CLOUD COMPUTING LAB

Lab 08 – Jenkins
(Creating a DevOps Pipeline, CI/CD tool)

Introduction:

Welcome to lab 8! This simple exercise is designed to introduce you to Jenkins and continuous integration.

Jenkins is an Open source, Java-based automation tool. This tool automates the Software Integration and delivery process called Continuous Integration and Continuous Delivery.

What is Jenkins?

Jenkins supports various source code management, build, and delivery tools. Jenkins provides features like Jenkins Pipelines which makes the delivery process very easy and helps teams to adopt DevOps easily.

Overview of the Experiment

- Setup Jenkins Using Docker.
- Set up a job in Jenkins to connect to your repository and build C++ hello.cpp.
- Set up a second job to run the program after completing the build.
- Add a webhook trigger to your GitHub repository in order to automate the execution of jobs in Jenkins
- Create a basic Jenkins pipeline.

Prerequisites:

- Docker Installed on your system. (Refer to installation guide steps in the Lab Experiment 2 manual).

- Git installed on your system and a GitHub account also Follow this tutorial to install and make yourself familiar with git.

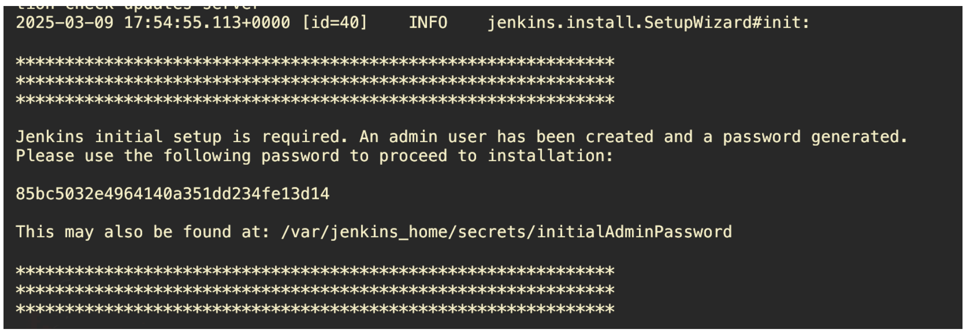
- Create a GitHub repo with the name as YOUR_SRN_Jenkins and make sure it's a **Public Repository**

Task-1

Aim: Set up Jenkins using Docker.

Deliverables:

1. Screenshot of the running Docker Container after installing Jenkins



```
2025-03-09 17:54:55.113+0000 [id=40]    INFO    jenkins.install.SetupWizard#init:

*************************************************************
*************************************************************
*************************************************************

Jenkins initial setup is required. An admin user has been created and a password generated.
Please use the following password to proceed to installation:

85bc5032e4964140a351dd234fe13d14

This may also be found at: /var/jenkins_home/secrets/initialAdminPassword

*************************************************************
*************************************************************
*************************************************************
```

Steps:

1. Use this repository link: https://github.com/capnmav77/CC_TA and download the zip file, extract the Jenkins_lab-main folder.

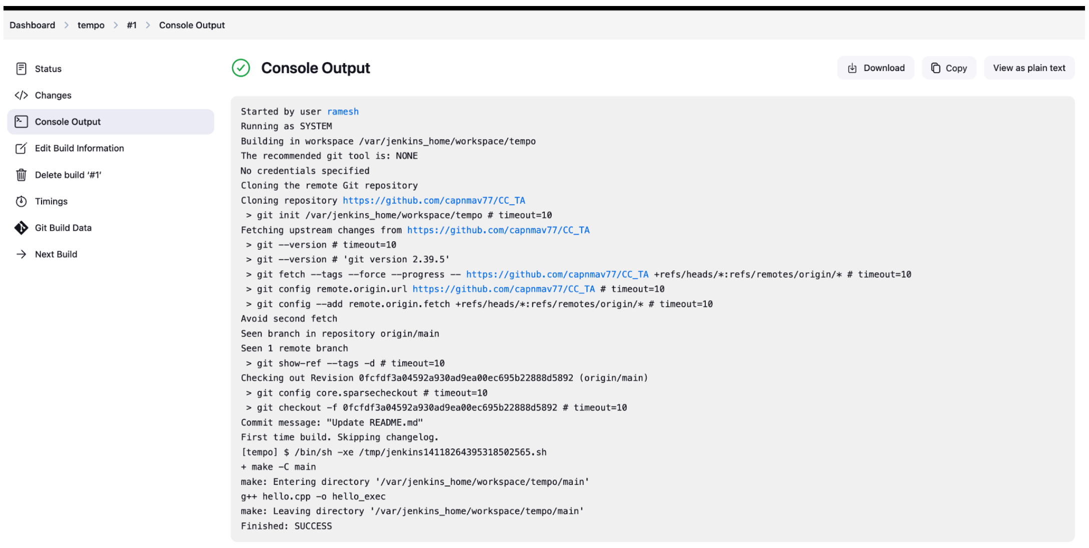
2. You will be given a Dockerfile, open a terminal in that Dockerfile folder.
3. Build the dockerfile using this command: `“sudo docker build . -t jenkins:YOUR_SRN” [Note: Omit **sudo** if working with Windows WSL or MacOS]`
4. Run your container using this command **`“sudo docker run -p 8080:8080 -p 50000:50000 -it jenkins:YOUR_SRN”`** `(Expose any other port for e.g. 8090:8080, if you are already using port 8080 for some other purpose).(Note down the password shown on the terminal).`
5. Open URL: localhost:8080 on your browser.
6. Enter the password shown on your terminal after running the container (You can set the password to ADMIN later).
   a. In case you did not note down the password displayed on the terminal, you can find the password by connecting to the container (via “ sudo docker exec –it <container_id> /bin/bash”) and checking the file /var/Jenkins_home /secrets/initialAdminPassword inside the container.
7. **Integrate GitHub to Jenkins**: When prompted for plugin installation, click on “Select Plugins to Install” and then search for GitHub and check the **GitHub** option. (This step may take a few minutes to complete)
8. Take the necessary Screenshots as mentioned in *Deliverables.*

Task-2

Aim: Set up a job in Jenkins to connect to your repository and build C++ hello.cpp.

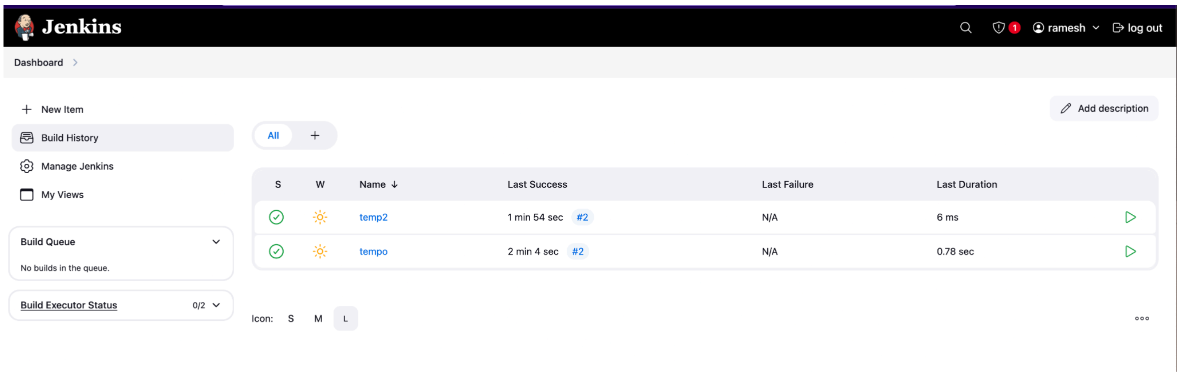
Deliverables:

1. Picture showing the console output after the build is successful



```
Started by user ramesh
Running as SYSTEM
Building in workspace /var/jenkins_home/workspace/tempo
The recommended git tool is: NONE
No credentials specified
Cloning the remote Git repository
Cloning repository https://github.com/capnmav77/CC_TA
 > git init /var/jenkins_home/workspace/tempo # timeout=10
Fetching upstream changes from https://github.com/capnmav77/CC_TA
 > git --version # timeout=10
 > git --version # 'git version 2.39.5'
 > git fetch --tags --force --progress -- https://github.com/capnmav77/CC_TA +refs/heads/*:refs/remotes/origin/* # timeout=10
 > git config remote.origin.url https://github.com/capnmav77/CC_TA # timeout=10
 > git config --add remote.origin.fetch +refs/heads/*:refs/remotes/origin/* # timeout=10
Avoid second fetch
Seen branch in repository origin/main
Seen 1 remote branch
 > git show-ref --tags -d # timeout=10
Checking out Revision 0fcfdf3a04592a930ad9ea00ec695b22888d5892 (origin/main)
 > git config core.sparsecheckout # timeout=10
 > git checkout -f 0fcfdf3a04592a930ad9ea00ec695b22888d5892 # timeout=10
Commit message: "Update README.md"
First time build. Skipping changelog.
[tempo] $ /bin/sh -xe /tmp/jenkins14118264395318502565.sh
+ make -C main
make: Entering directory '/var/jenkins_home/workspace/tempo/main'
g++ hello.cpp -o hello_exec
make: Leaving directory '/var/jenkins_home/workspace/tempo/main'
Finished: SUCCESS
```

2. Picture showing the Stable state of the task in Build History of Jenkins (PS:ignore the multiple jobs in the ss , you will be having a single job)

