Deployment of a Three-Tier Student Registration Application on AWS

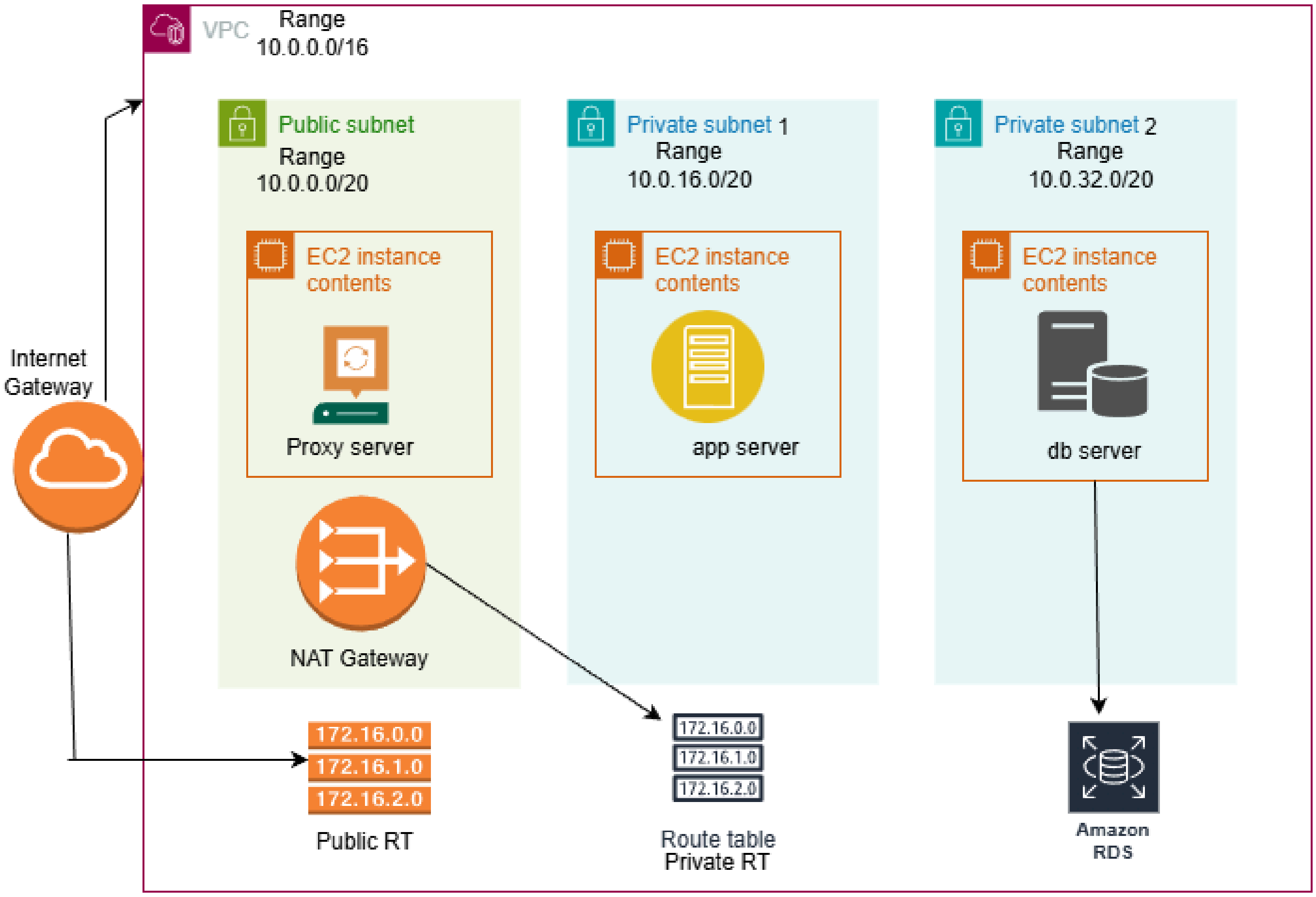
Indroduction

This project demonstrates the deployment of a Java-based Student Registration Web Application on Amazon Web Services (AWS) using a Three-Tier Architecture. The environment consists of an NGINX proxy server placed in a public subnet, an Apache Tomcat application server running in a private subnet, and a MariaDB database hosted on Amazon RDS.

The proxy server manages incoming HTTP requests and also functions as a bastion host, enabling secure SSH access to instances within the private subnet. The complete infrastructure is created within a custom VPC, incorporating subnets, route tables, a NAT gateway, and security groups to ensure secure and controlled communication between all tiers.

This architecture illustrates a real-world, scalable cloud deployment where user traffic flows from the proxy layer to the application layer and finally to the database layer.

Three-Tier Architecture Diagram



Architecture Layes

1. Presentation Tier (Proxy Layer) Hosted in a public subnet Uses NGINX as a reverse proxy Handles all incoming HTTP traffic Also works as a Jump Server (Bastion Host) to connect securely to private instances

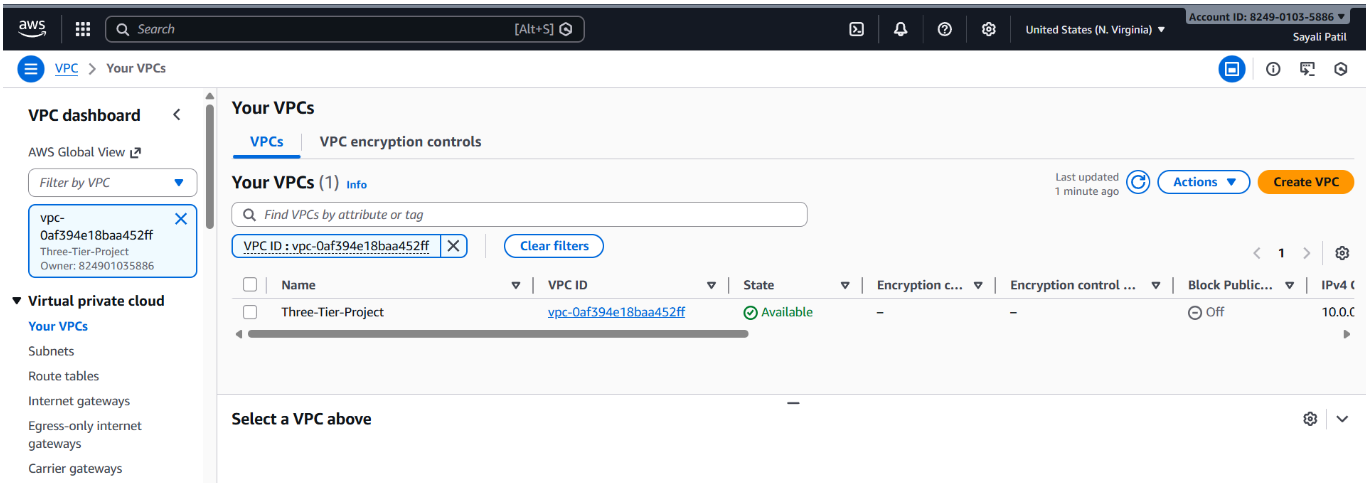
2. Application Tier (Private Subnet) Runs Apache Tomcat Hosts the Java-based Student Registration Web Application Connects to the database through JDBC

3. Database Tier (Private Subnet) Uses Amazon RDS (MariaDB) Stores student registration data Only accessible from the Application Tier (port 3306)

Steps for Deploying the Student Application Form

1. Create VPC

- Name: Three-Tier-Project
- CIDR: 10.0.0.0/16



Name	VPC ID	State	Encryption c...	Encryption control ...	Block Public...	IPv4 C
Three-Tier-Project	vpc-0af394e18baa452ff	Available	–	–	Off	10.0.C

2. Create subnets (across multiple Availability Zones to ensure high availability)

1. public-subnet

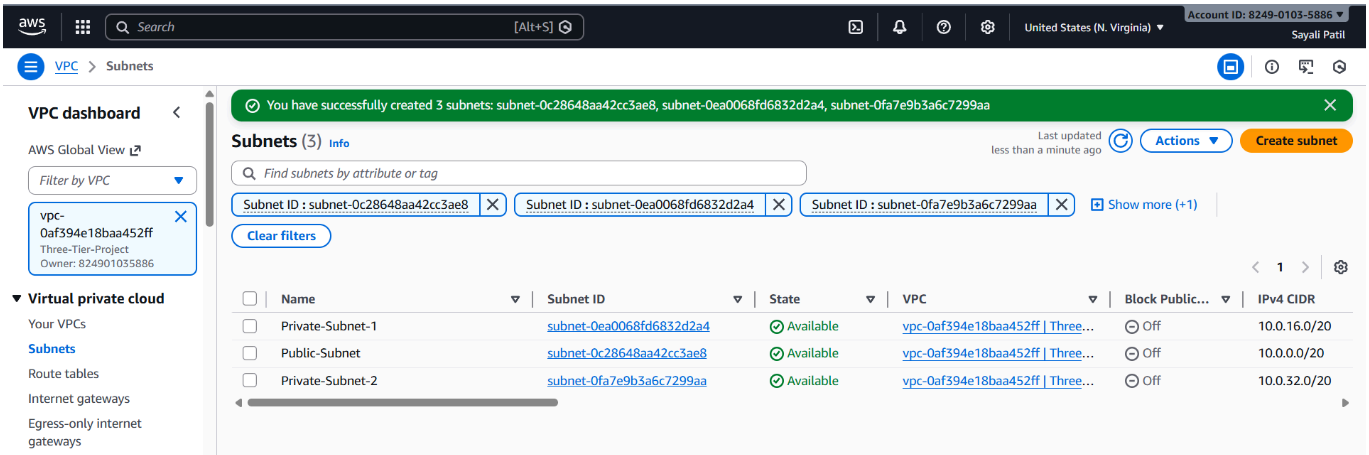
```
CIDR: 10.0.0.0/20
AZ: us-east-1a
Enable auto-assign public IPv4 if you want EC2 with public IP.
```

2. private-subnet-1

```
CIDR: 10.0.16.0/20
AZ: us-east-1b
```

3. private-subnet-2

```
CIDR: 10.0.32.0/20
AZ: us-east-1c
```



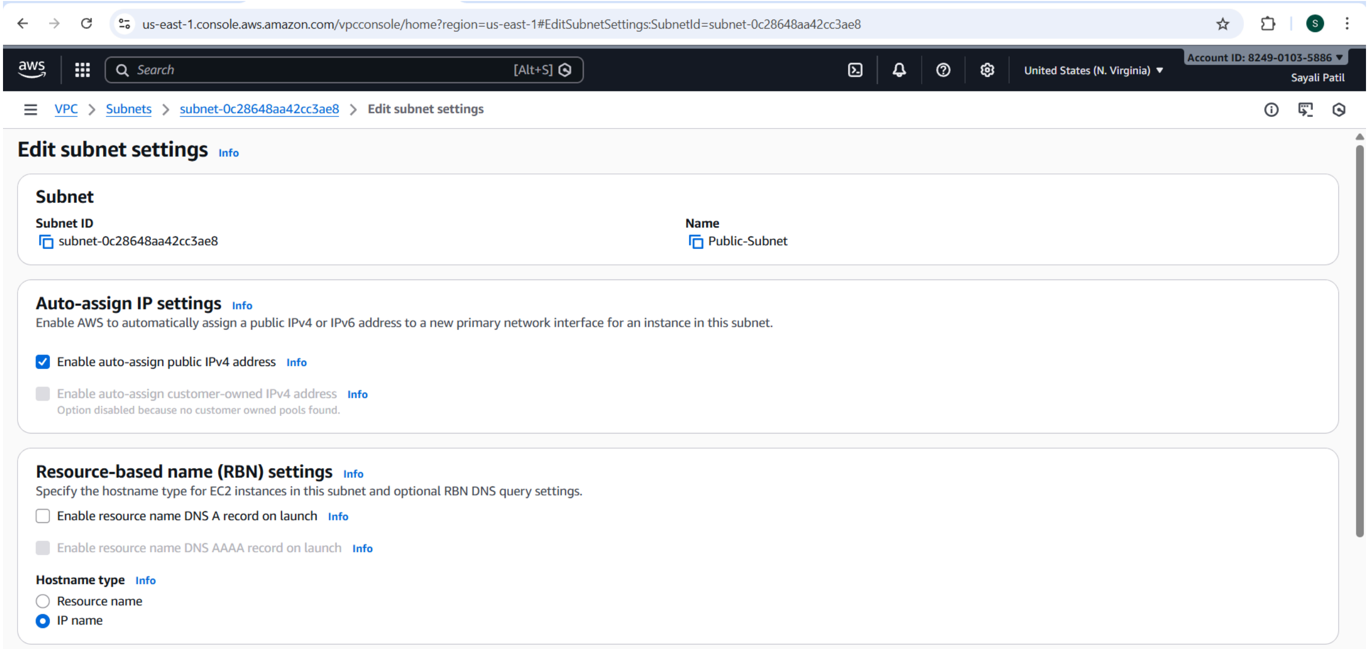
You have successfully created 3 subnets: subnet-0c28648aa42cc3ae8, subnet-0ea0068fd6832d2a4, subnet-0fa7e9b3a6c7299aa

Subnets (3)

Subnet ID : subnet-0c28648aa42cc3ae8 | Subnet ID : subnet-0ea0068fd6832d2a4 | Subnet ID : subnet-0fa7e9b3a6c7299aa

	Name	Subnet ID	State	VPC	Block Public...	IPv4 CIDR
□	Private-Subnet-1	subnet-0ea0068fd6832d2a4	Available	vpc-0af394e18baa452ff | Three...	Off	10.0.16.0/20
□	Public-Subnet	subnet-0c28648aa42cc3ae8	Available	vpc-0af394e18baa452ff | Three...	Off	10.0.0.0/20
□	Private-Subnet-2	subnet-0fa7e9b3a6c7299aa	Available	vpc-0af394e18baa452ff | Three...	Off	10.0.32.0/20

Enable auto assign IP for Public Subnet



us-east-1.console.aws.amazon.com/vpcconsole/home?region=us-east-1#EditSubnetSettings:SubnetId=subnet-0c28648aa42cc3ae8

Edit subnet settings

Subnet

Subnet ID: subnet-0c28648aa42cc3ae8

Name: Public-Subnet

Auto-assign IP settings

Enable AWS to automatically assign a public IPv4 or IPv6 address to a new primary network interface for an instance in this subnet.

☑ Enable auto-assign public IPv4 address

□ Enable auto-assign customer-owned IPv4 address
Option disabled because no customer owned pools found.

Resource-based name (RBN) settings

Specify the hostname type for EC2 instances in this subnet and optional RBN DNS query settings.

