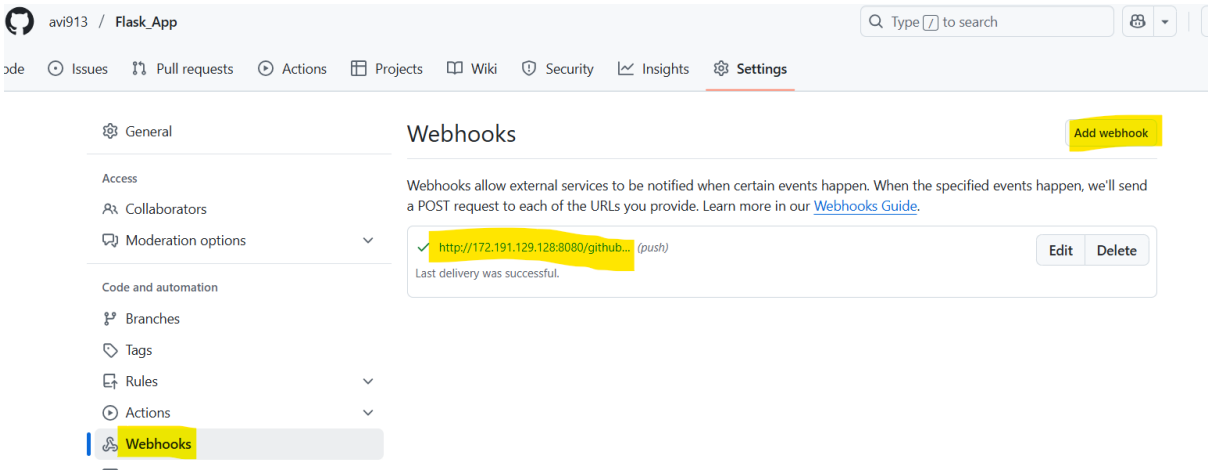



**Cmd:[kubectl get pods],[kubectl get svc],[kubectl get deployment]**

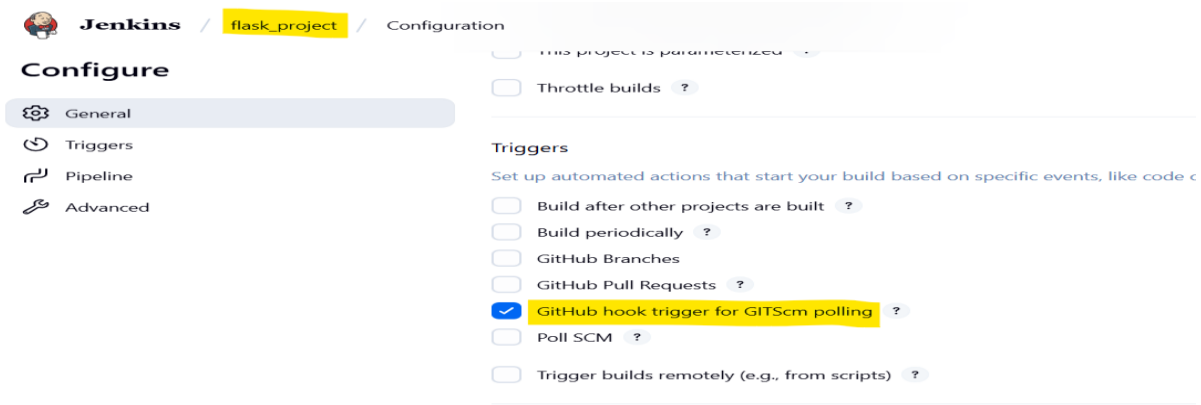
```
avi@master-vm:~$ kubectl get pods
NAME                         READY   STATUS    RESTARTS   AGE
flask-app-7bd4f79657-ln6k8   1/1     Running   0          73m
flask-app-7bd4f79657-lzfkk   1/1     Running   0          73m
avi@master-vm:~$ kubectl get svc
NAME            TYPE           CLUSTER-IP    EXTERNAL-IP     PORT(S)        AGE
flask-service   LoadBalancer   10.0.125.1    57.151.71.114   80:31078/TCP   76m
kubernetes      ClusterIP      10.0.0.1      <none>          443/TCP        43h
avi@master-vm:~$ kubectl get deployment
NAME        READY   UP-TO-DATE   AVAILABLE   AGE
flask-app   2/2     2            2           76m
avi@master-vm:~$
```