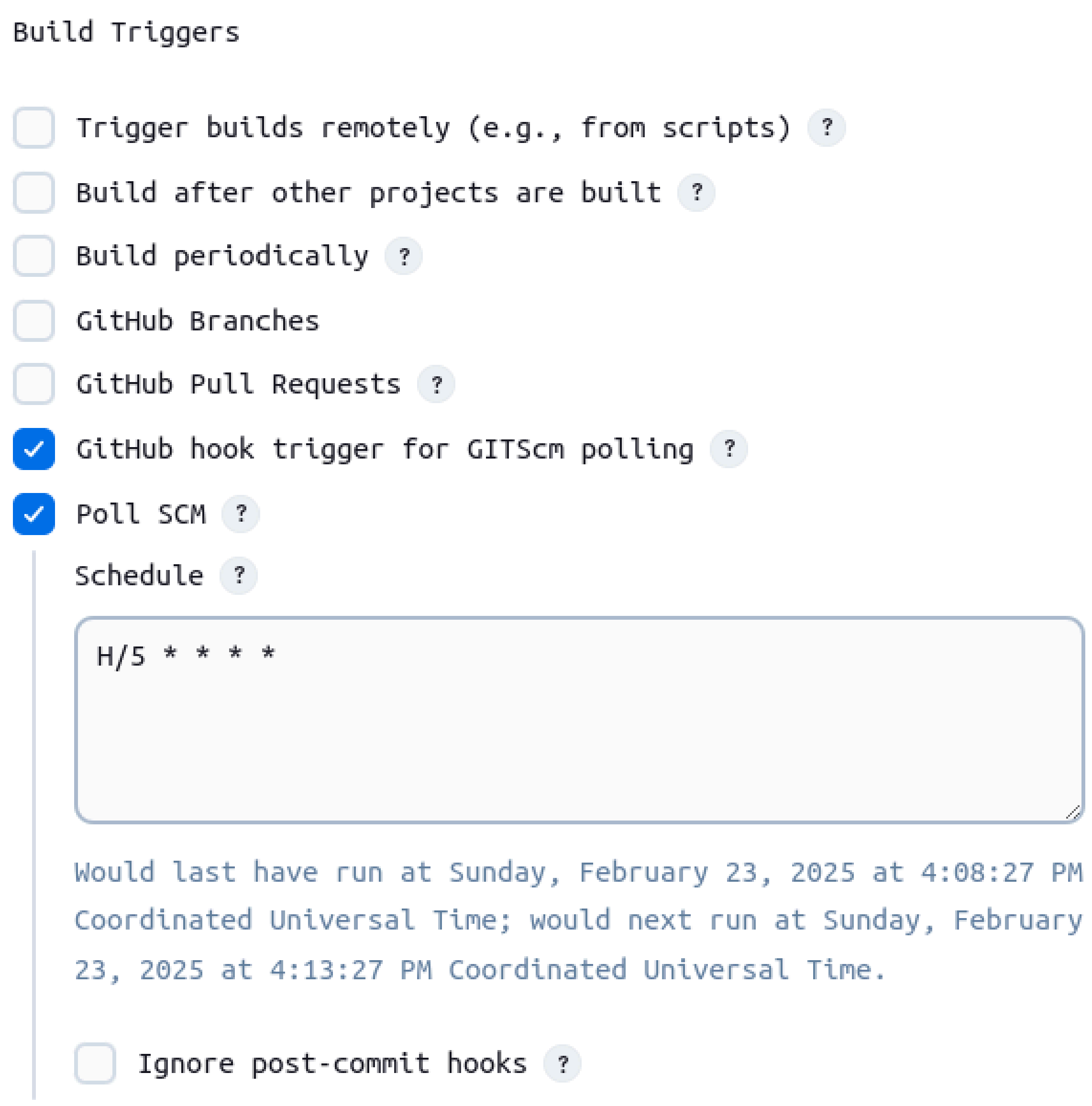


S	W	Name ↓	Last Success	Last Failure	Last Duration
✓	☀	temp2	1 min 54 sec #2	N/A	6 ms
✓	☀	tempo	2 min 4 sec #2	N/A	0.78 sec

Steps:

1. Make changes to hello.cpp file if you wish. Complete prerequisite 3(If not done already). Then, commit and push the Jenkins-main folder to your GitHub repository. Open Git Bash, navigate to Jenkins-main folder. (Note:- Please make sure to push both the main and dockerfile folders to your repository, otherwise you may face errors in subsequent tasks). Use the following commands in Git Bash
   - git init
   - git checkout -b main
   - git remote add origin "Your repository’s URL"
   - git add . # or specific files
   - git commit -m "Describe this commit"
   - git log # check if your commit is present
   - git push -f origin main # forcepush just to be safe , else use -u

2. Navigate to Jenkins server Dashboard. Click ***New Item***.
3. Enter the name for your project as YOUR_SRN-1 (as this is job 1. Ensure the project name is unique to avoid collisions)
4. Click *Freestyle Project*, then *OK*.
5. Select GitHub project and Enter your repository’s URL.
6. Set up *Source Code Management*, Select *git*. Enter the URL of git repository.
7. Add another branch with the value “`*/main`” in **Branches to build .** (Do not delete the existing */master branch please try and use more than one brain cell.)
8. Setting up *Build Triggers.* Select *Poll SCM and also github hooks for the future*. (This will keep on scanning and poll changes from your repository after a specified interval of time).


Build Triggers

- [ ] Trigger builds remotely (e.g., from scripts)
- [ ] Build after other projects are built
- [ ] Build periodically
- [ ] GitHub Branches
- [ ] GitHub Pull Requests
- [x] GitHub hook trigger for GITScm polling
- [x] Poll SCM

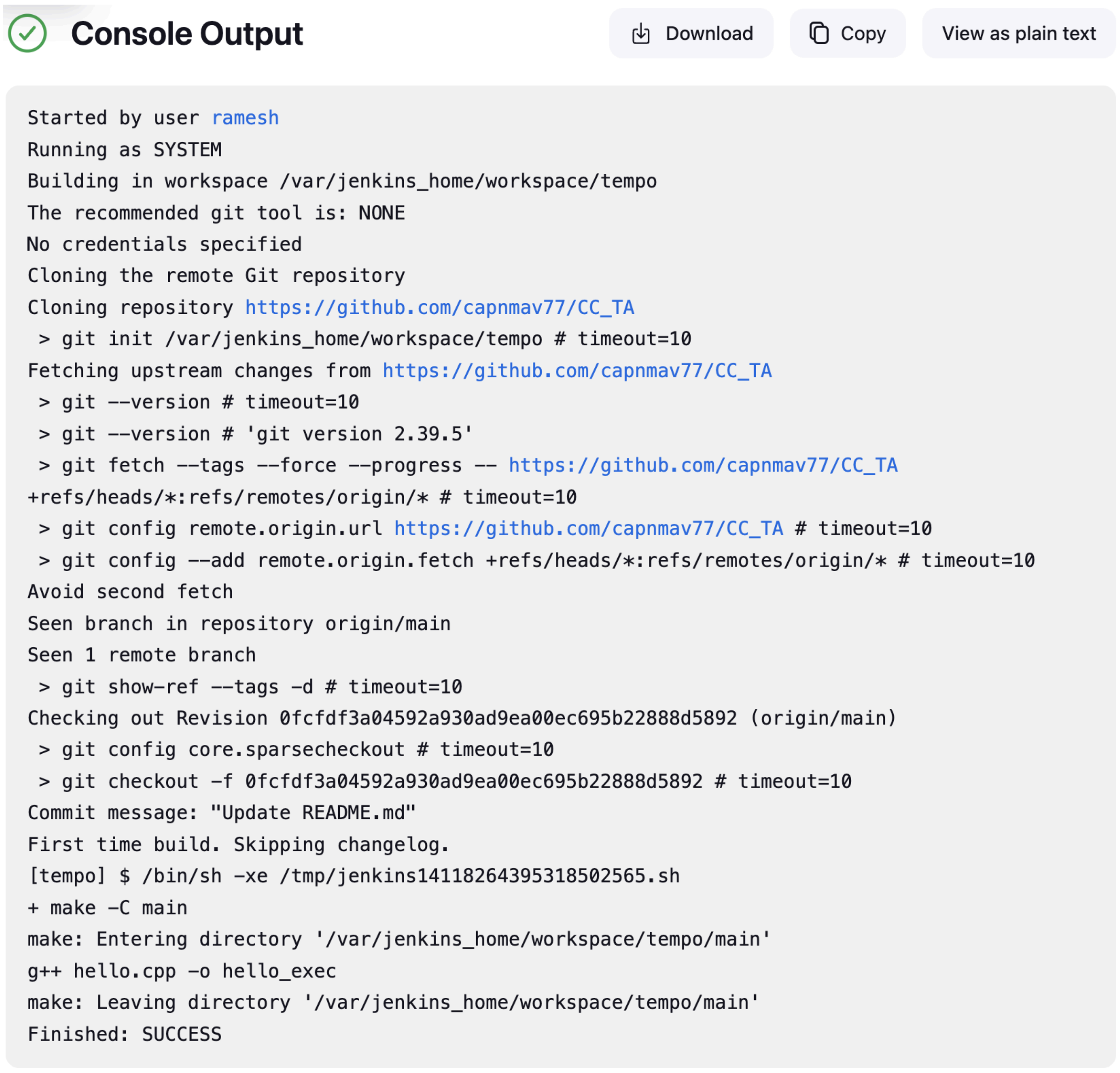
Schedule

```
H/5 * * * *
```

Would last have run at Sunday, February 23, 2025 at 4:08:27 PM Coordinated Universal Time; would next run at Sunday, February 23, 2025 at 4:13:27 PM Coordinated Universal Time.

- [ ] Ignore post-commit hooks

9. Set up job by putting in "`H/5 * * * *`" in the Schedule box Reference
   (H/5 * * * * implies it will check your job every 5 minutes. * the syntax of CRON. A CRON expression is a string comprising five or six fields separated by white space that represents a set of times, normally as a schedule to execute some routine.)
10. Set up *Build*. In **Add build step** pull-down menu, select *Execute Shell*.
11. Enter "`make -C main`" (This will run the Makefile).
12. Click *Save*.
13. Click on build now.
14. Take the required SS. , i.e Console Output as shown above , the one below is the output you are supposed to get .