□ Enable resource name DNS A record on launch

□ Enable resource name DNS AAAA record on launch

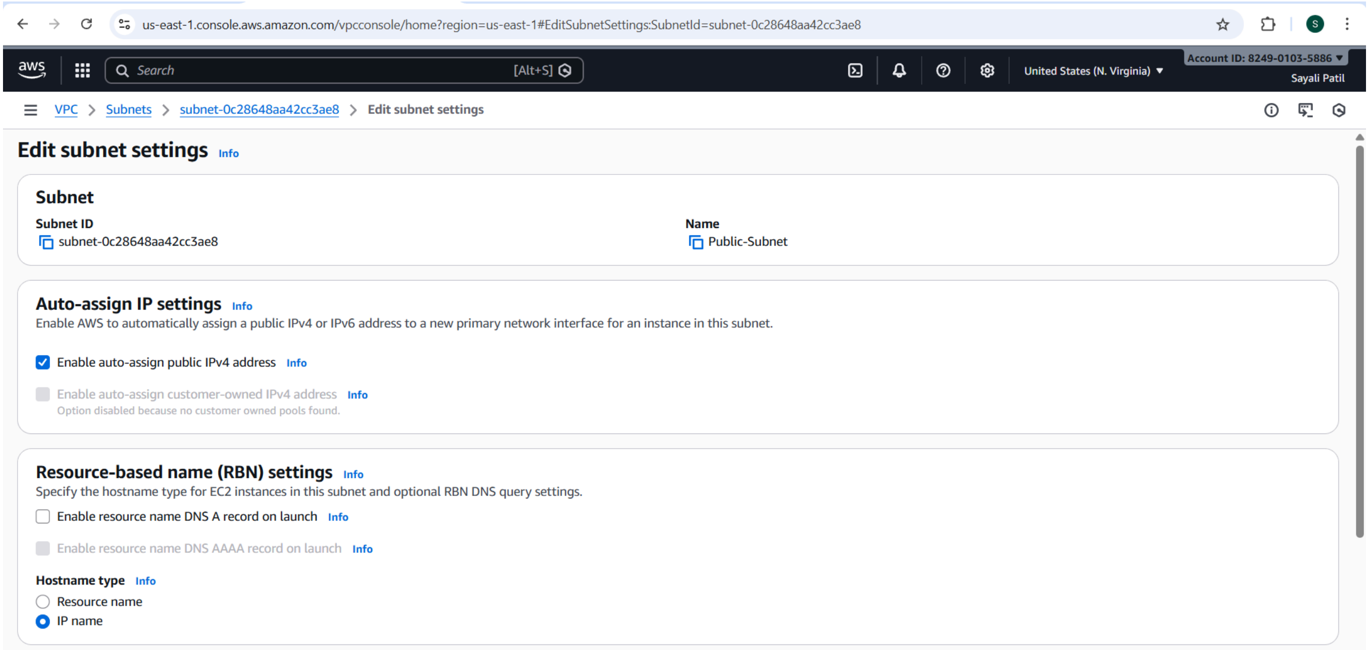
Hostname type

○ Resource name
● IP name

VPC > Subnets > subnet-0c28648aa42cc3ae8 > Edit subnet settings
Account ID: 8249-0103-5886
Sayali Patil
United States (N. Virginia)

3. Create an Internet Gateway + Public Route Table

Create an internet gateway (Three-Tier-IGW) and attach it to VPC (Three-Tier-Project)



us-east-1.console.aws.amazon.com/vpcconsole/home?region=us-east-1#EditSubnetSettings:SubnetId=subnet-0c28648aa42cc3ae8

Account ID: 8249-0103-5886 Sayali Patil

United States (N. Virginia)

VPC > Subnets > subnet-0c28648aa42cc3ae8 > Edit subnet settings

Edit subnet settings Info

Subnet

Subnet ID: subnet-0c28648aa42cc3ae8

Name: Public-Subnet

Auto-assign IP settings Info

Enable AWS to automatically assign a public IPv4 or IPv6 address to a new primary network interface for an instance in this subnet.

☑ Enable auto-assign public IPv4 address Info

□ Enable auto-assign customer-owned IPv4 address Info
Option disabled because no customer owned pools found.

Resource-based name (RBN) settings Info

Specify the hostname type for EC2 instances in this subnet and optional RBN DNS query settings.

□ Enable resource name DNS A record on launch Info

□ Enable resource name DNS AAAA record on launch Info

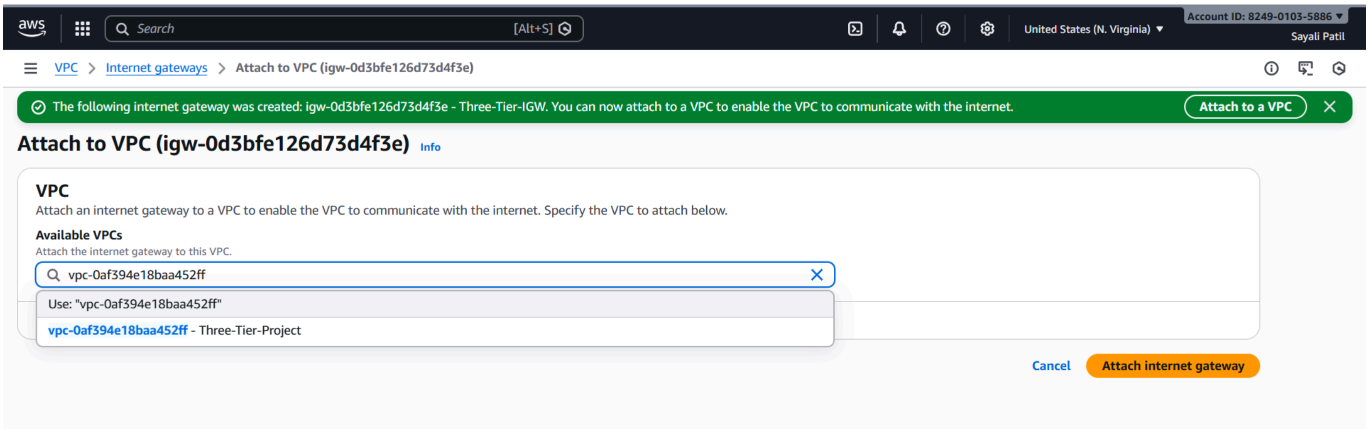
Hostname type Info
○ Resource name
● IP name

Edit Route Table for public traffic

Rename route table to Public-RT

Edit routes: add 0.0.0.0/0 → Target Three-Tier-IGW

Attach the public route table to the public subnet (Optional)



VPC > Internet gateways > Attach to VPC (igw-0d3bfe126d73d4f3e)

The following internet gateway was created: igw-0d3bfe126d73d4f3e - Three-Tier-IGW. You can now attach to a VPC to enable the VPC to communicate with the internet. Attach to a VPC

Attach to VPC (igw-0d3bfe126d73d4f3e) Info

VPC

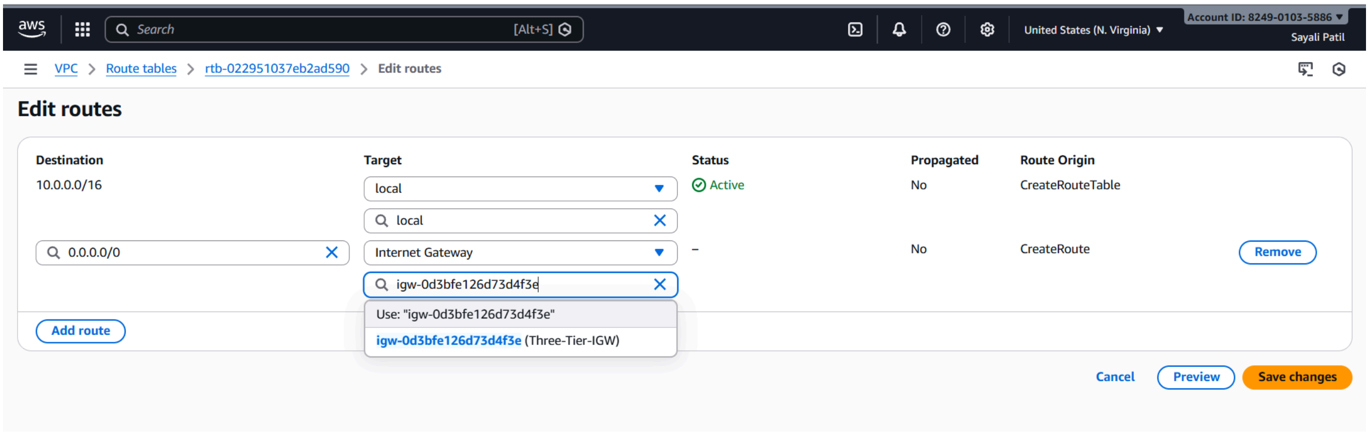
Attach an internet gateway to a VPC to enable the VPC to communicate with the internet. Specify the VPC to attach below.

Available VPCs
Attach the internet gateway to this VPC.

vpc-0af394e18baa452ff

Use: "vpc-0af394e18baa452ff"
vpc-0af394e18baa452ff - Three-Tier-Project

Cancel | Attach internet gateway



VPC > Route tables > rtb-022951037eb2ad590 > Edit routes

Edit routes

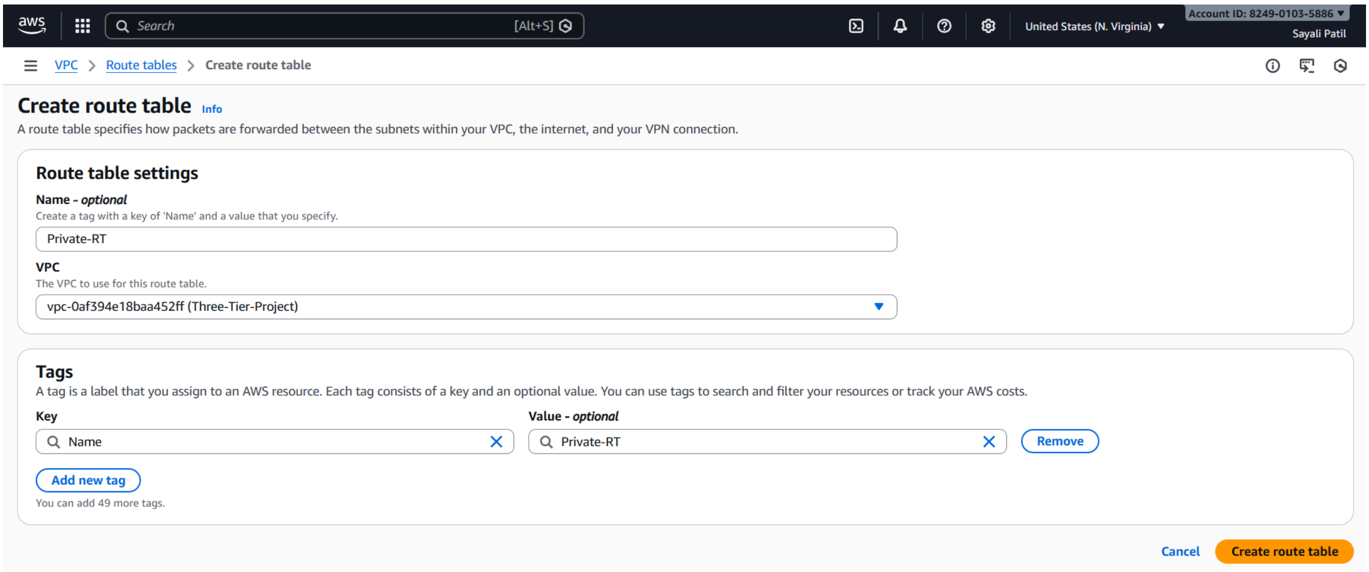
Destination	Target	Status	Propagated	Route Origin
10.0.0.0/16	local	Active	No	CreateRouteTable
0.0.0.0/0	Internet Gateway igw-0d3bfe126d73d4f3e	-	No	CreateRoute

Use: "igw-0d3bfe126d73d4f3e"
igw-0d3bfe126d73d4f3e (Three-Tier-IGW)

Add route | Remove | Cancel | Preview | Save changes

4. NAT Gateway + Private Route Table

1. Create a private route table (Private-RT). Associate private-RT with private-subnet-1 and private-subnet-2



VPC > Route tables > Create route table

Create route table

A route table specifies how packets are forwarded between the subnets within your VPC, the internet, and your VPN connection.

Route table settings

Name - *optional*
Create a tag with a key of 'Name' and a value that you specify.
Private-RT

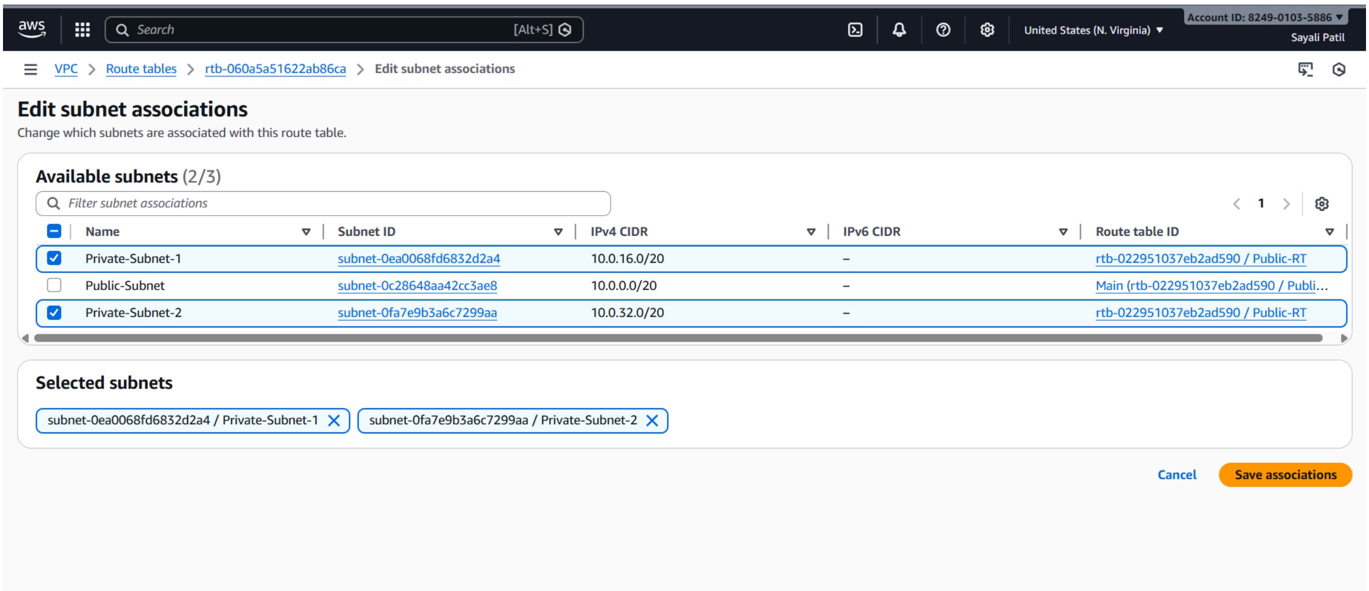
VPC
The VPC to use for this route table.
vpc-0af394e18baa452ff (Three-Tier-Project)

Tags

A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

Key	Value - *optional*
Name	Private-RT

You can add 49 more tags.



VPC > Route tables > rtb-060a5a51622ab86ca > Edit subnet associations

Edit subnet associations

Change which subnets are associated with this route table.

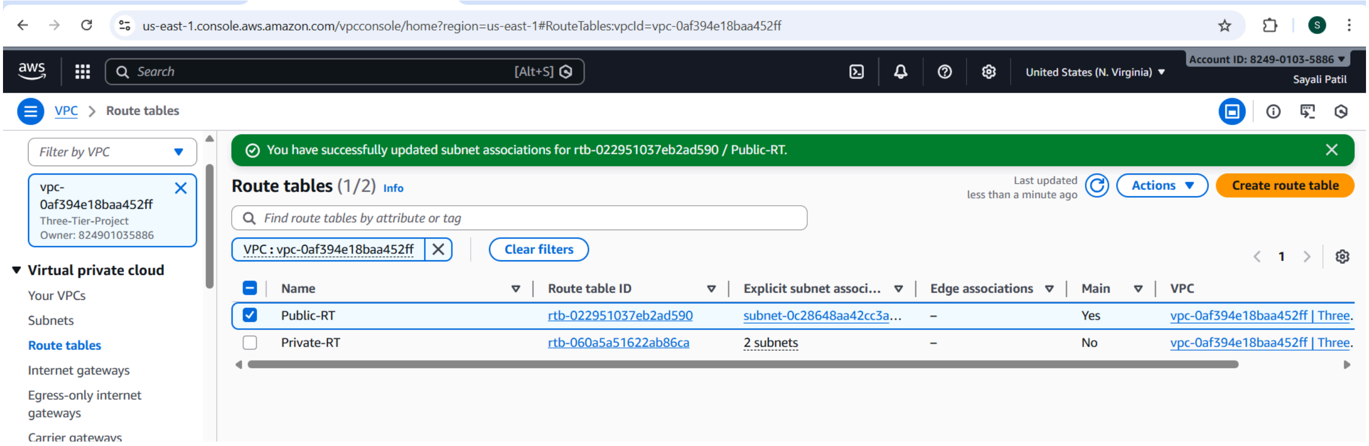
Available subnets (2/3)

	Name	Subnet ID	IPv4 CIDR	IPv6 CIDR	Route table ID
☑	Private-Subnet-1	subnet-0ea0068fd6832d2a4	10.0.16.0/20	–	rtb-022951037eb2ad590 / Public-RT
□	Public-Subnet	subnet-0c28648aa42cc3ae8	10.0.0.0/20	–	Main (rtb-022951037eb2ad590 / Publi…
☑	Private-Subnet-2	subnet-0fa7e9b3a6c7299aa	10.0.32.0/20	–	rtb-022951037eb2ad590 / Public-RT

Selected subnets

subnet-0ea0068fd6832d2a4 / Private-Subnet-1
subnet-0fa7e9b3a6c7299aa / Private-Subnet-2

Search
[Alt+S]
United States (N. Virginia)
Account ID: 8249-0103-5886
Sayali Patil
Filter subnet associations
1
Cancel
Save associations



us-east-1.console.aws.amazon.com/vpcconsole/home?region=us-east-1#RouteTables:vpcId=vpc-0af394e18baa452ff

VPC > Route tables

You have successfully updated subnet associations for rtb-022951037eb2ad590 / Public-RT.