## Webhook Setup in GitHub :-

**Figure 5: GitHub webhook configured to trigger Jenkins pipeline on code push.**



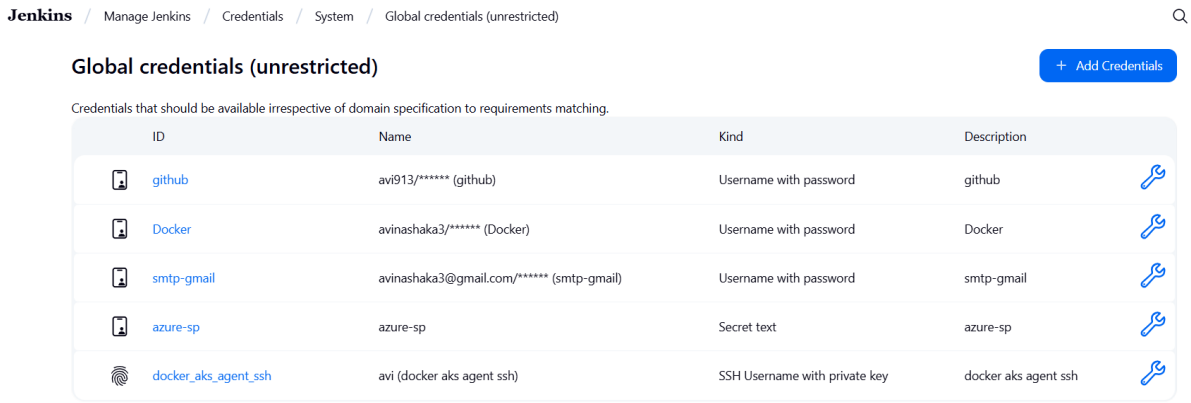

**In Jenkins pipeline project we need to select the “GitHub hook trigger for GITScm polling”**




## Service Principal Credentials in Jenkins :-

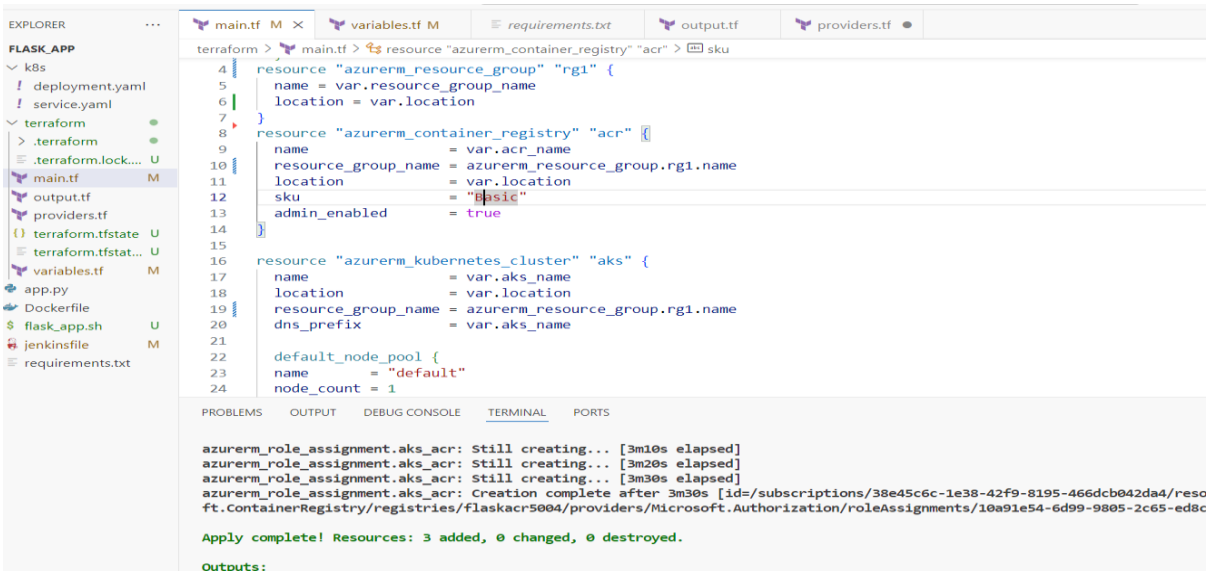
### Figure:6 Jenkins credentials configuration for Azure Service Principal authentication.

### Goto->manage Jenkins-> select credentials -> add new credentials




## Terraform Apply Output :-

### Figure 6: Terraform output showing successful provisioning of AKS and ACR.



## Jenkins  Plugins Used in the Project :-

1. **Git Plugin**
   Used to clone the source code from GitHub.
2. **Pipeline Plugin**
   Allows defining jobs in Jenkinsfile using Declarative or Scripted syntax.
3. **Blue Ocean Plugin**
   Provides a modern UI for visualizing pipeline stages and status.
4. **Docker Pipeline Plugin**
   Used to build and manage Docker containers from the pipeline.
5. **Credentials Binding Plugin**
   Manages and injects credentials like Azure Service Principal or API tokens securely.
6. **Azure CLI Plugin**
   Allows executing az CLI commands directly from Jenkins.
7. **Kubernetes CLI Plugin (kubectl)**
   Used to interact with AKS clusters via kubectl in pipeline steps.
8. **GitHub Integration Plugin**
   Enables webhook triggering and GitHub build status reporting.

## Conclusion:

The project successfully demonstrates an end-to-end CI/CD pipeline for deploying a Flask-based web application on Azure Kubernetes Service (AKS) using Jenkins, Docker, Terraform, and Azure Container Registry (ACR). It includes:

• Automated infrastructure provisioning using Terraform (AKS and ACR).

• A Jenkins pipeline that checks out code, builds a Docker image, pushes it to ACR, and deploys it to AKS.

• Integration with GitHub via webhooks for automated deployment.

• Use of key DevOps plugins and Azure authentication via Service Principal