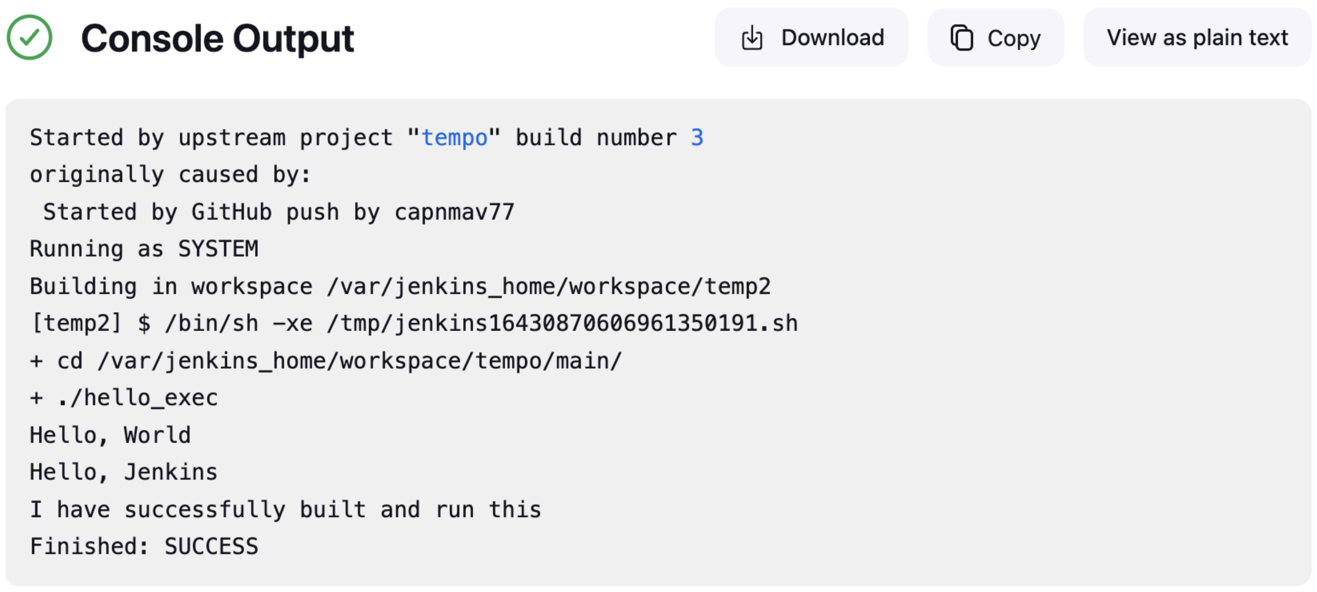
```
Started by user ramesh
Running as SYSTEM
Building in workspace /var/jenkins_home/workspace/tempo
The recommended git tool is: NONE
No credentials specified
Cloning the remote Git repository
Cloning repository https://github.com/capnmav77/CC_TA
 > git init /var/jenkins_home/workspace/tempo # timeout=10
Fetching upstream changes from https://github.com/capnmav77/CC_TA
 > git --version # timeout=10
 > git --version # 'git version 2.39.5'
 > git fetch --tags --force --progress -- https://github.com/capnmav77/CC_TA
+refs/heads/*:refs/remotes/origin/* # timeout=10
 > git config remote.origin.url https://github.com/capnmav77/CC_TA # timeout=10
 > git config --add remote.origin.fetch +refs/heads/*:refs/remotes/origin/* # timeout=10
Avoid second fetch
Seen branch in repository origin/main
Seen 1 remote branch
 > git show-ref --tags -d # timeout=10
Checking out Revision 0fcfdf3a04592a930ad9ea00ec695b22888d5892 (origin/main)
 > git config core.sparsecheckout # timeout=10
 > git checkout -f 0fcfdf3a04592a930ad9ea00ec695b22888d5892 # timeout=10
Commit message: "Update README.md"
First time build. Skipping changelog.
[tempo] $ /bin/sh -xe /tmp/jenkins14118264395318502565.sh
+ make -C main
make: Entering directory '/var/jenkins_home/workspace/tempo/main'
g++ hello.cpp -o hello_exec
make: Leaving directory '/var/jenkins_home/workspace/tempo/main'
Finished: SUCCESS
```

Task-3

Aim: Set up a second job that automatically runs after the project builds. This is different from the other job because this will not have a git repository - it doesn't even build anything.

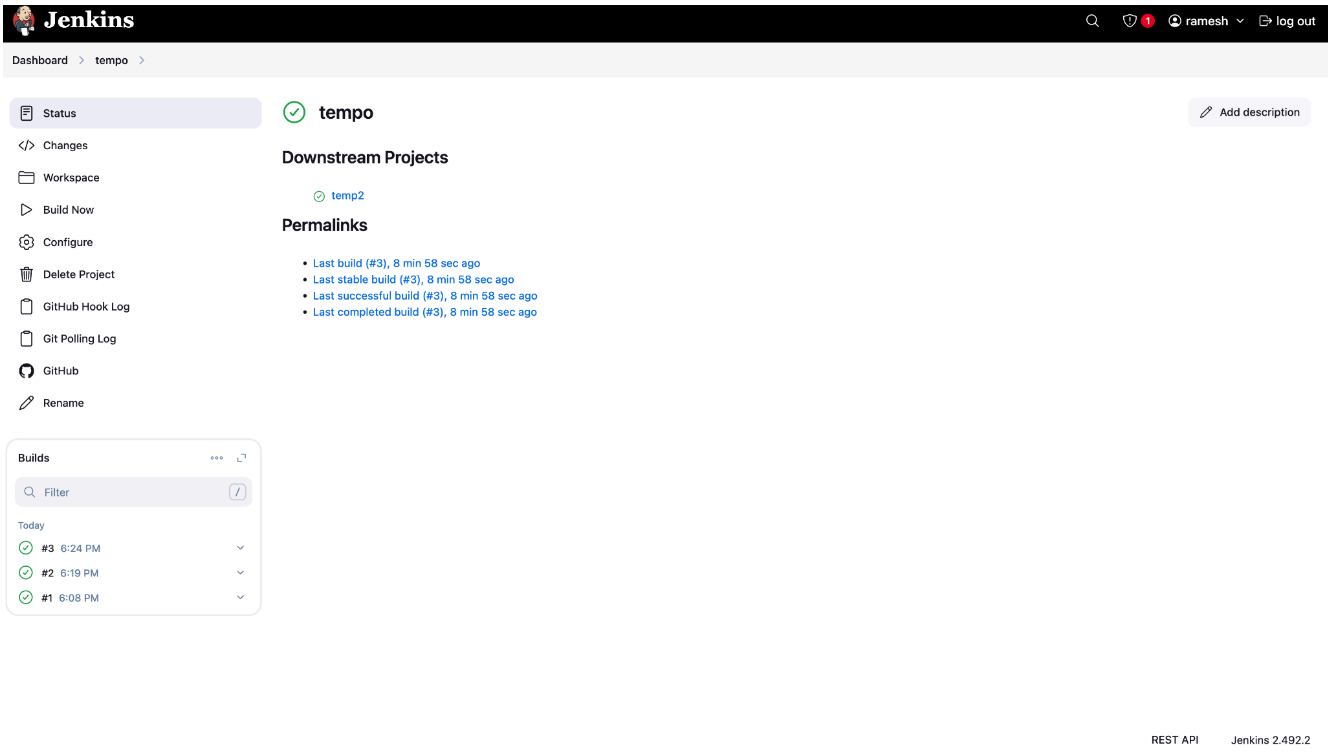
Just a note: In a real-life scenario you wouldn't run a program through a build job just like this because I/O is not possible via this console. There are other tools people use at this step like SeleniumHQ, SonarQube, or a Deployment. The point of this is to show downstream/upstream job relationships.

Deliverable



```
Started by upstream project "tempo" build number 3
originally caused by:
 Started by GitHub push by capnmav77
Running as SYSTEM
Building in workspace /var/jenkins_home/workspace/temp2
[temp2] $ /bin/sh -xe /tmp/jenkins16430870606961350191.sh
+ cd /var/jenkins_home/workspace/tempo/main/
+ ./hello_exec
Hello, World
Hello, Jenkins
I have successfully built and run this
Finished: SUCCESS
```

1. Console output of second job [Note : it is a job that is started by a upstream project]



Jenkins | ramesh | log out

Dashboard > tempo >

- Status
- Changes
- Workspace
- Build Now
- Configure
- Delete Project
- GitHub Hook Log
- Git Polling Log
- GitHub
- Rename

Builds

Filter

Today

- #3 6:24 PM
- #2 6:19 PM
- #1 6:08 PM

tempo

Add description

Downstream Projects

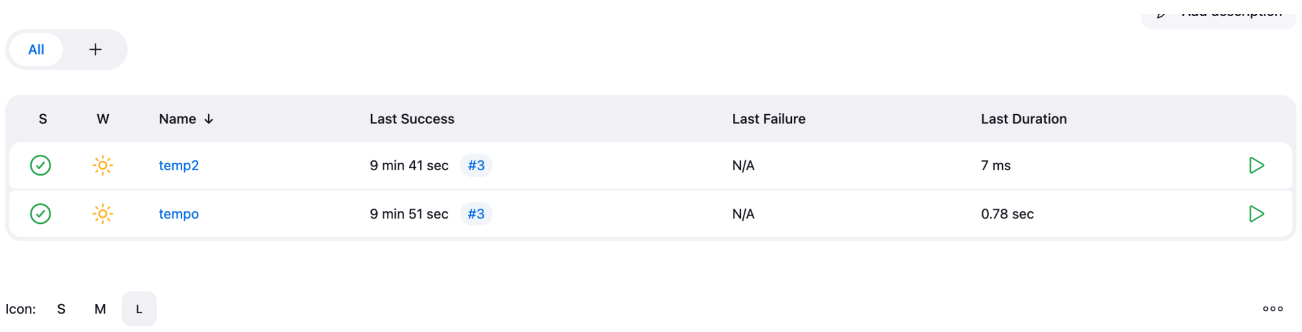
- temp2

Permalinks

- Last build (#3), 8 min 58 sec ago
- Last stable build (#3), 8 min 58 sec ago
- Last successful build (#3), 8 min 58 sec ago
- Last completed build (#3), 8 min 58 sec ago