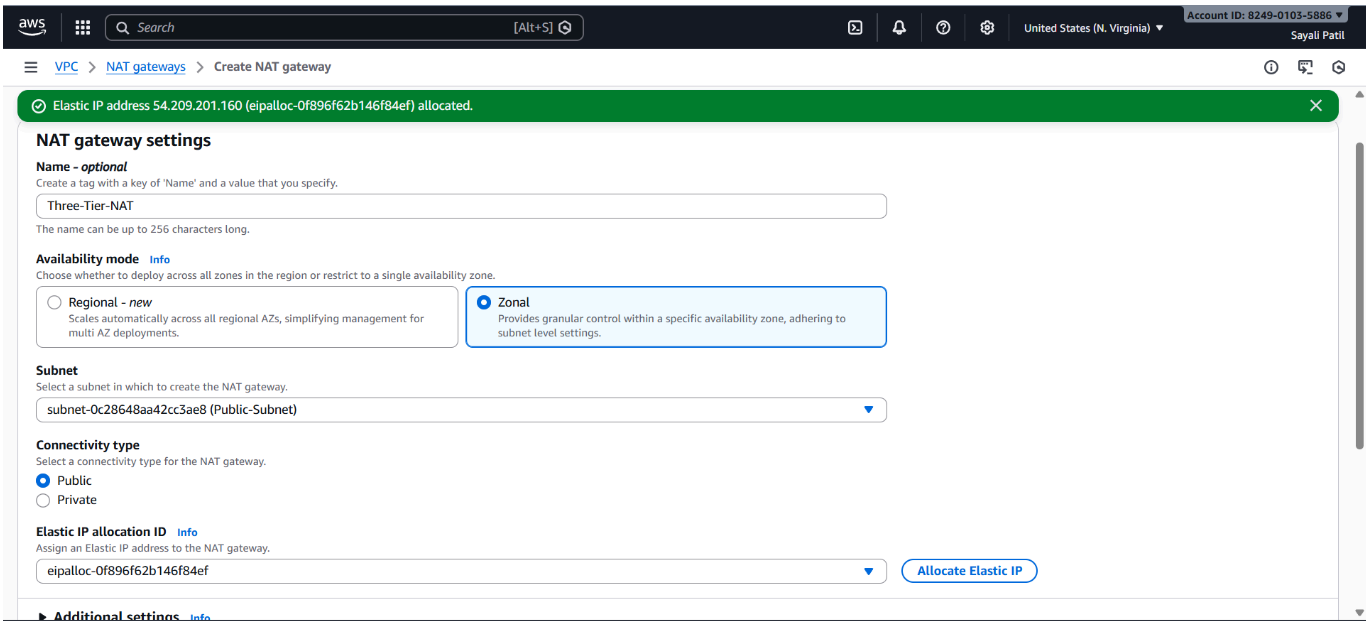
Route tables (1/2)

VPC : vpc-0af394e18baa452ff

	Name	Route table ID	Explicit subnet associ…	Edge associations	Main	VPC
☑	Public-RT	rtb-022951037eb2ad590	subnet-0c28648aa42cc3a…	–	Yes	vpc-0af394e18baa452ff | Three…
□	Private-RT	rtb-060a5a51622ab86ca	2 subnets	–	No	vpc-0af394e18baa452ff | Three…

2. Create NAT Gateway

- Name: Three-Tier-NAT
- Subnet: Public-subnet
- Allocate an Elastic IP for it


aws
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United States (N. Virginia) ▾
Account ID: 8249-0103-5886 ▾
Sayali Patil
VPC > NAT gateways > Create NAT gateway

Elastic IP address 54.209.201.160 (eipalloc-0f896f62b146f84ef) allocated.

NAT gateway settings

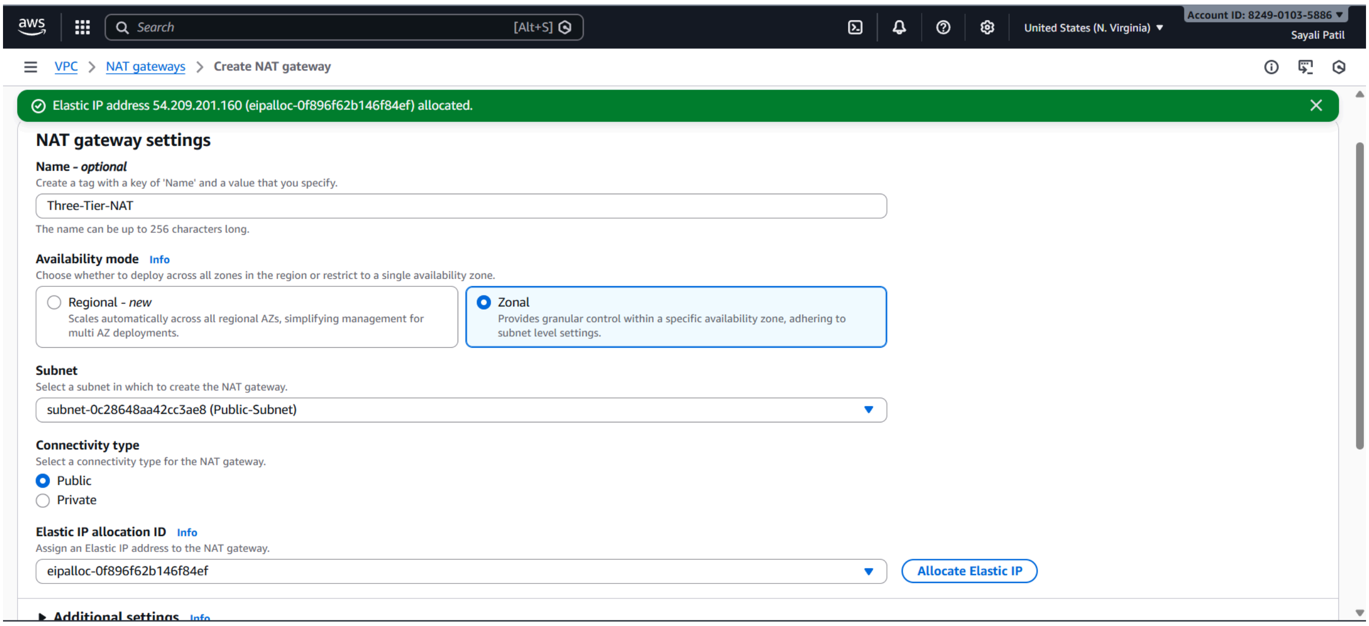
Name - *optional*
Create a tag with a key of 'Name' and a value that you specify.
Three-Tier-NAT
The name can be up to 256 characters long.

Availability mode Info
Choose whether to deploy across all zones in the region or restrict to a single availability zone.
○ Regional - *new* Scales automatically across all regional AZs, simplifying management for multi AZ deployments.
● Zonal Provides granular control within a specific availability zone, adhering to subnet level settings.

Subnet
Select a subnet in which to create the NAT gateway.
subnet-0c28648aa42cc3ae8 (Public-Subnet)

Connectivity type
Select a connectivity type for the NAT gateway.
● Public
○ Private

Elastic IP allocation ID Info
Assign an Elastic IP address to the NAT gateway.
eipalloc-0f896f62b146f84ef


Elastic IP address 54.209.201.160 (eipalloc-0f896f62b146f84ef) allocated.

NAT gateway settings

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Create a tag with a key of 'Name' and a value that you specify.
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The name can be up to 256 characters long.

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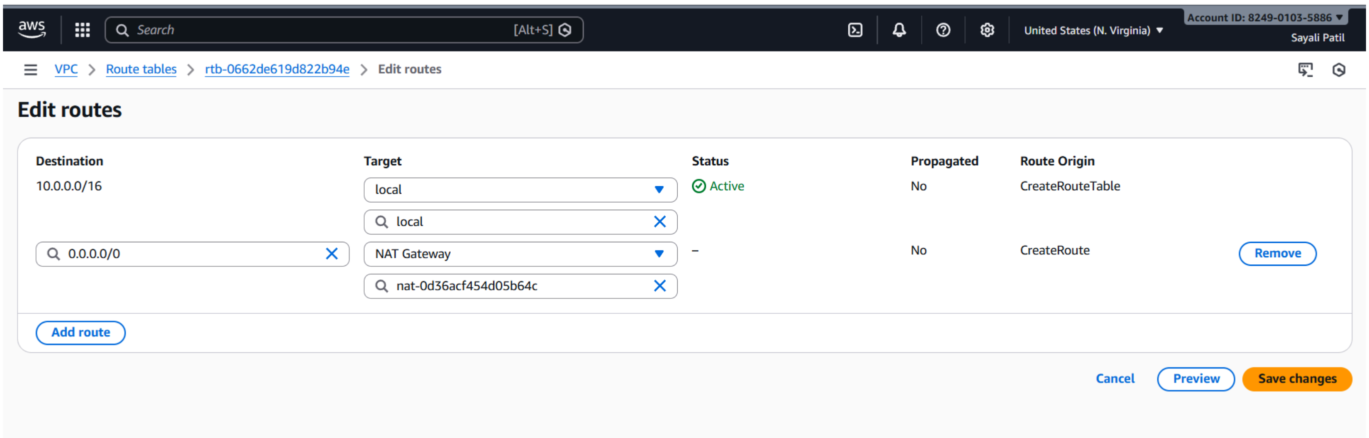
subnet-0c28648aa42cc3ae8 (Public-Subnet)

Connectivity type
Select a connectivity type for the NAT gateway.
● Public
○ Private

Elastic IP allocation ID Info
Assign an Elastic IP address to the NAT gateway.
eipalloc-0f896f62b146f84ef

Edit private-RT routes

- Add 0.0.0.0/0 → target three-tier-NAT.


aws
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United States (N. Virginia) ▾
Account ID: 8249-0103-5886 ▾
Sayali Patil
VPC > Route tables > rtb-0662de619d822b94e > Edit routes

Edit routes

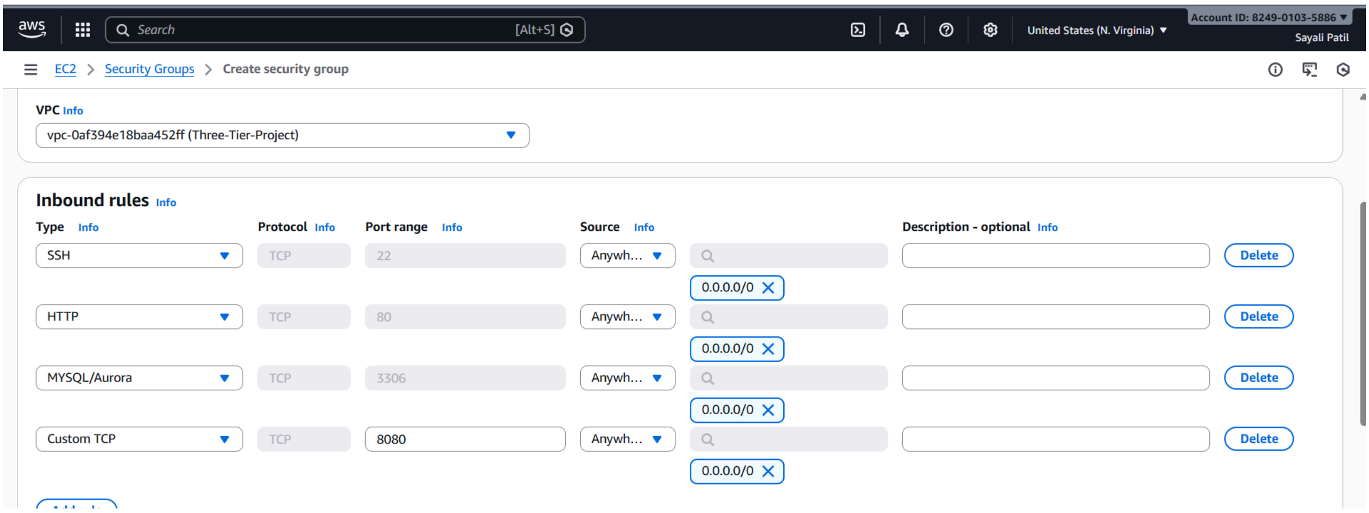
Destination	Target	Status	Propagated	Route Origin	
10.0.0.0/16	local local	✓ Active	No	CreateRouteTable	
0.0.0.0/0	NAT Gateway nat-0d36acf454d05b64c	-	No	CreateRoute	Remove

Add route
Cancel
Preview
Save changes

5. Security Group (Three-Tier-SG)

Create a Security Group with inbound rules in EC2

- 22 (SSH)
- 80 (HTTP)
- 8080 (Tomcat)
- 3306 (MySQL/RDS)



EC2 > Security Groups > Create security group

VPC Info
vpc-0af394e18baa452ff (Three-Tier-Project) ▼

Inbound rules Info

Type Info	Protocol Info	Port range Info	Source Info		Description - optional Info	
SSH	TCP	22	Anywh...	0.0.0.0/0		Delete
HTTP	TCP	80	Anywh...	0.0.0.0/0		Delete
MYSQL/Aurora	TCP	3306	Anywh...	0.0.0.0/0		Delete
Custom TCP	TCP	8080	Anywh...	0.0.0.0/0		Delete

6. Launch EC2 Instances

1. Proxy Server (public)

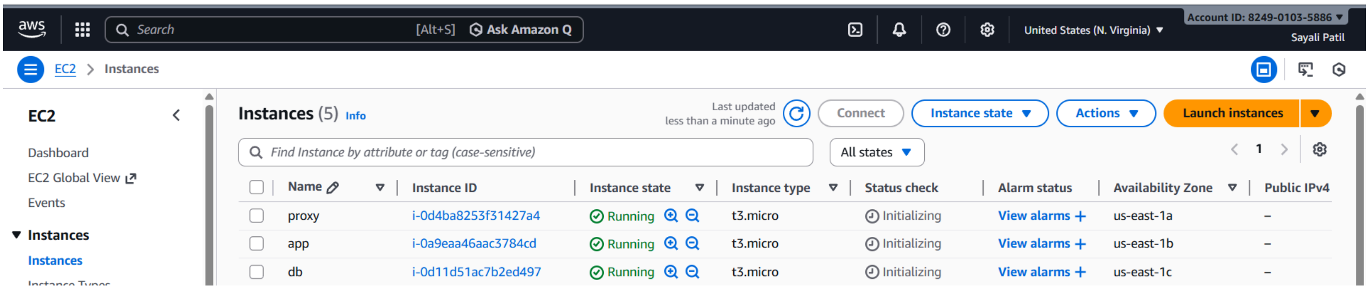
```
Name: Proxy
AMI: Amazon Linux
VPC: Three-Tier-Project
Subnet: Public-subnet
SG: Three-Tier-SG
```

2. App Server (private)

```
Name: App
AMI: Amazon Linux
VPC: Three-Tier-Project
Subnet: Private-subnet-1
SG: Three-Tier-SG
```

3. DB Server (private)

```
Name: DB
AMI: Amazon Linux
VPC: three-tier-Project
Subnet: private-subnet-2
SG: Three-Tier-SG
```