REST API   Jenkins 2.492.2

2. Status page of first job with your downstream project



All +

S	W	Name ↓	Last Success	Last Failure	Last Duration
✓	☀	temp2	9 min 41 sec #3	N/A	7 ms
✓	☀	tempo	9 min 51 sec #3	N/A	0.78 sec

Icon: S M L

3. Build History of Jenkins where tempo is project1 and temp2 is project 2

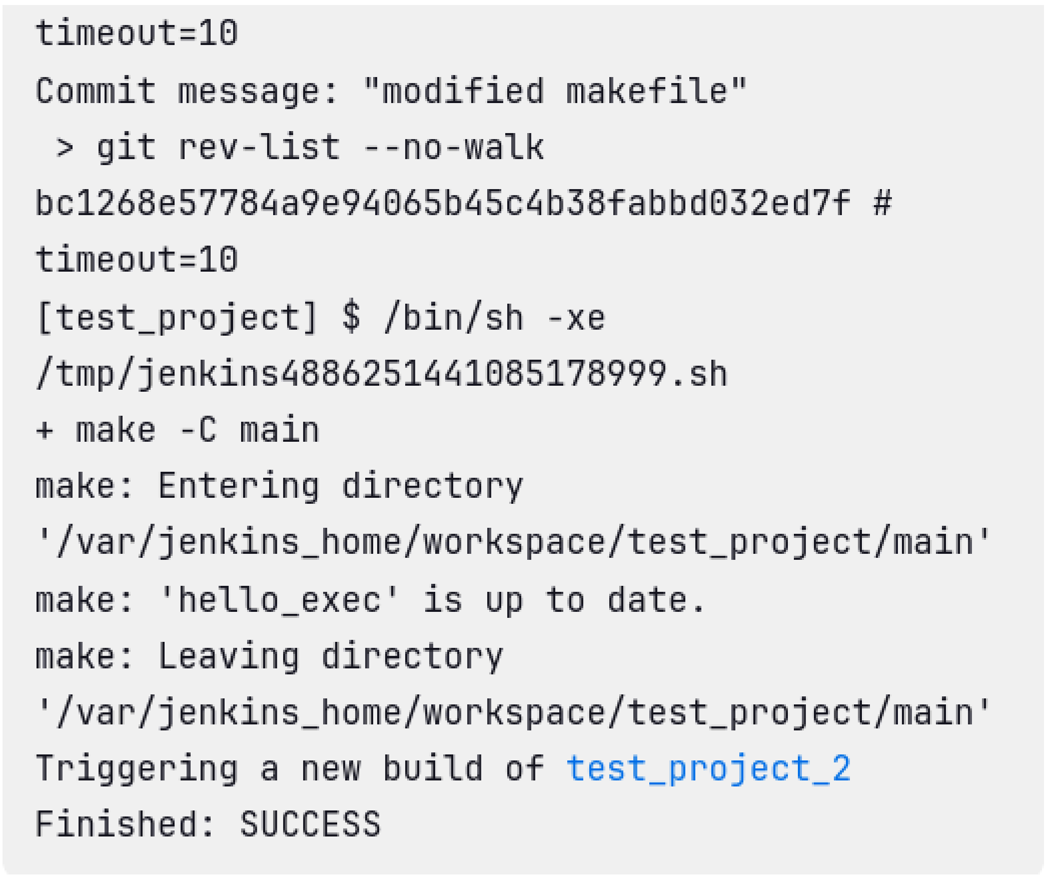
Steps:

1. Create a new Job in Jenkins, Click *New Item* in the left panel.
2. Enter a name for your second job as YOUR_SRN-2 (as this is your 2nd job), click *Freestyle Project*, then *OK*.
3. Go immediately to the build step and select *Execute Shell*.
4. Enter the following Command

```
cd /var/jenkins_home/workspace/<the name of your first
project>/main/
./hello_exec
```

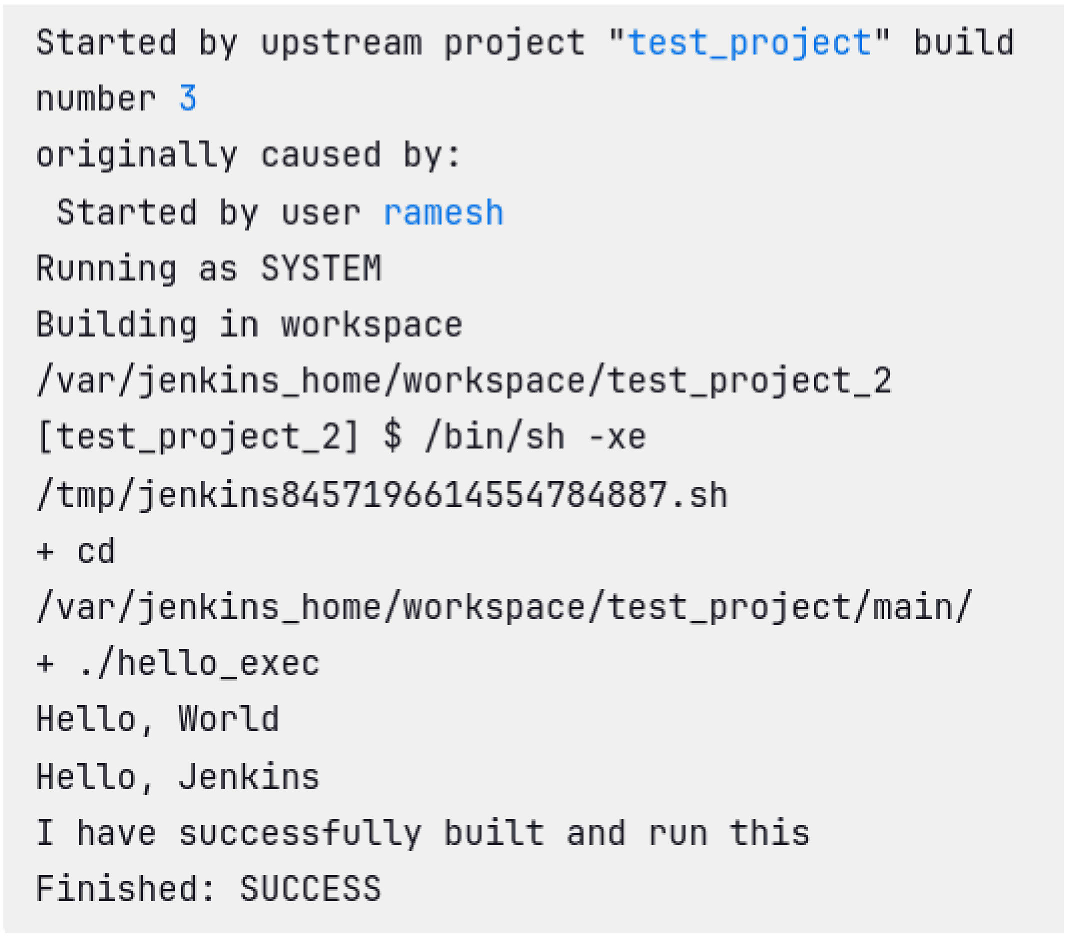
5. Click on Save.
6. Now, set your first job to call the second.
7. Go to your first job (i.e. YOUR_SRN-1) and open the *Configure* page in the pull-down menu.
8. Scroll to bottom and add a Post-Build Action. Select ***Build other projects***.
9. Enter the name of your second job.
10. Click on Save.
11. Run your first job.
12. Do this by clicking build now on the main page.
13. After that successfully builds, go, and check your second job. You should see it successfully run.

first job :



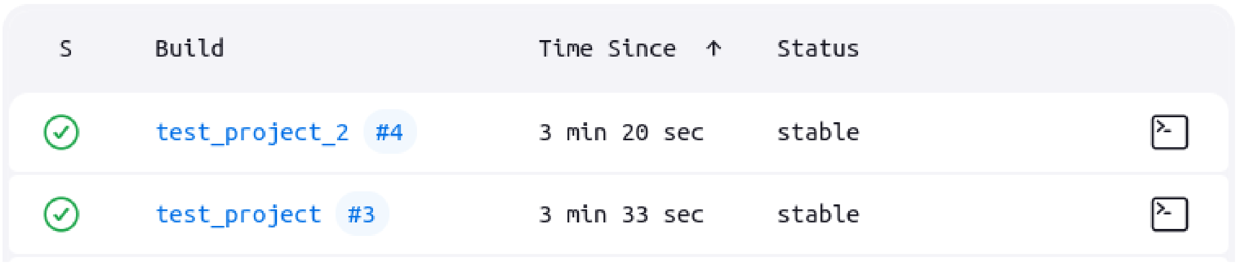
```
timeout=10
Commit message: "modified makefile"
 > git rev-list --no-walk
bc1268e57784a9e94065b45c4b38fabbd032ed7f #
timeout=10
[test_project] $ /bin/sh -xe
/tmp/jenkins4886251441085178999.sh
+ make -C main
make: Entering directory
'/var/jenkins_home/workspace/test_project/main'
make: 'hello_exec' is up to date.
make: Leaving directory
'/var/jenkins_home/workspace/test_project/main'
Triggering a new build of test_project_2
Finished: SUCCESS
```

second job :



```
Started by upstream project "test_project" build
number 3
originally caused by:
 Started by user ramesh
Running as SYSTEM
Building in workspace
/var/jenkins_home/workspace/test_project_2
[test_project_2] $ /bin/sh -xe
/tmp/jenkins8457196614554784887.sh
+ cd
/var/jenkins_home/workspace/test_project/main/
+ ./hello_exec
Hello, World
Hello, Jenkins
I have successfully built and run this
Finished: SUCCESS
```

14. Select a Build Job from History and go to the console log to see your program output. If your program has run there, then you successfully set up a basic pipeline.



S	Build	Time Since ↑	Status	
✓	test_project_2 #4	3 min 20 sec	stable	
✓	test_project #3	3 min 33 sec	stable	

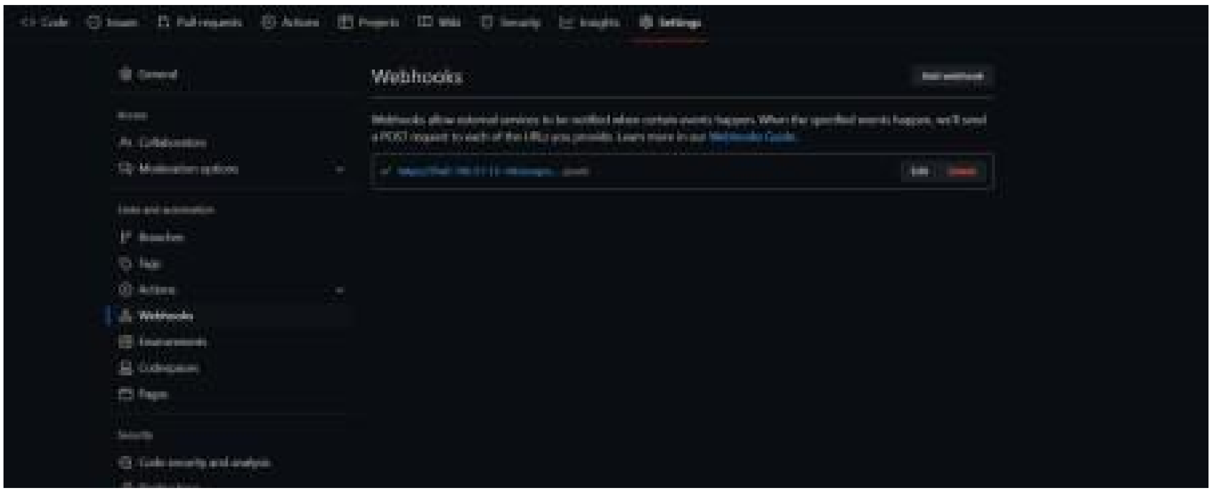
15. Take the required Screenshots.

Task-4

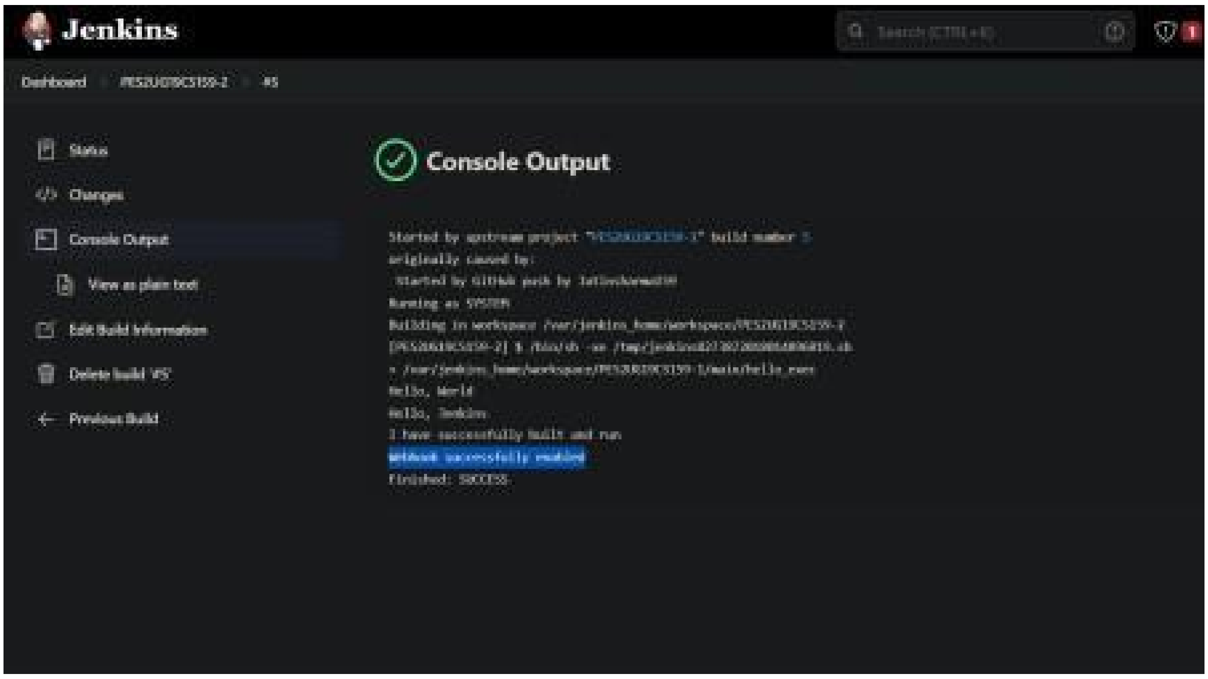
Aim: Add a webhook trigger to your repository in order to automate builds in Jenkin
In the previous tasks, we were polling changes from the repository at an interval of every 5 mins. It is an expensive approach. There is, however, a better approach. By adding a Webhook trigger to your repository and connecting it to your Jenkins server, the instant you commit a change to your repository, your job is automatically executed.

Webhooks allow external services to be notified when certain events happen. When those events happen, a POST request is sent to the designated URL.

Deliverables



1. Webhook added to your GitHub repository



```
Started by upstream project "[illegible]" build number [illegible]
originally caused by:
 Started by GitHub push by [illegible]
Running as SYSTEM
Building in workspace /var/jenkins_home/workspace/[illegible]
[[illegible]] $ /bin/sh -xe /tmp/[illegible].sh
+ /var/jenkins_home/workspace/[illegible]/main/hello_exec
Hello, World
Hello, Jenkins
I have successfully built and run
Webhook successfully enabled
Finished: SUCCESS
```

2. Console Output of second job displaying the change made in hello.cpp file.

Steps:

1. This part of the assignment requires you to have bore installed and running form the previous labs . We are just reusing such good functionality .
2. Open command prompt, navigate to the path where ngrok is downloaded and run the following commands:-

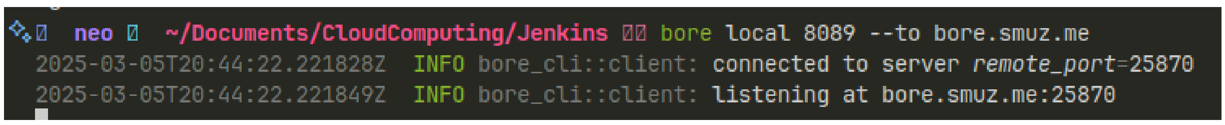
bore local 8080 –to bore.smuz.me

NOTE : the port should be the port that the jenkins container has exposed which is usually

8080

Copy the provided https URL.(ps : forwarding url) eg:

bore.smuz.me:xxxxx

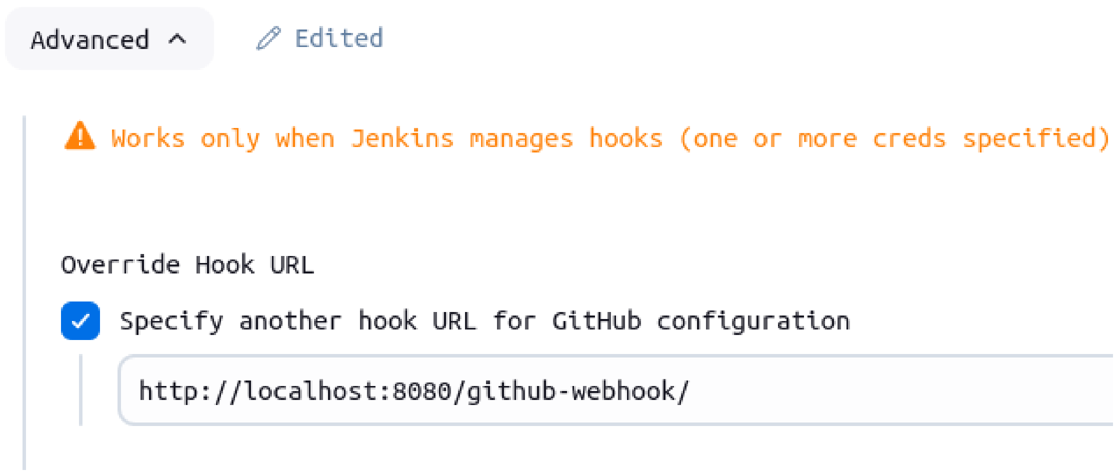


```
neo  ~/Documents/CloudComputing/Jenkins  bore local 8089 --to bore.smuz.me
2025-03-05T20:44:22.221828Z  INFO bore_cli::client: connected to server remote_port=25870
2025-03-05T20:44:22.221849Z  INFO bore_cli::client: listening at bore.smuz.me:25870
```

Make sure to keep this running until the lab is done , basically don't let stupidity

take over .