EC2 > Instances

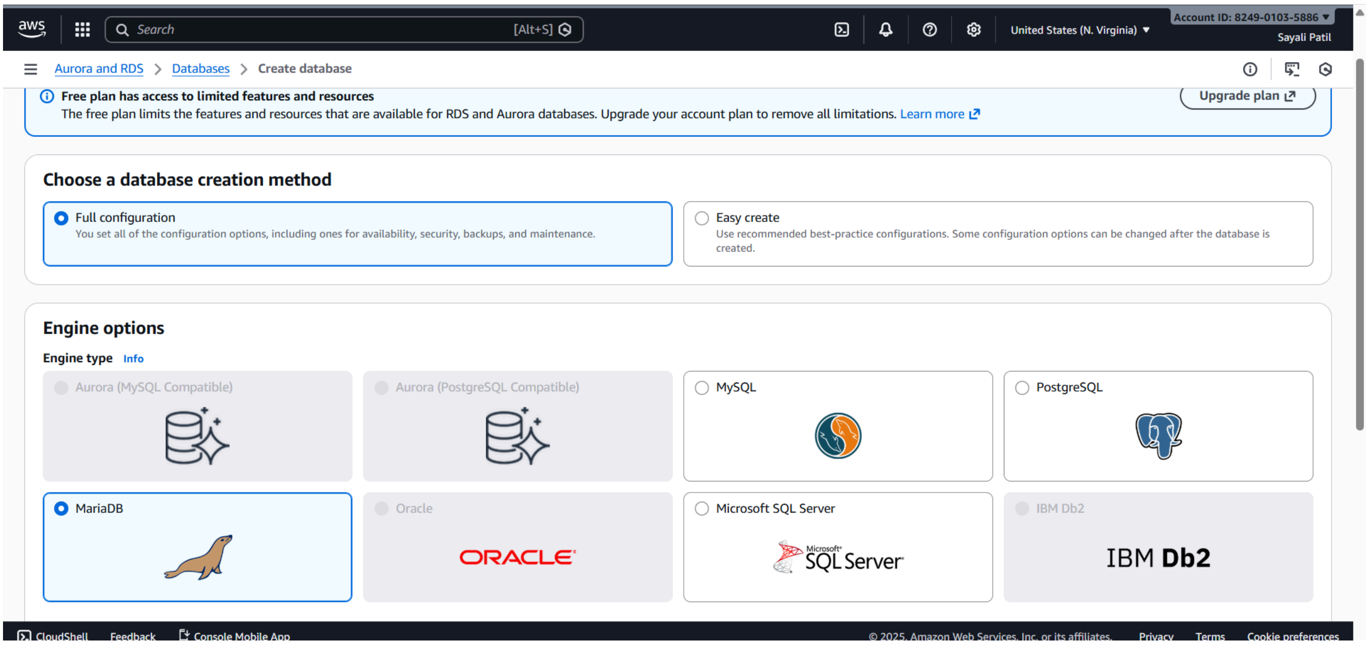
Instances (5) Info

Find Instance by attribute or tag (case-sensitive) All states

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4
proxy	i-0d4ba8253f31427a4	Running	t3.micro	Initializing	View alarms +	us-east-1a	–
app	i-0a9eaa46aac3784cd	Running	t3.micro	Initializing	View alarms +	us-east-1b	–
db	i-0d11d51ac7b2ed497	Running	t3.micro	Initializing	View alarms +	us-east-1c	–

7. RDS MariaDB (Managed DB)

```
Type: full configuration
Engine: MariaDB
DB Identifier: ThreeTierRds
Authentication: Auto-generate password(store securely)
VPC: Three-Tier-Project
Security Group: Three-Tier-SG
Availability Zone: us-east-1c (or use Multi-AZ for higher availability)
```



Aurora and RDS > Databases > Create database

Free plan has access to limited features and resources
The free plan limits the features and resources that are available for RDS and Aurora databases. Upgrade your account plan to remove all limitations. Learn more

Choose a database creation method

● Full configuration
You set all of the configuration options, including ones for availability, security, backups, and maintenance.

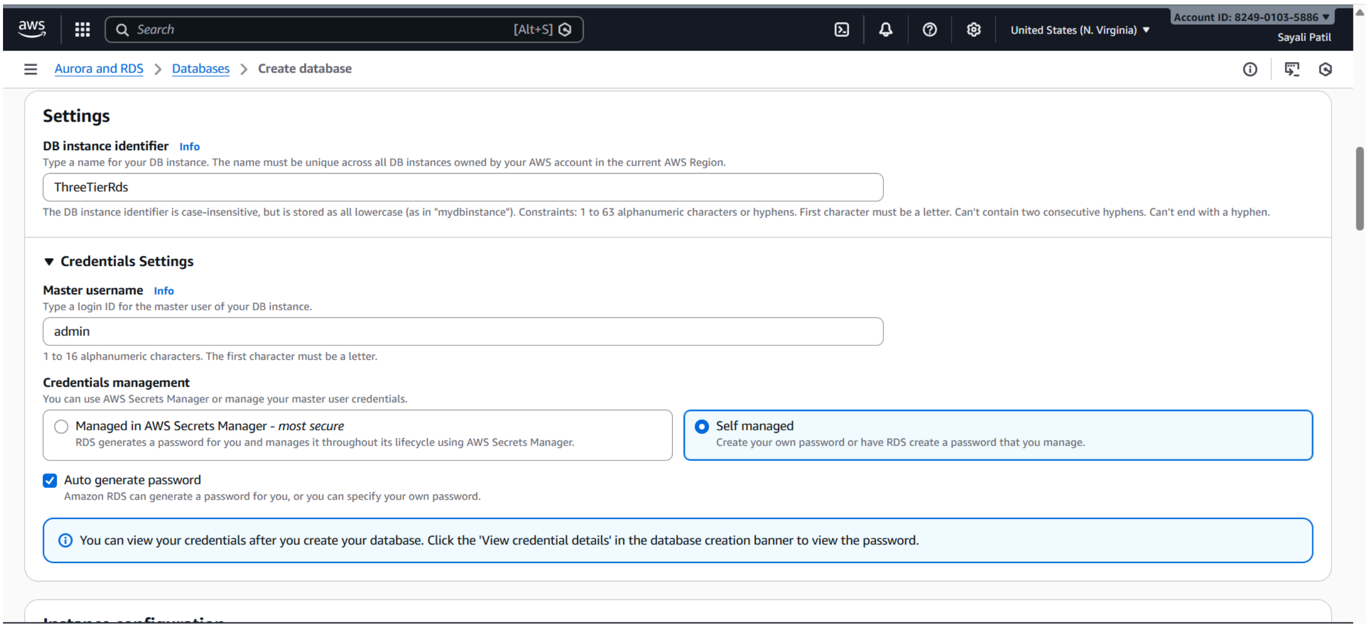
○ Easy create
Use recommended best-practice configurations. Some configuration options can be changed after the database is created.

Engine options

Engine type Info

○ Aurora (MySQL Compatible) ○ Aurora (PostgreSQL Compatible) ○ MySQL ○ PostgreSQL

● MariaDB ○ Oracle ○ Microsoft SQL Server ○ IBM Db2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United States (N. Virginia) ▾
Account ID: 8249-0103-5886 ▾
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Aurora and RDS > Databases > Create database

Settings

DB instance identifier Info

Type a name for your DB instance. The name must be unique across all DB instances owned by your AWS account in the current AWS Region.

ThreeTierRds

The DB instance identifier is case-insensitive, but is stored as all lowercase (as in "mydbinstance"). Constraints: 1 to 63 alphanumeric characters or hyphens. First character must be a letter. Can't contain two consecutive hyphens. Can't end with a hyphen.

▼ **Credentials Settings**

Master username Info

Type a login ID for the master user of your DB instance.

admin

1 to 16 alphanumeric characters. The first character must be a letter.

Credentials management

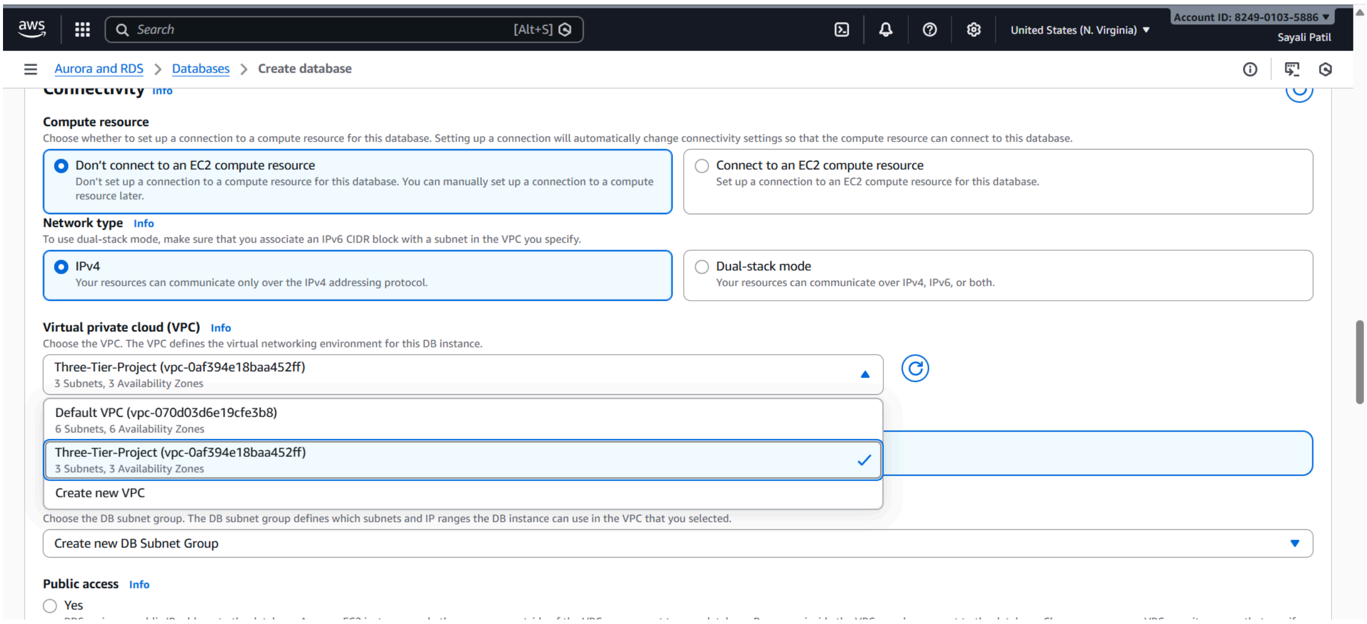
You can use AWS Secrets Manager or manage your master user credentials.

○ Managed in AWS Secrets Manager - *most secure*
RDS generates a password for you and manages it throughout its lifecycle using AWS Secrets Manager.

● Self managed
Create your own password or have RDS create a password that you manage.

☑ Auto generate password
Amazon RDS can generate a password for you, or you can specify your own password.

ⓘ You can view your credentials after you create your database. Click the 'View credential details' in the database creation banner to view the password.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United States (N. Virginia) ▾
Account ID: 8249-0103-5886 ▾
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Aurora and RDS > Databases > Create database

Connectivity Info

Compute resource

Choose whether to set up a connection to a compute resource for this database. Setting up a connection will automatically change connectivity settings so that the compute resource can connect to this database.

● Don't connect to an EC2 compute resource
Don't set up a connection to a compute resource for this database. You can manually set up a connection to a compute resource later.

○ Connect to an EC2 compute resource
Set up a connection to an EC2 compute resource for this database.

Network type Info

To use dual-stack mode, make sure that you associate an IPv6 CIDR block with a subnet in the VPC you specify.

● IPv4
Your resources can communicate only over the IPv4 addressing protocol.

○ Dual-stack mode
Your resources can communicate over IPv4, IPv6, or both.

Virtual private cloud (VPC) Info

Choose the VPC. The VPC defines the virtual networking environment for this DB instance.

Three-Tier-Project (vpc-0af394e18baa452ff)
3 Subnets, 3 Availability Zones

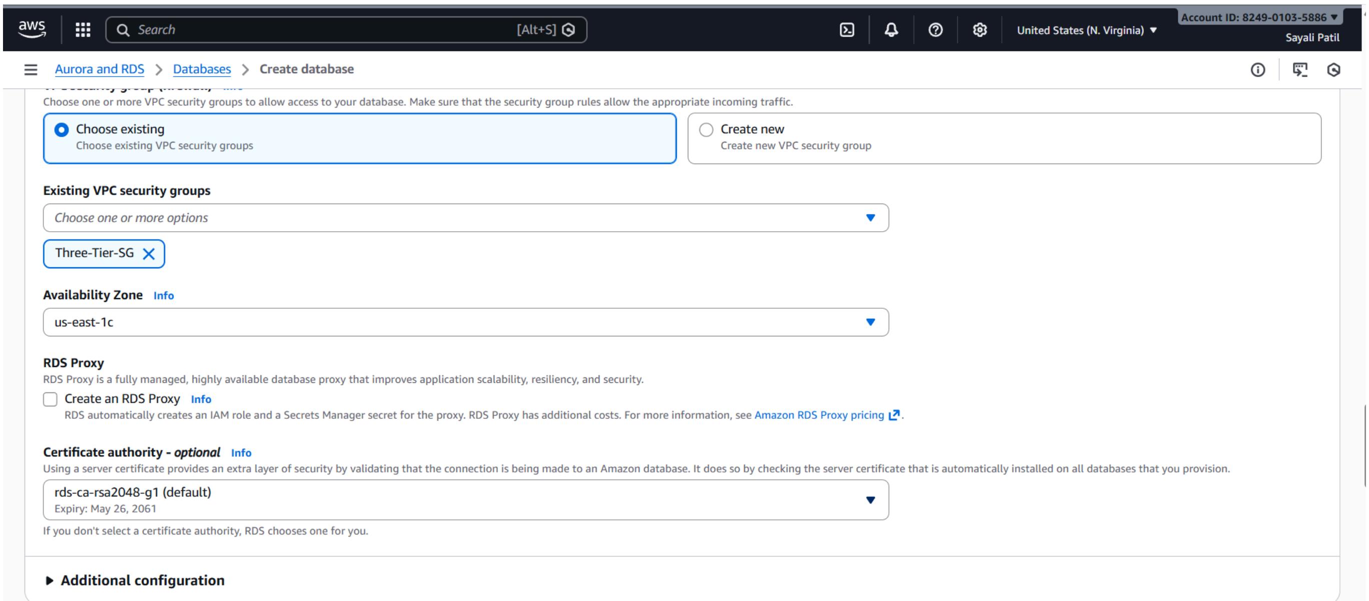
- Default VPC (vpc-070d03d6e19cfe3b8)
  6 Subnets, 6 Availability Zones
- Three-Tier-Project (vpc-0af394e18baa452ff) ✓
  3 Subnets, 3 Availability Zones
- Create new VPC

Choose the DB subnet group. The DB subnet group defines which subnets and IP ranges the DB instance can use in the VPC that you selected.

Create new DB Subnet Group

Public access Info

○ Yes


aws
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United States (N. Virginia) ▾
Account ID: 8249-0103-5886 ▾
Sayali Patil
Aurora and RDS > Databases > Create database

Choose one or more VPC security groups to allow access to your database. Make sure that the security group rules allow the appropriate incoming traffic.

● Choose existing
Choose existing VPC security groups

○ Create new
Create new VPC security group

Existing VPC security groups

Choose one or more options

Three-Tier-SG ✕

Availability Zone Info

us-east-1c

RDS Proxy

RDS Proxy is a fully managed, highly available database proxy that improves application scalability, resiliency, and security.

□ Create an RDS Proxy Info
RDS automatically creates an IAM role and a Secrets Manager secret for the proxy. RDS Proxy has additional costs. For more information, see Amazon RDS Proxy pricing.

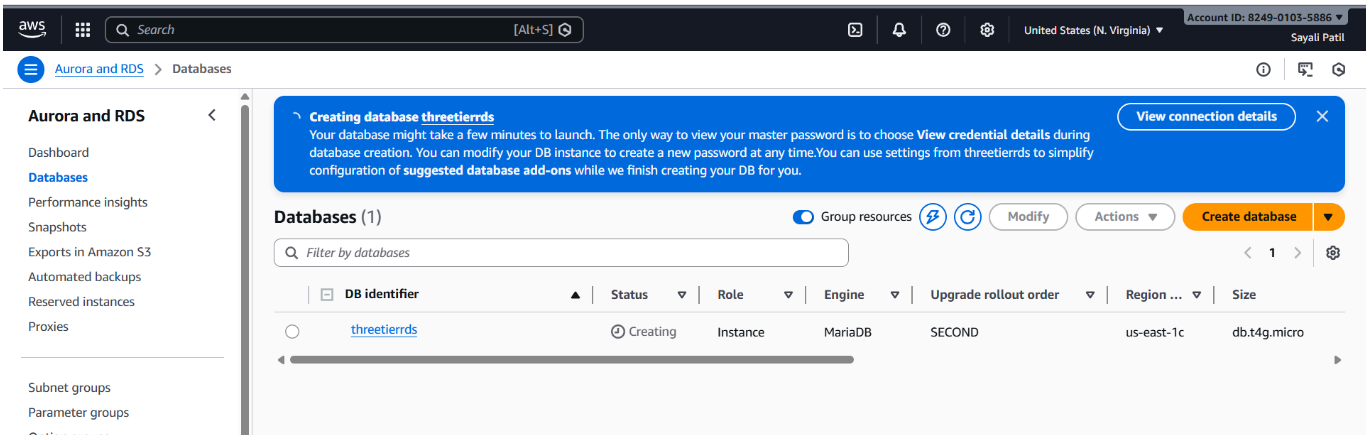
Certificate authority - *optional* Info

Using a server certificate provides an extra layer of security by checking that the connection is being made to an Amazon database. It does so by checking the server certificate that is automatically installed on all databases that you provision.

rds-ca-rsa2048-g1 (default)
Expiry: May 26, 2061

If you don't select a certificate authority, RDS chooses one for you.