1. Go to settings of your GitHub repo, look for Webhooks→ Add webhook → Paste the https URL in the Payload URL field and append /github-webhook/ to it. Keep the default settings, however you can explore individual events to trigger this webhook
eg : http://bore.smuz.me:xxxxx/github-webhook
also give a look at manage jenkins > system > github :



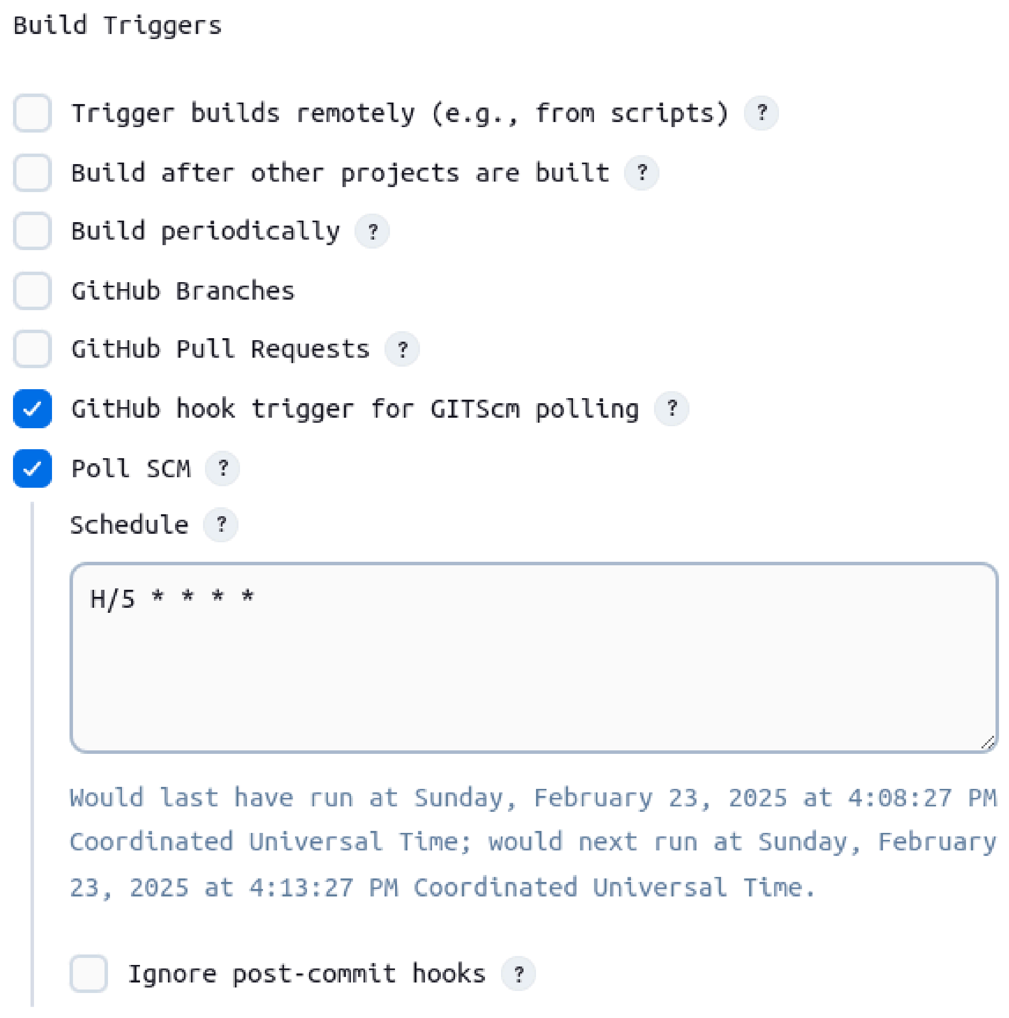
Works only when Jenkins manages hooks (one or more creds specified)

Override Hook URL

☑ Specify another hook URL for GitHub configuration

http://localhost:8080/github-webhook/

it should look like the above picture
→ Add webhook. also make sure your project is configured for webhook :


Build Triggers

- [ ] Trigger builds remotely (e.g., from scripts) ?
- [ ] Build after other projects are built ?
- [ ] Build periodically ?
- [ ] GitHub Branches
- [ ] GitHub Pull Requests ?
- [x] GitHub hook trigger for GITScm polling ?
- [x] Poll SCM ?

Schedule ?

```
H/5 * * * *
```

Would last have run at Sunday, February 23, 2025 at 4:08:27 PM Coordinated Universal Time; would next run at Sunday, February 23, 2025 at 4:13:27 PM Coordinated Universal Time.

- [ ] Ignore post-commit hooks ?

2. Now make a change to your hello.cpp file and commit the change to your repo. Go to the Jenkins server and observe whether your job is executed automatically. Awesome, isn't it?

```
Started by GitHub push by capnmav77
Running as SYSTEM
Building in workspace /var/jenkins_home/workspace/tempo
The recommended git tool is: NONE
No credentials specified
 > git rev-parse --resolve-git-dir /var/jenkins_home/workspace/tempo/.git # timeout=10
Fetching changes from the remote Git repository
 > git config remote.origin.url https://github.com/capnmav77/CC_TA # timeout=10
Fetching upstream changes from https://github.com/capnmav77/CC_TA
 > git --version # timeout=10
 > git --version # 'git version 2.39.5'
 > git fetch --tags --force --progress -- https://github.com/capnmav77/CC_TA
+refs/heads/*:refs/remotes/origin/* # timeout=10
Seen branch in repository origin/main
Seen 1 remote branch
 > git show-ref --tags -d # timeout=10
Checking out Revision 04e5e8e8bf1df85d0e13eb3f0b6ccff1fd17dedb (origin/main)
 > git config core.sparsecheckout # timeout=10
 > git checkout -f 04e5e8e8bf1df85d0e13eb3f0b6ccff1fd17dedb # timeout=10
Commit message: "modified main file"
 > git rev-list --no-walk 0fcfdf3a04592a930ad9ea00ec695b22888d5892 # timeout=10
[tempo] $ /bin/sh -xe /tmp/jenkins17107608479469206706.sh
+ make -C main
make: Entering directory '/var/jenkins_home/workspace/tempo/main'
g++ hello.cpp -o hello_exec
make: Leaving directory '/var/jenkins_home/workspace/tempo/main'
Triggering a new build of temp2
Finished: SUCCESS
```

With this task, we automated our build/execution of jobs and thereby achieving Continuous Integration.

What is Jenkins Pipeline?

Jenkins
COMMIT
BUILD
TEST
STAGE
DEPLOY

In simple words, Jenkins Pipeline is a combination of plugins that support the integration and implementation of continuous delivery pipelines using Jenkins. The pipeline as Code describes a set of features that allow Jenkins users to define pipelined job processes with code, stored and versioned in a source repository.

Why do we need to use Jenkins Pipeline: -

- Pipelines are better than freestyle jobs, you can write a lot of complex tasks using pipelines when compared to Freestyle jobs.

- You can see how long each stage takes to execute so you have more control compared to freestyle.

- Pipeline is a Groovy based script that has a set of plug-ins integrated for automating the builds, deployment and test execution.

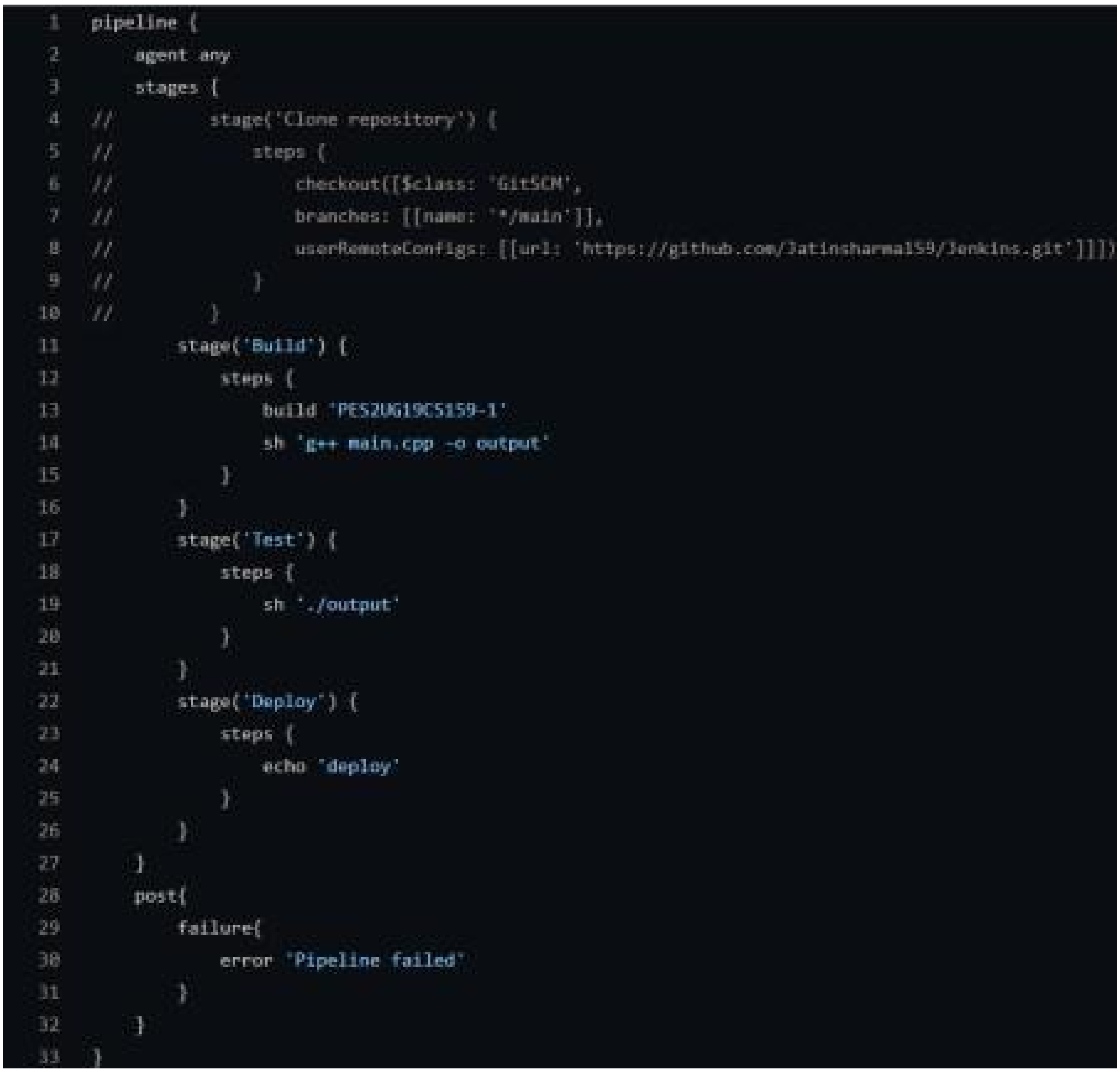
- Pipeline defines your entire build process, which typically includes stages for building an application, testing it and then delivering it.

- You can use a snippet generator to generate pipeline code for the stages where you don't know how to write groovy code.

Task-5

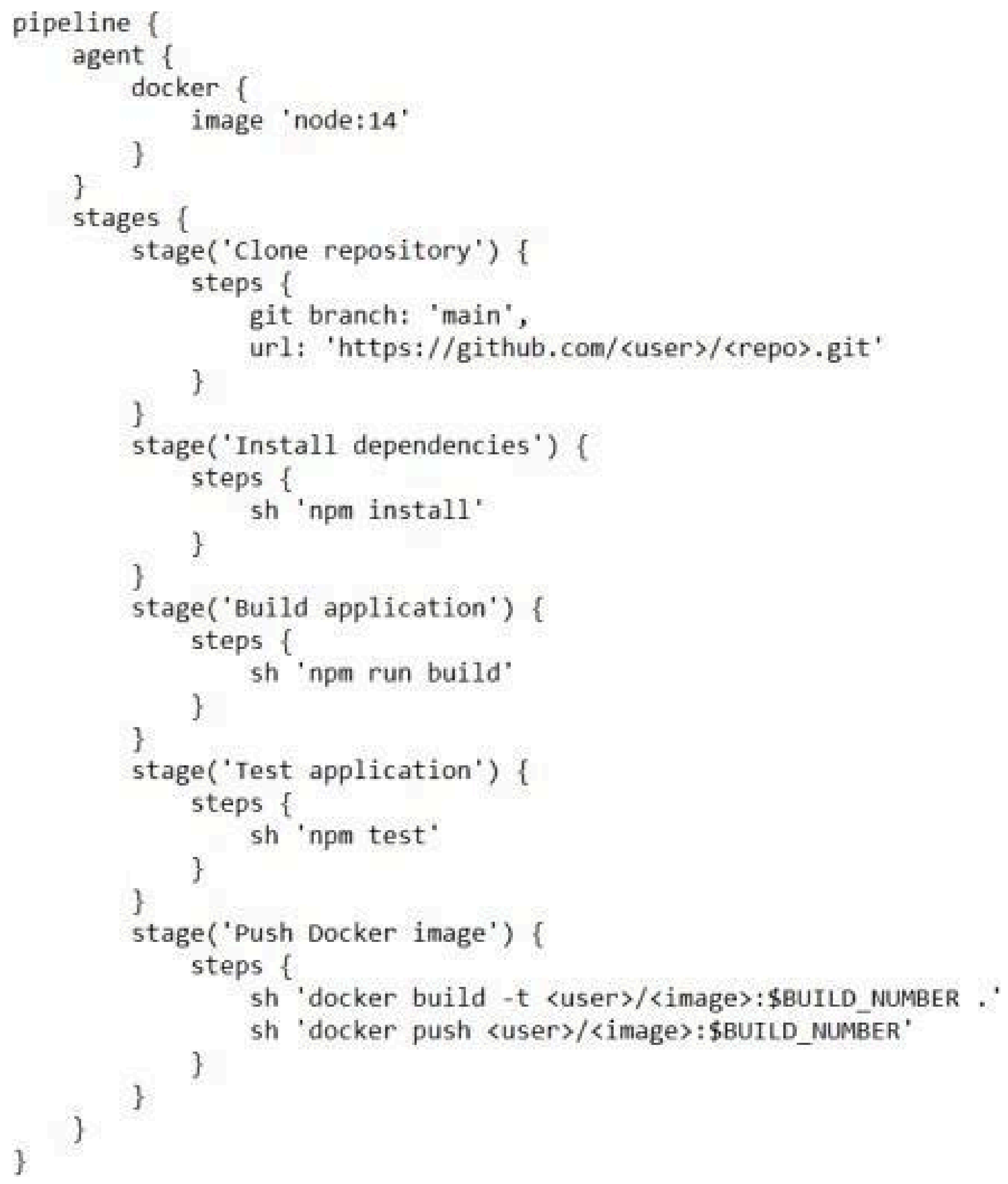
Aim: To create a basic Jenkins pipeline.

Deliverables:



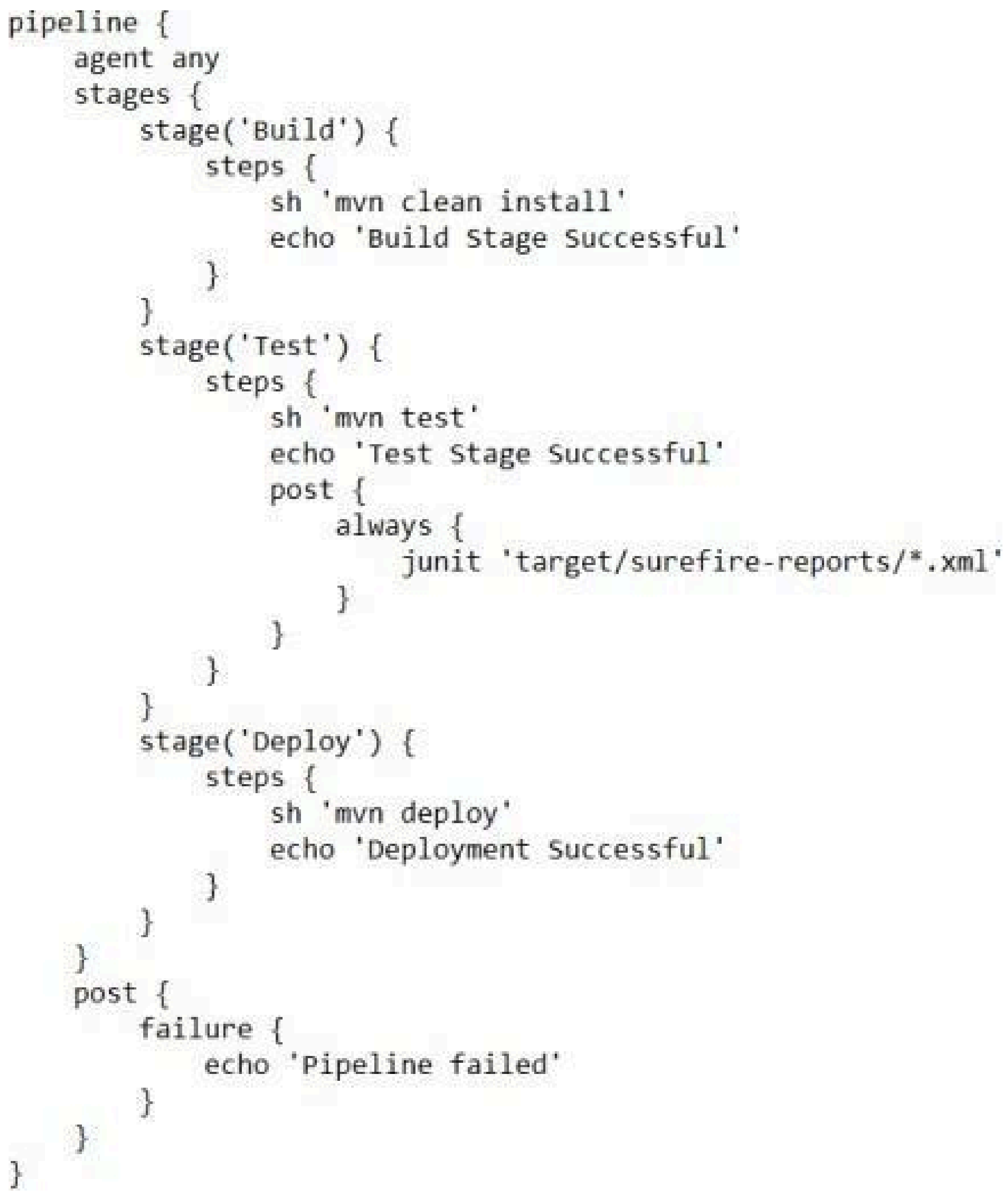
```
pipeline {
    agent any
    stages {
//          stage('Clone repository') {
//              steps {
//                  checkout([$class: 'GitSCM',
//                  branches: [[name: '*/main']],
//                  userRemoteConfigs: [[url: 'https://github.com/Jatinsharma159/Jenkins.git']]])
//              }
//          }
        stage('Build') {
            steps {
                build 'PES2UG19CS159-1'
                sh 'g++ main.cpp -o output'
            }
        }
        stage('Test') {
            steps {
                sh './output'
            }
        }
        stage('Deploy') {
            steps {
                echo 'deploy'
            }
        }
    }
    post{
        failure{
            error 'Pipeline failed'
        }
    }
}
```