▶ **Additional configuration**



Creating database threetierrds
Your database might take a few minutes to launch. The only way to view your master password is to choose **View credential details** during database creation. You can modify your DB instance to create a new password at any time.You can use settings from threetierrds to simplify configuration of **suggested database add-ons** while we finish creating your DB for you.

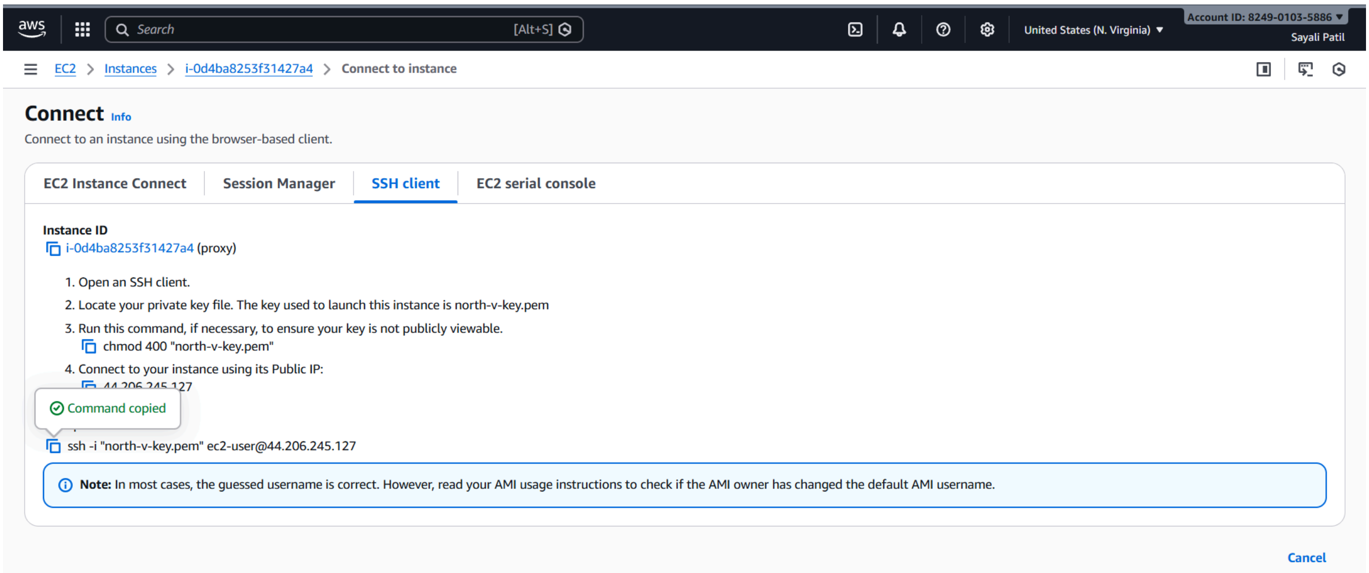
Databases (1)

DB identifier	Status	Role	Engine	Upgrade rollout order	Region ...	Size
threetierrds	Creating	Instance	MariaDB	SECOND	us-east-1c	db.t4g.micro

Make a note of the RDS endpoint and stored password for use in the application DB settings.

8. Proxy Server Setup (NGINX)

Step 1 :Connect via SSH to the Proxy instance.



aws
Search [Alt+S]
Account ID: 8249-0103-5886
United States (N. Virginia)
Sayali Patil
EC2 > Instances > i-0d4ba8253f31427a4 > Connect to instance
EC2 Instance Connect
Session Manager
SSH client
EC2 serial console
Command copied
Cancel

Connect Info

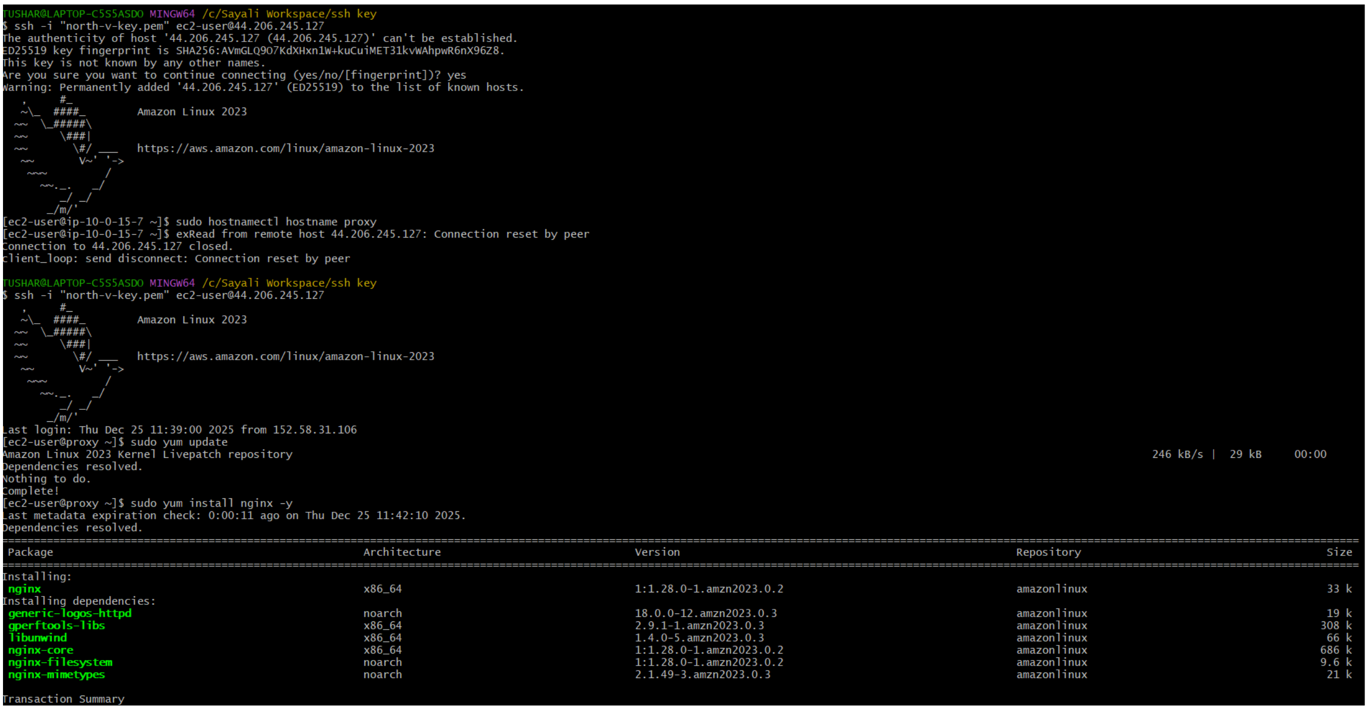
Connect to an instance using the browser-based client.

Instance ID
i-0d4ba8253f31427a4 (proxy)

1. Open an SSH client.
2. Locate your private key file. The key used to launch this instance is north-v-key.pem
3. Run this command, if necessary, to ensure your key is not publicly viewable.
   chmod 400 "north-v-key.pem"
4. Connect to your instance using its Public IP:
   44.206.245.127

ssh -i "north-v-key.pem" ec2-user@44.206.245.127

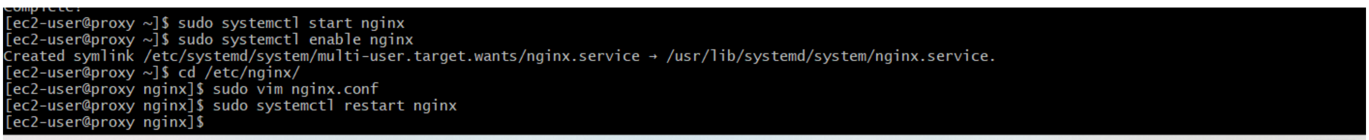
Note: In most cases, the guessed username is correct. However, read your AMI usage instructions to check if the AMI owner has changed the default AMI username.



```
TUSHAR@LAPTOP-C5S5ASDO MINGW64 /c/Sayali Workspace/ssh key
$ ssh -i "north-v-key.pem" ec2-user@44.206.245.127
The authenticity of host '44.206.245.127 (44.206.245.127)' can't be established.
ED25519 key fingerprint is SHA256:AVmGLQ9O7KdXHxn1W+kuCuiMET31kvWAhpwR6nX96Z8.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '44.206.245.127' (ED25519) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
[ec2-user@ip-10-0-15-7 ~]$ sudo hostnamectl hostname proxy
[ec2-user@ip-10-0-15-7 ~]$ exRead from remote host 44.206.245.127: Connection reset by peer
Connection to 44.206.245.127 closed.
client_loop: send disconnect: Connection reset by peer

TUSHAR@LAPTOP-C5S5ASDO MINGW64 /c/Sayali Workspace/ssh key
$ ssh -i "north-v-key.pem" ec2-user@44.206.245.127
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Thu Dec 25 11:39:00 2025 from 152.58.31.106
[ec2-user@proxy ~]$ sudo yum update
Amazon Linux 2023 Kernel Livepatch repository                                                        246 kB/s |  29 kB     00:00
Dependencies resolved.
Nothing to do.
Complete!
[ec2-user@proxy ~]$ sudo yum install nginx -y
Last metadata expiration check: 0:00:11 ago on Thu Dec 25 11:42:10 2025.
Dependencies resolved.
==================================================================================================================================
 Package                          Architecture            Version                            Repository                      Size
==================================================================================================================================
Installing:
 nginx                            x86_64                  1:1.28.0-1.amzn2023.0.2            amazonlinux                     33 k
Installing dependencies:
 generic-logos-httpd              noarch                  18.0.0-12.amzn2023.0.3             amazonlinux                     19 k
 gperftools-libs                  x86_64                  2.9.1-1.amzn2023.0.3               amazonlinux                    308 k
 libunwind                        x86_64                  1.4.0-5.amzn2023.0.3               amazonlinux                     66 k
 nginx-core                       x86_64                  1:1.28.0-1.amzn2023.0.2            amazonlinux                    686 k
 nginx-filesystem                 noarch                  1:1.28.0-1.amzn2023.0.2            amazonlinux                    9.6 k
 nginx-mimetypes                  noarch                  2.1.49-3.amzn2023.0.3              amazonlinux                     21 k

Transaction Summary
```

Step 2: Install and start NGINX

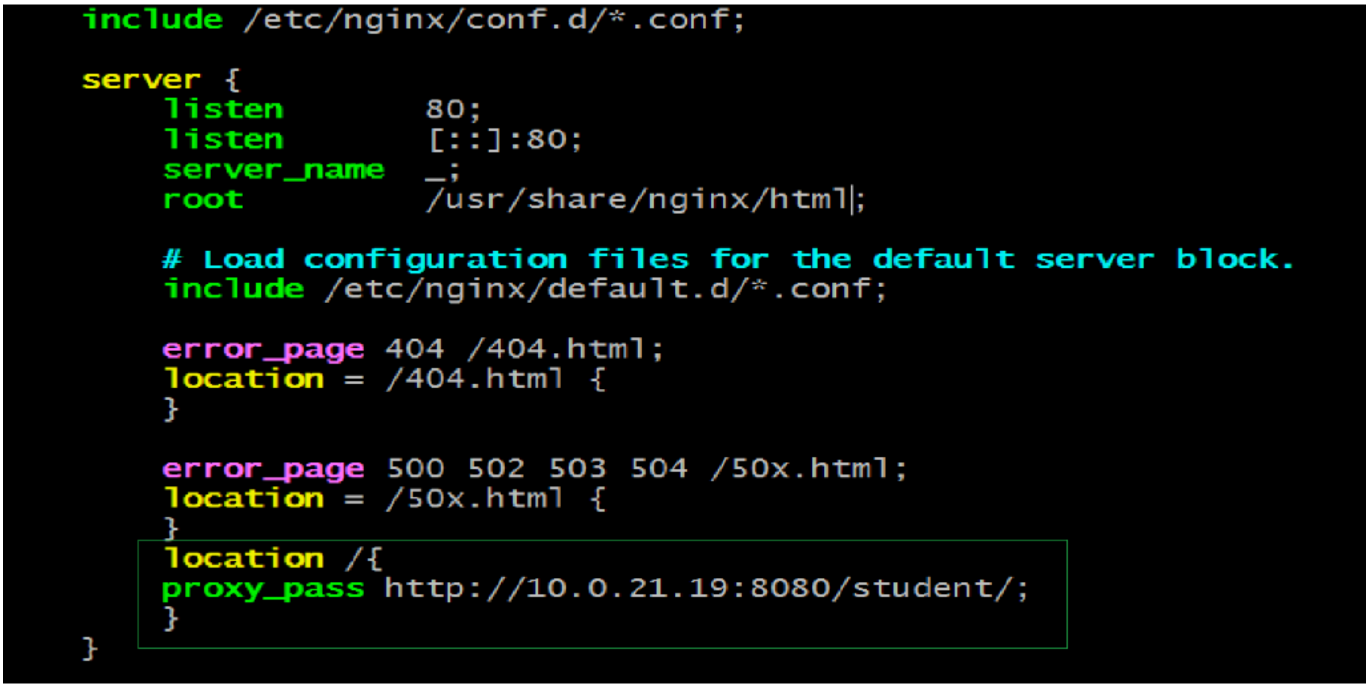
```
sudo yum update -y
sudo yum install nginx -y
sudo systemctl start nginx
sudo systemctl enable nginx
sudo systemctl status nginx
cd /etc/nginx
```



```
Complete!
[ec2-user@proxy ~]$ sudo systemctl start nginx
[ec2-user@proxy ~]$ sudo systemctl enable nginx
Created symlink /etc/systemd/system/multi-user.target.wants/nginx.service → /usr/lib/systemd/system/nginx.service.
[ec2-user@proxy ~]$ cd /etc/nginx/
[ec2-user@proxy nginx]$ sudo vim nginx.conf
[ec2-user@proxy nginx]$ sudo systemctl restart nginx
[ec2-user@proxy nginx]$
```

Step 3: Edit NGINX configuration

```
sudo vim nginx.conf
Inside the server block, add: location / { proxy_pass http://:8080/student/; }
```



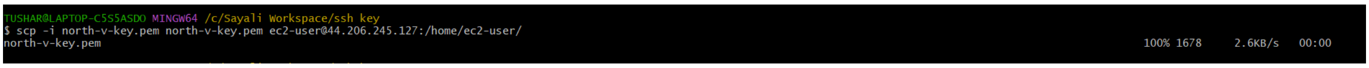
```
    include /etc/nginx/conf.d/*.conf;

    server {
        listen       80;
        listen       [::]:80;
        server_name  _;
        root         /usr/share/nginx/html;

        # Load configuration files for the default server block.
        include /etc/nginx/default.d/*.conf;

        error_page 404 /404.html;
        location = /404.html {
        }

        error_page 500 502 503 504 /50x.html;
        location = /50x.html {
        }
        location /{
        proxy_pass http://10.0.21.19:8080/student/;
        }
    }
```

Step 4: Restart Nginx

```
sudo systemctl restart nginx
```

9. Copy the private key to the proxy server if SSH access to the application server will be done through the proxy

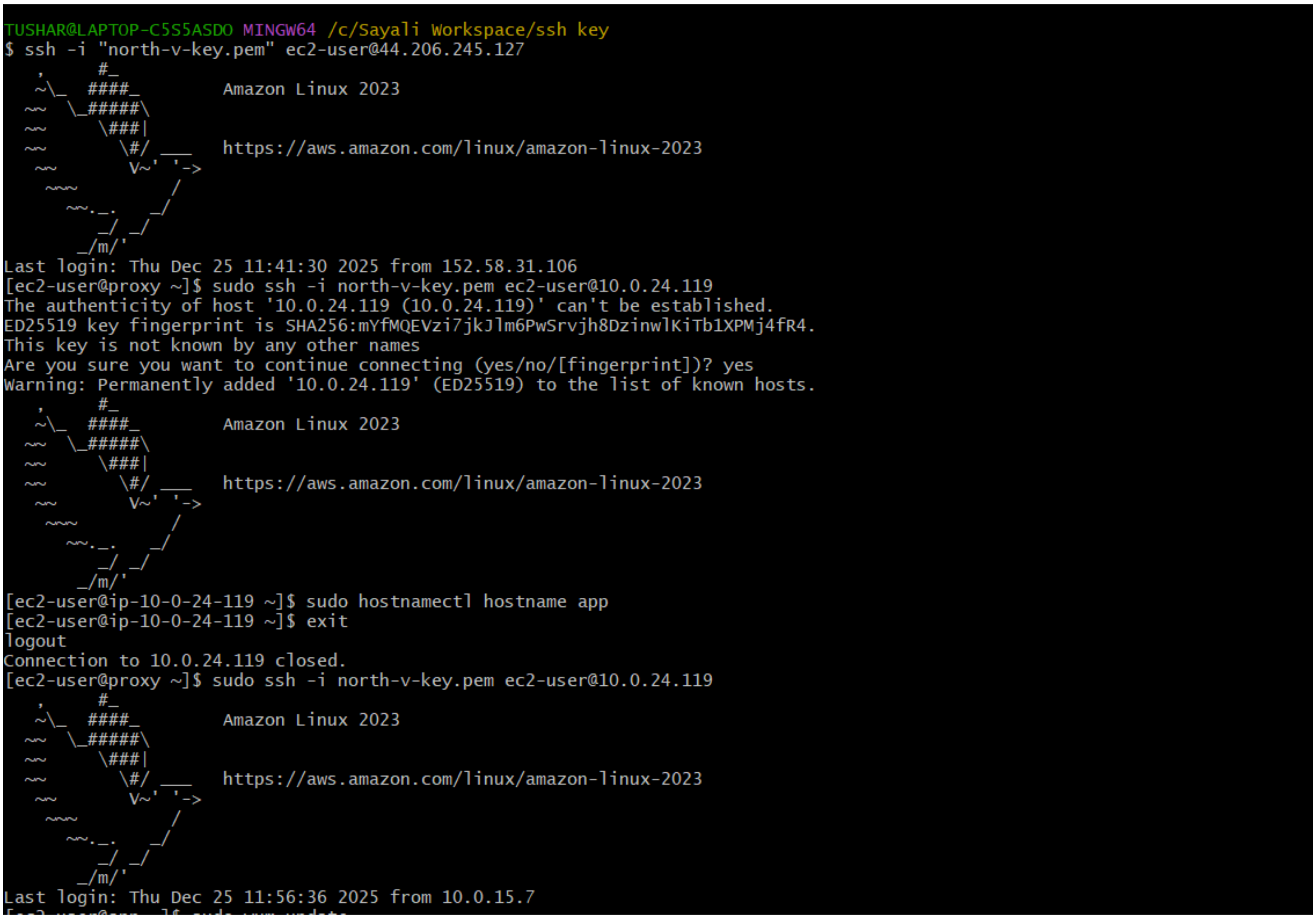
```
scp -i <key.pem> <key.pem> ec2-user@<proxy-public-ip>:/home/ec2-user/
```



```
TUSHAR@LAPTOP-C5S5ASDO MINGW64 /c/Sayali Workspace/ssh key
$ scp -i north-v-key.pem north-v-key.pem ec2-user@44.206.245.127:/home/ec2-user/
north-v-key.pem                                                    100% 1678     2.6KB/s   00:00
```

10. Access the Application Server via SSH, either through the proxy or using AWS SSM

```
sudo ssh -i <key.pem> ec2-user@<app-server-private-ip>
sudo hostnamectl hostname app-server
exit
```



```
TUSHAR@LAPTOP-C5S5ASDO MINGW64 /c/Sayali Workspace/ssh key
$ ssh -i "north-v-key.pem" ec2-user@44.206.245.127
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Thu Dec 25 11:41:30 2025 from 152.58.31.106
[ec2-user@proxy ~]$ sudo ssh -i north-v-key.pem ec2-user@10.0.24.119
The authenticity of host '10.0.24.119 (10.0.24.119)' can't be established.
ED25519 key fingerprint is SHA256:mYfMQEVzi7jkJlm6PwSrvjh8DzinwlKiTb1XPMj4fR4.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '10.0.24.119' (ED25519) to the list of known hosts.
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
[ec2-user@ip-10-0-24-119 ~]$ sudo hostnamectl hostname app
[ec2-user@ip-10-0-24-119 ~]$ exit
logout
Connection to 10.0.24.119 closed.
[ec2-user@proxy ~]$ sudo ssh -i north-v-key.pem ec2-user@10.0.24.119
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Thu Dec 25 11:56:36 2025 from 10.0.15.7
```

ssh again to app server

11. Install Java and Tomcat on App Server

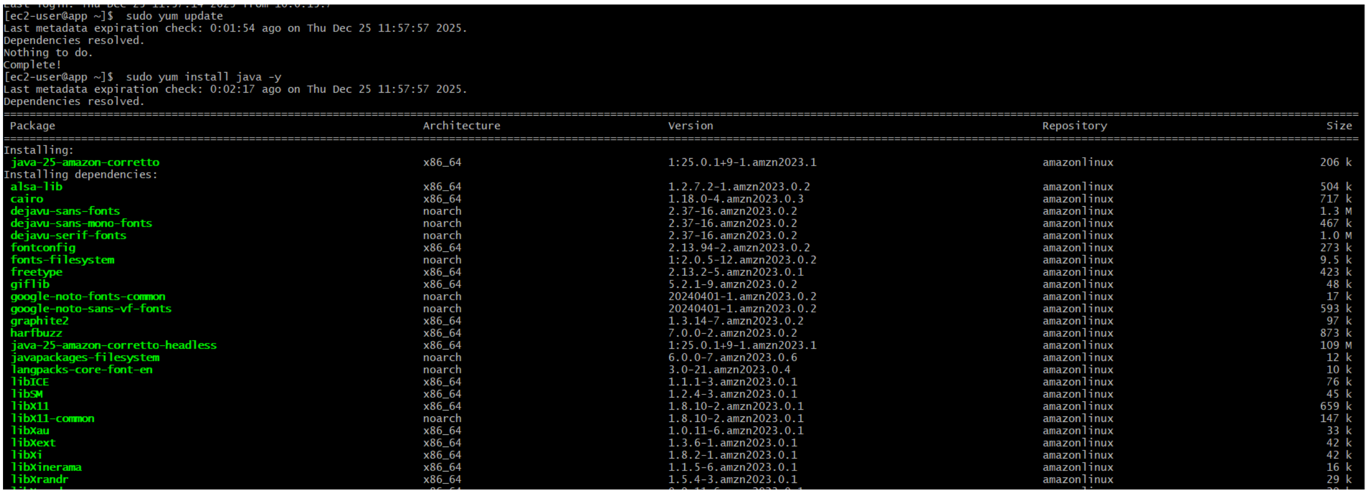
1. Install Java and Tomcat

update system

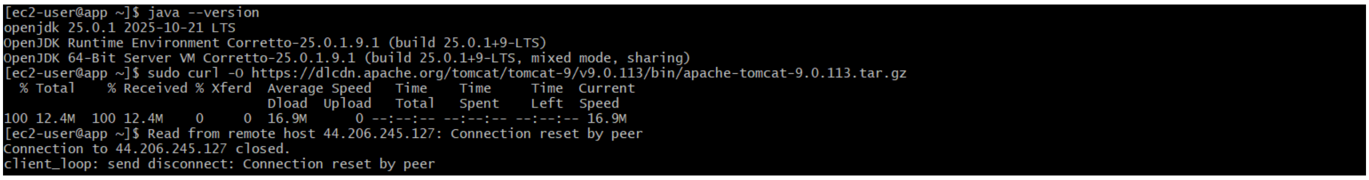
install java

install tomcat

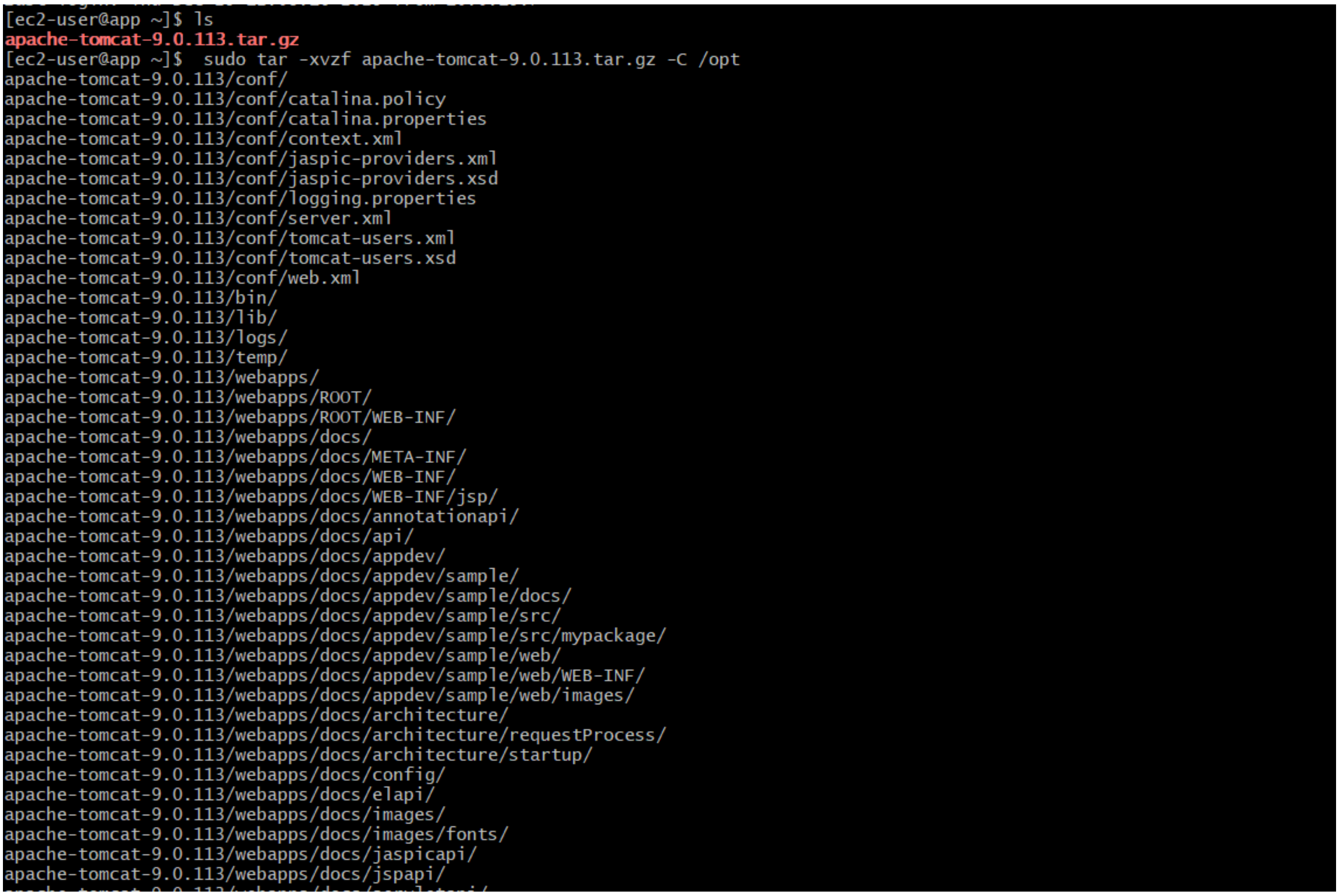
```
    sudo yum update -y
    sudo yum install java -y
    wget https://dlcdn.apache.org/tomcat/tomcat-9/v9.0.98/bin/apache-tomcat-9.0.98.tar.gz
    sudo tar -xvzf apache-tomcat-9.0.98.tar.gz -C /opt
```



```
[ec2-user@app ~]$  sudo yum update
Last metadata expiration check: 0:01:54 ago on Thu Dec 25 11:57:57 2025.
Dependencies resolved.
Nothing to do.
Complete!
[ec2-user@app ~]$  sudo yum install java -y
Last metadata expiration check: 0:02:17 ago on Thu Dec 25 11:57:57 2025.
Dependencies resolved.
================================================================================================================
 Package                             Architecture      Version                      Repository            Size
================================================================================================================
Installing:
 java-25-amazon-corretto             x86_64            1:25.0.1+9-1.amzn2023.1      amazonlinux          206 k
Installing dependencies:
 alsa-lib                            x86_64            1.2.7.2-1.amzn2023.0.2       amazonlinux          504 k
 cairo                               x86_64            1.18.0-4.amzn2023.0.3        amazonlinux          717 k
 dejavu-sans-fonts                   noarch            2.37-16.amzn2023.0.2         amazonlinux          1.3 M
 dejavu-sans-mono-fonts              noarch            2.37-16.amzn2023.0.2         amazonlinux          467 k
 dejavu-serif-fonts                  noarch            2.37-16.amzn2023.0.2         amazonlinux          1.0 M
 fontconfig                          x86_64            2.13.94-2.amzn2023.0.2       amazonlinux          273 k
 fonts-filesystem                    noarch            1:2.0.5-12.amzn2023.0.2      amazonlinux          9.5 k
 freetype                            x86_64            2.13.2-5.amzn2023.0.1        amazonlinux          423 k
 giflib                              x86_64            5.2.1-9.amzn2023.0.2         amazonlinux           48 k
 google-noto-fonts-common            noarch            20240401-1.amzn2023.0.2      amazonlinux           17 k
 google-noto-sans-vf-fonts           noarch            20240401-1.amzn2023.0.2      amazonlinux          593 k
 graphite2                           x86_64            1.3.14-7.amzn2023.0.2        amazonlinux           97 k
 harfbuzz                            x86_64            7.0.0-2.amzn2023.0.2         amazonlinux          873 k
 java-25-amazon-corretto-headless    x86_64            1:25.0.1+9-1.amzn2023.1      amazonlinux          109 M
 javapackages-filesystem             noarch            6.0.0-7.amzn2023.0.6         amazonlinux           12 k
 langpacks-core-font-en              noarch            3.0-21.amzn2023.0.4          amazonlinux           10 k
 libICE                              x86_64            1.1.1-3.amzn2023.0.1         amazonlinux           76 k
 libSM                               x86_64            1.2.4-3.amzn2023.0.1         amazonlinux           45 k
 libX11                              x86_64            1.8.10-2.amzn2023.0.1        amazonlinux          659 k
 libX11-common                       noarch            1.8.10-2.amzn2023.0.1        amazonlinux          147 k
 libXau                              x86_64            1.0.11-6.amzn2023.0.1        amazonlinux           33 k
 libXext                             x86_64            1.3.6-1.amzn2023.0.1         amazonlinux           42 k
 libXi                               x86_64            1.8.2-1.amzn2023.0.1         amazonlinux           42 k
 libXinerama                         x86_64            1.1.5-6.amzn2023.0.1         amazonlinux           16 k
 libXrandr                           x86_64            1.5.4-3.amzn2023.0.1         amazonlinux           29 k
```