1. Code/script written to create basic pipeline using GitHub repository Sample 1 (reference template only)



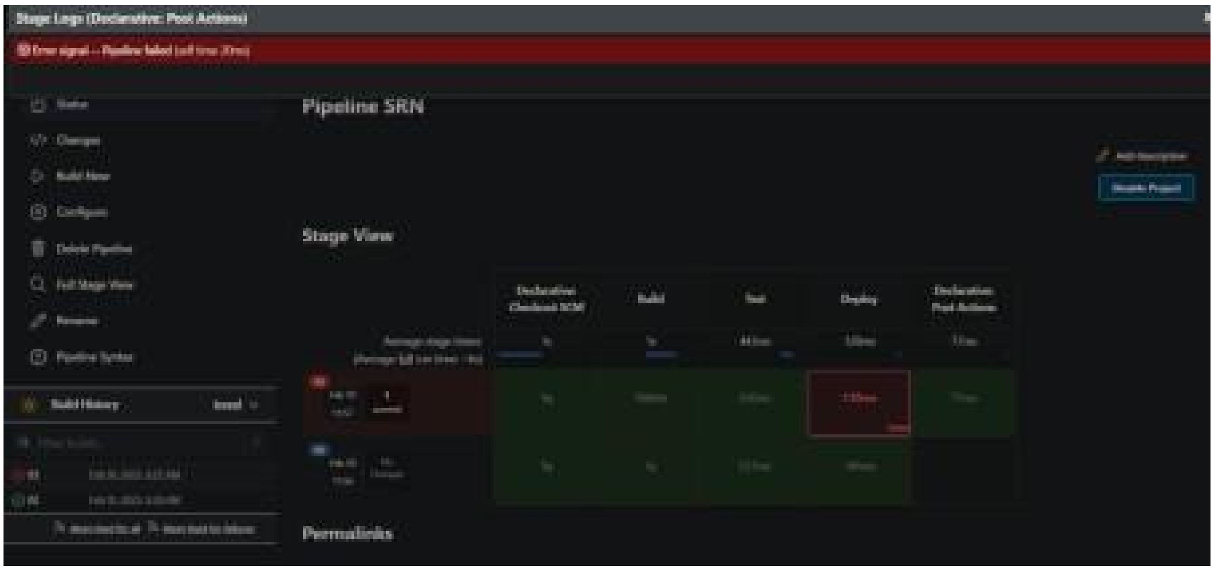
```
pipeline {
    agent {
        docker {
            image 'node:14'
        }
    }
    stages {
        stage('Clone repository') {
            steps {
                git branch: 'main',
                url: 'https://github.com/<user>/<repo>.git'
            }
        }
        stage('Install dependencies') {
            steps {
                sh 'npm install'
            }
        }
        stage('Build application') {
            steps {
                sh 'npm run build'
            }
        }
        stage('Test application') {
            steps {
                sh 'npm test'
            }
        }
        stage('Push Docker image') {
            steps {
                sh 'docker build -t <user>/<image>:$BUILD_NUMBER .'
                sh 'docker push <user>/<image>:$BUILD_NUMBER'
            }
        }
    }
}
```

Sample 2



```
pipeline {
    agent any
    stages {
        stage('Build') {
            steps {
                sh 'mvn clean install'
                echo 'Build Stage Successful'
            }
        }
        stage('Test') {
            steps {
                sh 'mvn test'
                echo 'Test Stage Successful'
                post {
                    always {
                        junit 'target/surefire-reports/*.xml'
                    }
                }
            }
        }
        stage('Deploy') {
            steps {
                sh 'mvn deploy'
                echo 'Deployment Successful'
            }
        }
    }
    post {
        failure {
            echo 'Pipeline failed'
        }
    }
}
```

2. Output of working created pipeline, the screenshot should include
    - Stage view / Execution status of pipeline with all stages succeeded
    - Verify Declarative: Post Actions stage for handling failures.



Stage Logs (Declarative: Post Actions)

Error signal -- Pipeline failed [illegible]

Status
Changes
Build Now
Configure
Delete Pipeline
Full Stage View
Rename
Pipeline Syntax

Build History

Pipeline SRN

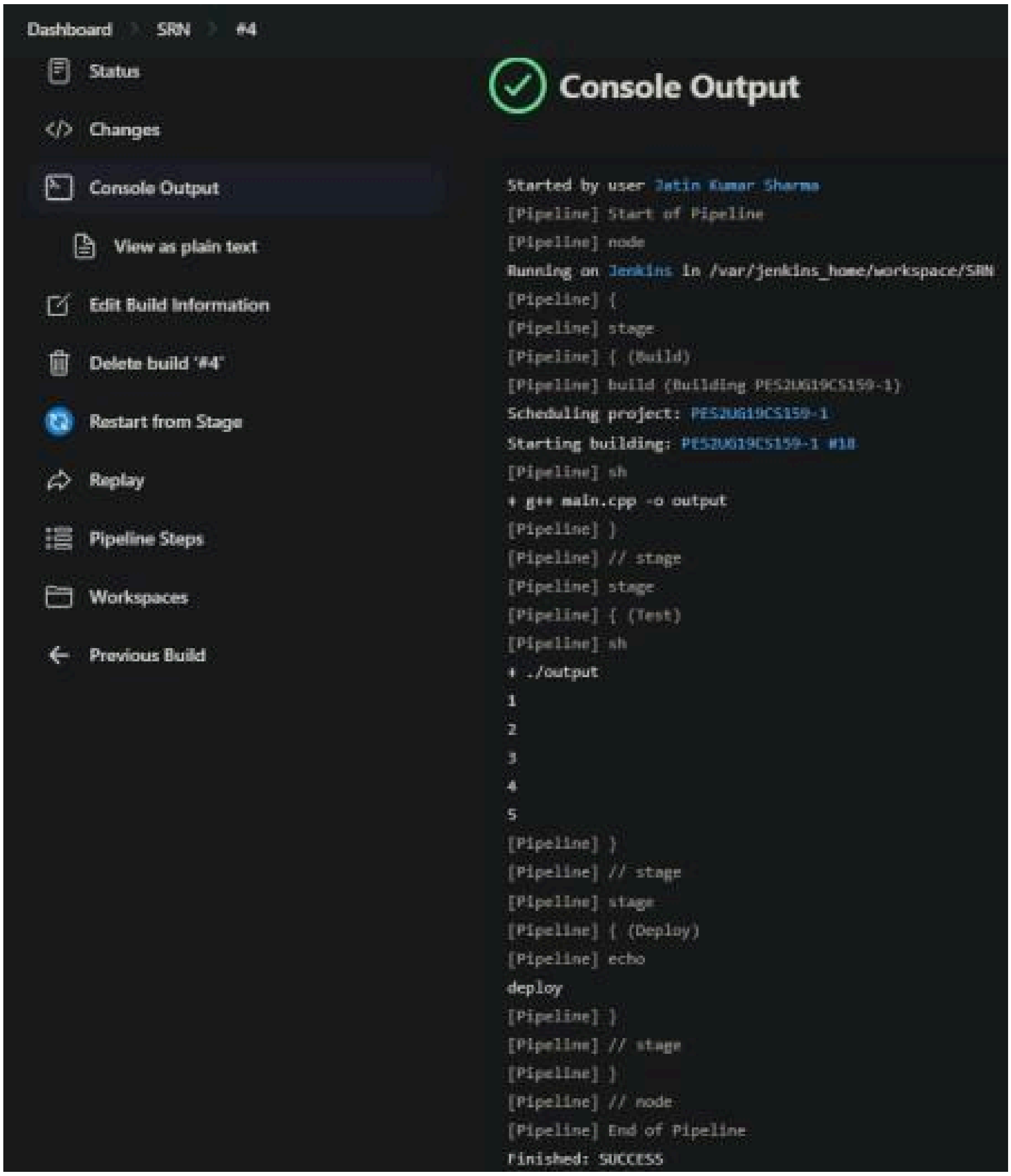
Add description
Disable Project

Stage View

	Declarative: Checkout SCM	Build	Test	Deploy	Declarative: Post Actions
Average stage times:	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Permalinks

3. Console Output of the Pipeline



Console Output

```
Started by user Jatin Kumar Sharma
[Pipeline] Start of Pipeline
[Pipeline] node
Running on Jenkins in /var/jenkins_home/workspace/SRN
[Pipeline] {
[Pipeline] stage
[Pipeline] { (Build)
[Pipeline] build (Building PES2UG19CS159-1)
Scheduling project: PES2UG19CS159-1
Starting building: PES2UG19CS159-1 #18
[Pipeline] sh
+ g++ main.cpp -o output
[Pipeline] }
[Pipeline] // stage
[Pipeline] stage
[Pipeline] { (Test)
[Pipeline] sh
+ ./output
1
2
3
4
5
[Pipeline] }
[Pipeline] // stage
[Pipeline] stage
[Pipeline] { (Deploy)
[Pipeline] echo
deploy
[Pipeline] }
[Pipeline] // stage
[Pipeline] }
[Pipeline] // node
[Pipeline] End of Pipeline
Finished: SUCCESS
```

4. Link to the created GitHub repository

Steps:

1. Create a job in Jenkins. Name the job/item as YOUR_SRN. Select **Pipeline** under projects.
2. Select Pipeline Script. Under sample pipelines, choose Hello World.
3. Save the pipeline and build. You should now have a basic working pipeline containing 1 stage.

4. Write a Jenkinsfile to create a basic pipeline script:
    - Go to your repository⟶Add file ⟶create new file⟶Name the file as Jenkinsfile.
    - Write a script containing a Build, Test, and Deploy stage using Groovy. Also add a post condition to display 'pipeline failed' incase of any errors within the pipeline. Refer to attached scripts. Create a new working .cpp file, push it to your repository.
    - For Build stage :- Compile the .cpp file using shell script, build YOUR_SRN- 1.
    - For the Test stage :- Print output of .cpp file using shell script.
    - Explore pipeline syntax for references.
5. Configure the existing Hello World pipeline job.
6. In pipeline definition, choose Pipeline from SCM
7. Add the link to your GitHub repo in the URL section. Add branch "`*/main`" in **Branches to build** (Do not delete the existing */master branch). Save Pipeline.
8. Execute the pipeline and verify in the stage view whether all stages were executed successfully.
9. Now edit your Jenkinsfile, make an intentional error in one of the stages and commit. Execute the pipeline again, check if the expected stage fails and declarative post action "pipeline failed" carried out successfully.
10. Take the required screenshot of the Stage View.

And that's your Jenkins Lab done and congratulations on making it through . Hope you had fun .
PS credits : CC Faculty , CC TA group '25 , CC TA group '24 and C418 .