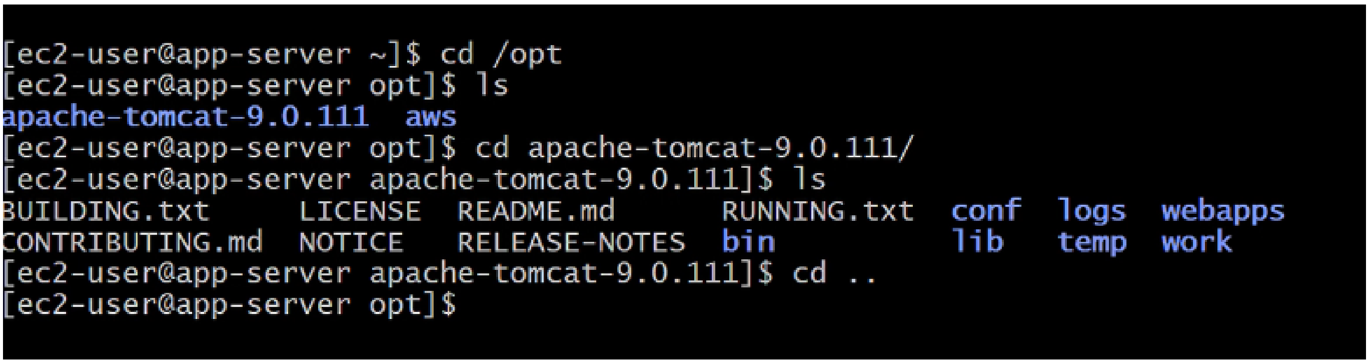


```
[ec2-user@app ~]$ java --version
openjdk 25.0.1 2025-10-21 LTS
OpenJDK Runtime Environment Corretto-25.0.1.9.1 (build 25.0.1+9-LTS)
OpenJDK 64-Bit Server VM Corretto-25.0.1.9.1 (build 25.0.1+9-LTS, mixed mode, sharing)
[ec2-user@app ~]$ sudo curl -O https://dlcdn.apache.org/tomcat/tomcat-9/v9.0.113/bin/apache-tomcat-9.0.113.tar.gz
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 12.4M  100 12.4M    0     0  16.9M      0 --:--:-- --:--:-- --:--:-- 16.9M
[ec2-user@app ~]$ Read from remote host 44.206.245.127: Connection reset by peer
Connection to 44.206.245.127 closed.
client_loop: send disconnect: Connection reset by peer
```



```
[ec2-user@app ~]$ ls
apache-tomcat-9.0.113.tar.gz
[ec2-user@app ~]$  sudo tar -xvzf apache-tomcat-9.0.113.tar.gz -C /opt
apache-tomcat-9.0.113/conf/
apache-tomcat-9.0.113/conf/catalina.policy
apache-tomcat-9.0.113/conf/catalina.properties
apache-tomcat-9.0.113/conf/context.xml
apache-tomcat-9.0.113/conf/jaspic-providers.xml
apache-tomcat-9.0.113/conf/jaspic-providers.xsd
apache-tomcat-9.0.113/conf/logging.properties
apache-tomcat-9.0.113/conf/server.xml
apache-tomcat-9.0.113/conf/tomcat-users.xml
apache-tomcat-9.0.113/conf/tomcat-users.xsd
apache-tomcat-9.0.113/conf/web.xml
apache-tomcat-9.0.113/bin/
apache-tomcat-9.0.113/lib/
apache-tomcat-9.0.113/logs/
apache-tomcat-9.0.113/temp/
apache-tomcat-9.0.113/webapps/
apache-tomcat-9.0.113/webapps/ROOT/
apache-tomcat-9.0.113/webapps/ROOT/WEB-INF/
apache-tomcat-9.0.113/webapps/docs/
apache-tomcat-9.0.113/webapps/docs/META-INF/
apache-tomcat-9.0.113/webapps/docs/WEB-INF/
apache-tomcat-9.0.113/webapps/docs/WEB-INF/jsp/
apache-tomcat-9.0.113/webapps/docs/annotationapi/
apache-tomcat-9.0.113/webapps/docs/api/
apache-tomcat-9.0.113/webapps/docs/appdev/
apache-tomcat-9.0.113/webapps/docs/appdev/sample/
apache-tomcat-9.0.113/webapps/docs/appdev/sample/docs/
apache-tomcat-9.0.113/webapps/docs/appdev/sample/src/
apache-tomcat-9.0.113/webapps/docs/appdev/sample/src/mypackage/
apache-tomcat-9.0.113/webapps/docs/appdev/sample/web/
apache-tomcat-9.0.113/webapps/docs/appdev/sample/web/WEB-INF/
apache-tomcat-9.0.113/webapps/docs/appdev/sample/web/images/
apache-tomcat-9.0.113/webapps/docs/architecture/
apache-tomcat-9.0.113/webapps/docs/architecture/requestProcess/
apache-tomcat-9.0.113/webapps/docs/architecture/startup/
apache-tomcat-9.0.113/webapps/docs/config/
apache-tomcat-9.0.113/webapps/docs/elapi/
apache-tomcat-9.0.113/webapps/docs/images/
apache-tomcat-9.0.113/webapps/docs/images/fonts/
apache-tomcat-9.0.113/webapps/docs/jaspicapi/
apache-tomcat-9.0.113/webapps/docs/jspapi/
```

Check that tomcat is installed correctly



```
[ec2-user@app-server ~]$ cd /opt
[ec2-user@app-server opt]$ ls
apache-tomcat-9.0.111  aws
[ec2-user@app-server opt]$ cd apache-tomcat-9.0.111/
[ec2-user@app-server apache-tomcat-9.0.111]$ ls
BUILDING.txt     LICENSE  README.md       RUNNING.txt  conf  logs  webapps
CONTRIBUTING.md  NOTICE   RELEASE-NOTES  bin          lib   temp  work
[ec2-user@app-server apache-tomcat-9.0.111]$ cd ..
[ec2-user@app-server opt]$
```

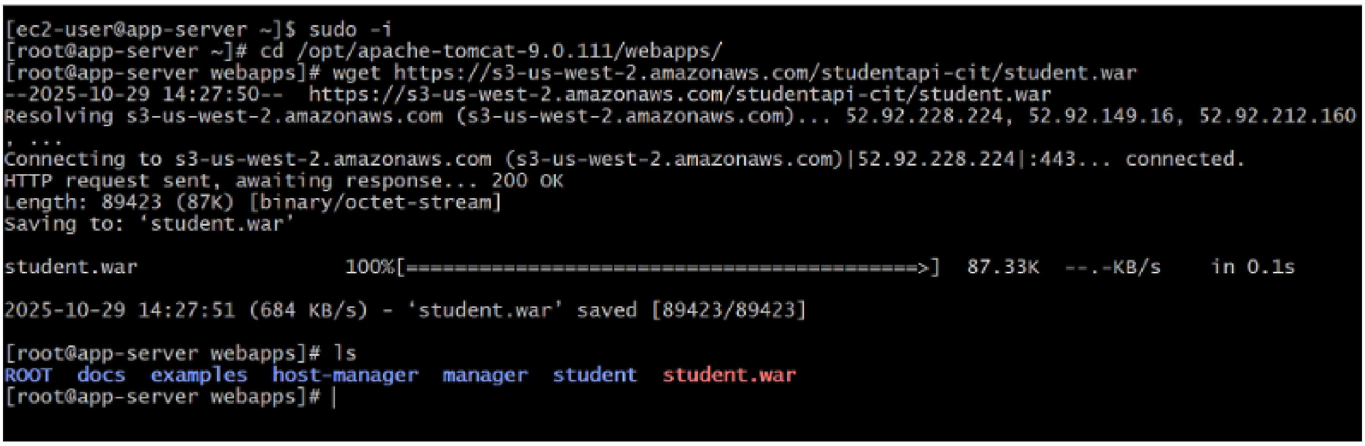
12. Deploy Student Application

- On the app server

```
cd /opt/<apache-tomcat-folder>/webapps/
```

- download the WAR provided by your source (e.g., from a PDF link or artifact storage)

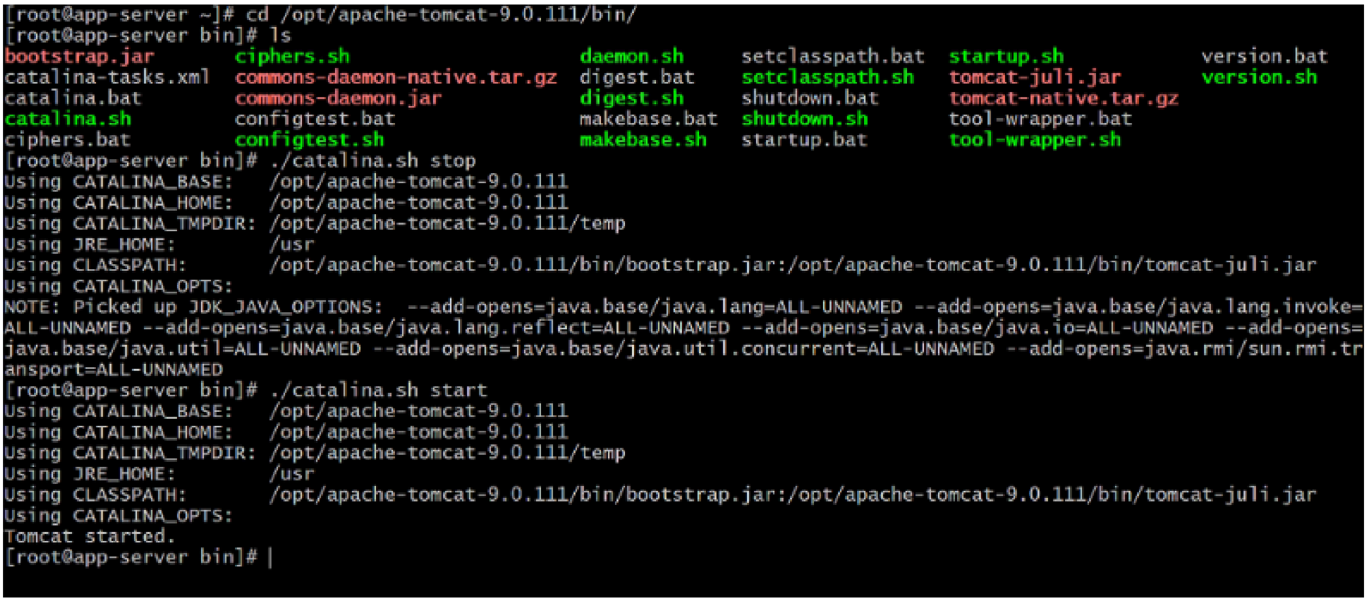
```
wget <link-to-studentapp.war>
```



```
[ec2-user@app-server ~]$ sudo -i
[root@app-server ~]# cd /opt/apache-tomcat-9.0.111/webapps/
[root@app-server webapps]# wget https://s3-us-west-2.amazonaws.com/studentapi-cit/student.war
--2025-10-29 14:27:50--  https://s3-us-west-2.amazonaws.com/studentapi-cit/student.war
Resolving s3-us-west-2.amazonaws.com (s3-us-west-2.amazonaws.com)... 52.92.228.224, 52.92.149.16, 52.92.212.160
, ...
Connecting to s3-us-west-2.amazonaws.com (s3-us-west-2.amazonaws.com)|52.92.228.224|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 89423 (87K) [binary/octet-stream]
Saving to: ‘student.war’

student.war              100%[=========================================>]  87.33K  --.-KB/s    in 0.1s

2025-10-29 14:27:51 (684 KB/s) - ‘student.war’ saved [89423/89423]

[root@app-server webapps]# ls
ROOT  docs  examples  host-manager  manager  student  student.war
[root@app-server webapps]# |
```

13 Restart Tomcat

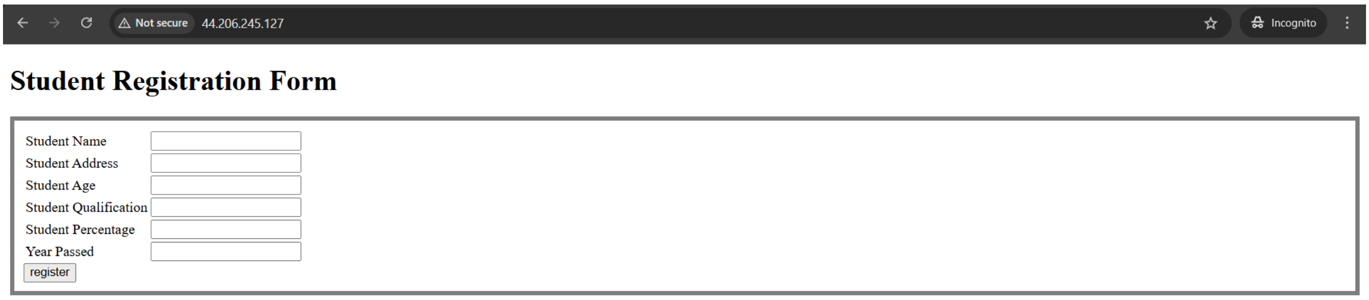
```
    cd /opt/apache-tomcat/bin
    ./catalina.sh stop
    ./catalina.sh start
```



```
[root@app-server ~]# cd /opt/apache-tomcat-9.0.111/bin/
[root@app-server bin]# ls
bootstrap.jar        ciphers.sh                daemon.sh     setclasspath.bat  startup.sh          version.bat
catalina-tasks.xml   commons-daemon-native.tar.gz  digest.bat    setclasspath.sh   tomcat-juli.jar     version.sh
catalina.bat         commons-daemon.jar        digest.sh     shutdown.bat      tomcat-native.tar.gz
catalina.sh          configtest.bat            makebase.bat  shutdown.sh       tool-wrapper.bat
ciphers.bat          configtest.sh             makebase.sh   startup.bat       tool-wrapper.sh
[root@app-server bin]# ./catalina.sh stop
Using CATALINA_BASE:   /opt/apache-tomcat-9.0.111
Using CATALINA_HOME:   /opt/apache-tomcat-9.0.111
Using CATALINA_TMPDIR: /opt/apache-tomcat-9.0.111/temp
Using JRE_HOME:        /usr
Using CLASSPATH:       /opt/apache-tomcat-9.0.111/bin/bootstrap.jar:/opt/apache-tomcat-9.0.111/bin/tomcat-juli.jar
Using CATALINA_OPTS:
NOTE: Picked up JDK_JAVA_OPTIONS:  --add-opens=java.base/java.lang=ALL-UNNAMED --add-opens=java.base/java.lang.invoke=
ALL-UNNAMED --add-opens=java.base/java.lang.reflect=ALL-UNNAMED --add-opens=java.base/java.io=ALL-UNNAMED --add-opens=
java.base/java.util=ALL-UNNAMED --add-opens=java.base/java.util.concurrent=ALL-UNNAMED --add-opens=java.rmi/sun.rmi.tr
ansport=ALL-UNNAMED
[root@app-server bin]# ./catalina.sh start
Using CATALINA_BASE:   /opt/apache-tomcat-9.0.111
Using CATALINA_HOME:   /opt/apache-tomcat-9.0.111
Using CATALINA_TMPDIR: /opt/apache-tomcat-9.0.111/temp
Using JRE_HOME:        /usr
Using CLASSPATH:       /opt/apache-tomcat-9.0.111/bin/bootstrap.jar:/opt/apache-tomcat-9.0.111/bin/tomcat-juli.jar
Using CATALINA_OPTS:
Tomcat started.
[root@app-server bin]# |
```

14 Open your browser to check java page

Paste the public ip of proxy-server on the Google



Student Registration Form

Student Name

Student Address

Student Age

Student Qualification

Student Percentage

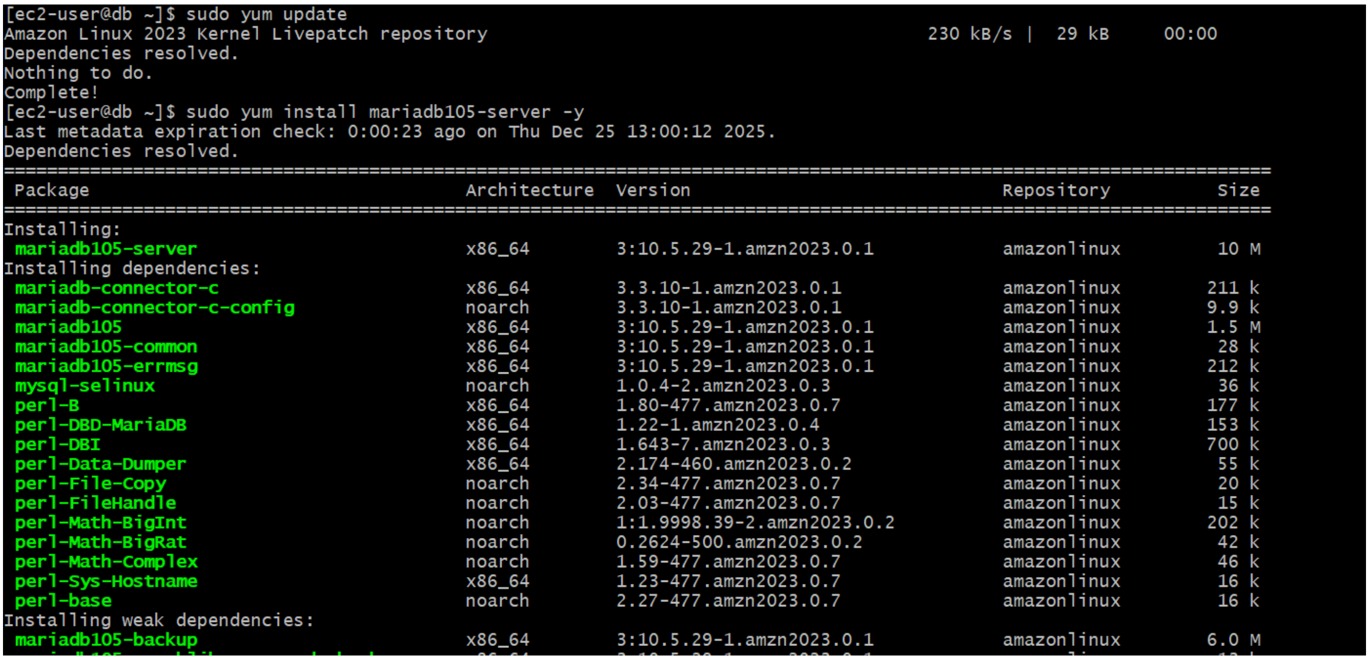
Year Passed

register

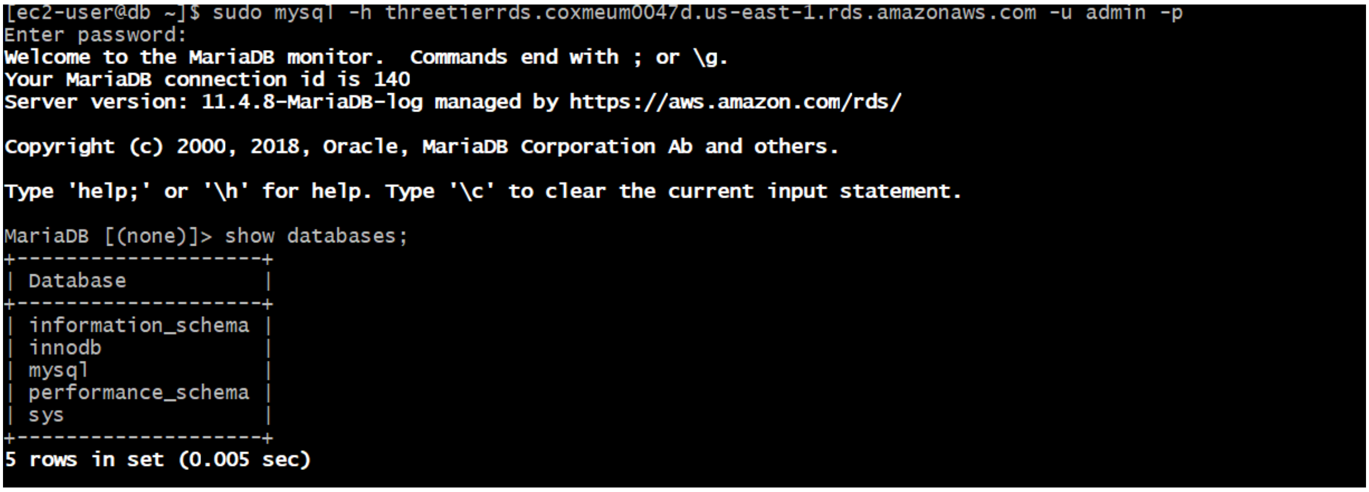
15. Database Setup (MariaDB / RDS)

1. SSH into DB instance and take access of RDS

```
sudo yum install mariadb105-server -y
mysql -h <RDS-ENDPOINT> -u admin -p
```



```
[ec2-user@db ~]$ sudo yum update
Amazon Linux 2023 Kernel Livepatch repository                                 230 kB/s |  29 kB     00:00
Dependencies resolved.
Nothing to do.
Complete!
[ec2-user@db ~]$ sudo yum install mariadb105-server -y
Last metadata expiration check: 0:00:23 ago on Thu Dec 25 13:00:12 2025.
Dependencies resolved.
=================================================================================================================
 Package                              Architecture  Version                            Repository          Size
=================================================================================================================
Installing:
 mariadb105-server                    x86_64        3:10.5.29-1.amzn2023.0.1           amazonlinux         10 M
Installing dependencies:
 mariadb-connector-c                  x86_64        3.3.10-1.amzn2023.0.1              amazonlinux        211 k
 mariadb-connector-c-config           noarch        3.3.10-1.amzn2023.0.1              amazonlinux        9.9 k
 mariadb105                           x86_64        3:10.5.29-1.amzn2023.0.1           amazonlinux        1.5 M
 mariadb105-common                    x86_64        3:10.5.29-1.amzn2023.0.1           amazonlinux         28 k
 mariadb105-errmsg                    x86_64        3:10.5.29-1.amzn2023.0.1           amazonlinux        212 k
 mysql-selinux                        noarch        1.0.4-2.amzn2023.0.3               amazonlinux         36 k
 perl-B                               x86_64        1.80-477.amzn2023.0.7              amazonlinux        177 k
 perl-DBD-MariaDB                     x86_64        1.22-1.amzn2023.0.4                amazonlinux        153 k
 perl-DBI                             x86_64        1.643-7.amzn2023.0.3               amazonlinux        700 k
 perl-Data-Dumper                     x86_64        2.174-460.amzn2023.0.2             amazonlinux         55 k
 perl-File-Copy                       noarch        2.34-477.amzn2023.0.7              amazonlinux         20 k
 perl-FileHandle                      noarch        2.03-477.amzn2023.0.7              amazonlinux         15 k
 perl-Math-BigInt                     noarch        1:1.9998.39-2.amzn2023.0.2         amazonlinux        202 k
 perl-Math-BigRat                     noarch        0.2624-500.amzn2023.0.2            amazonlinux         42 k
 perl-Math-Complex                    noarch        1.59-477.amzn2023.0.7              amazonlinux         46 k
 perl-Sys-Hostname                    x86_64        1.23-477.amzn2023.0.7              amazonlinux         16 k
 perl-base                            noarch        2.27-477.amzn2023.0.7              amazonlinux         16 k
Installing weak dependencies:
 mariadb105-backup                    x86_64        3:10.5.29-1.amzn2023.0.1           amazonlinux        6.0 M
```

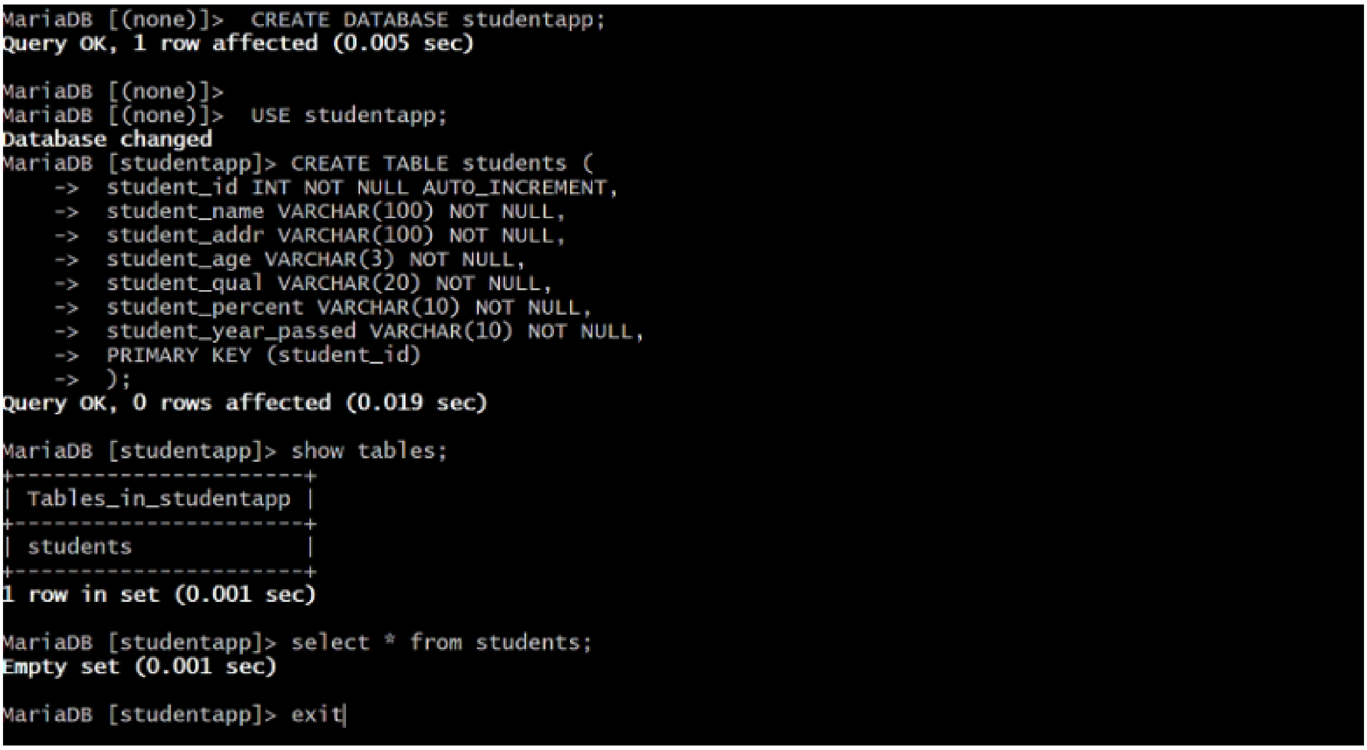


```
[ec2-user@db ~]$ sudo mysql -h threetierrds.coxmeum0047d.us-east-1.rds.amazonaws.com -u admin -p
Enter password:
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MariaDB connection id is 140
Server version: 11.4.8-MariaDB-log managed by https://aws.amazon.com/rds/

Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

MariaDB [(none)]> show databases;
+--------------------+
| Database           |
+--------------------+
| information_schema |
| innodb             |
| mysql              |
| performance_schema |
| sys                |
+--------------------+
5 rows in set (0.005 sec)
```

2. Create Database and table

```
CREATE DATABASE studentapp;

USE studentapp;

CREATE TABLE IF NOT EXISTS students (
 student_id INT NOT NULL AUTO_INCREMENT,
 student_name VARCHAR(100) NOT NULL,
 student_addr VARCHAR(100) NOT NULL,
 student_age VARCHAR(3) NOT NULL,
 student_qual VARCHAR(20) NOT NULL,
 student_percent VARCHAR(10) NOT NULL,
 student_year_passed VARCHAR(10) NOT NULL,
 PRIMARY KEY (student_id)
);

SHOW TABLES;
```

```
SELECT * FROM students;
exit
```

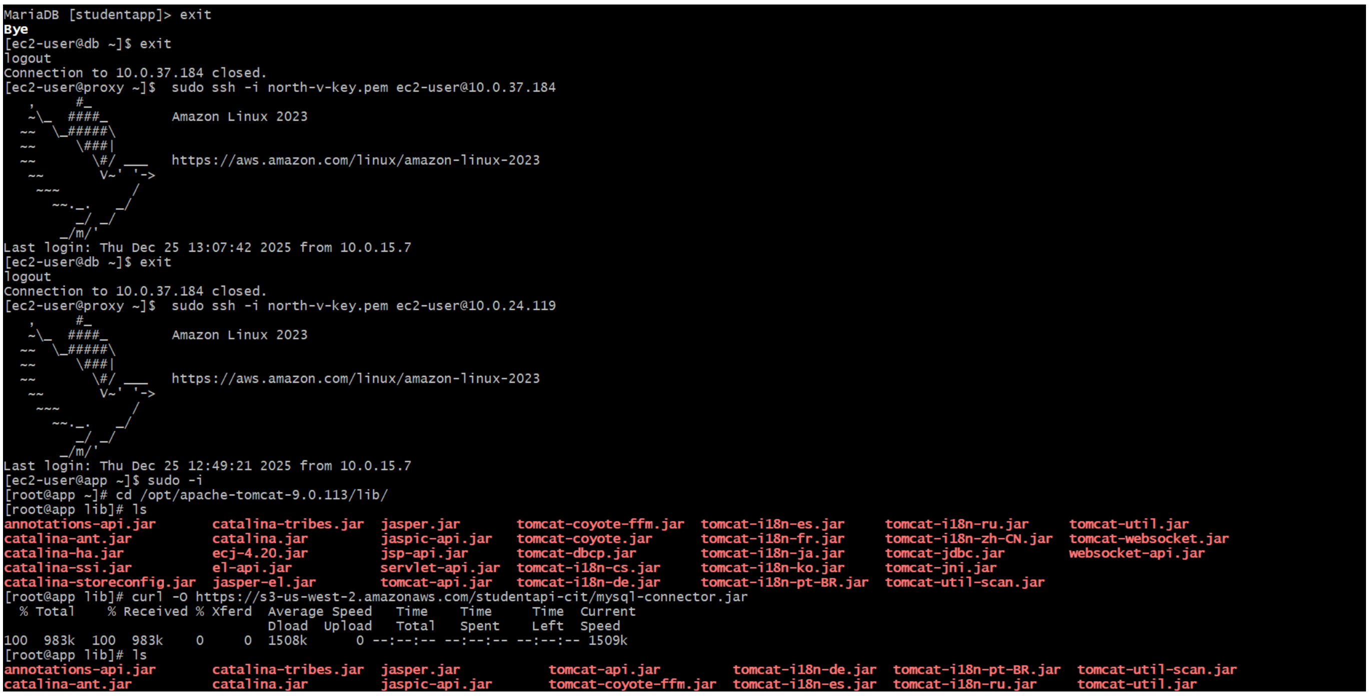


```
MariaDB [(none)]>  CREATE DATABASE studentapp;
Query OK, 1 row affected (0.005 sec)

MariaDB [(none)]>
MariaDB [(none)]>  USE studentapp;
Database changed
MariaDB [studentapp]> CREATE TABLE students (
    ->  student_id INT NOT NULL AUTO_INCREMENT,
    ->  student_name VARCHAR(100) NOT NULL,
    ->  student_addr VARCHAR(100) NOT NULL,
    ->  student_age VARCHAR(3) NOT NULL,
    ->  student_qual VARCHAR(20) NOT NULL,
    ->  student_percent VARCHAR(10) NOT NULL,
    ->  student_year_passed VARCHAR(10) NOT NULL,
    ->  PRIMARY KEY (student_id)
    ->  );
Query OK, 0 rows affected (0.019 sec)

MariaDB [studentapp]> show tables;
+----------------------+
| Tables_in_studentapp |
+----------------------+
| students             |
+----------------------+
1 row in set (0.001 sec)

MariaDB [studentapp]> select * from students;
Empty set (0.001 sec)

MariaDB [studentapp]> exit
```

16. Connect App Server to RDS

1. Install JDBC connector in App server

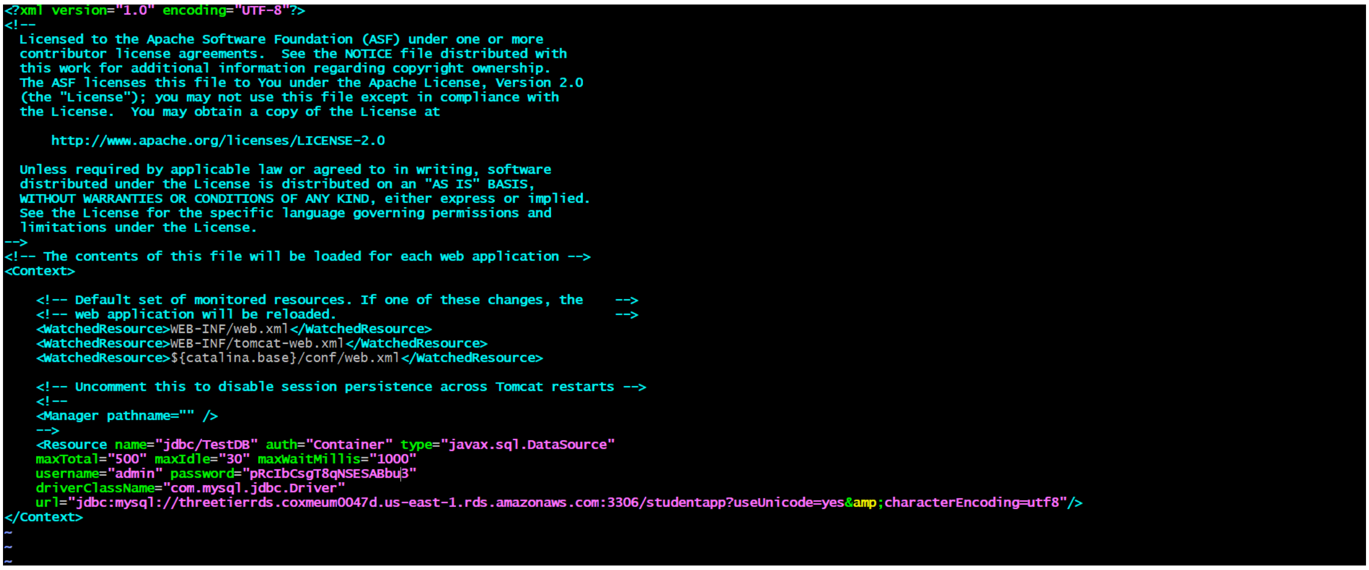
```
sudo -i
cd /opt/apache-tomcat-folder/lib
wget <S3-Bucket-URL-to-JDBC-Connector>
ls
```



```
MariaDB [studentapp]> exit
Bye
[ec2-user@db ~]$ exit
logout
Connection to 10.0.37.184 closed.
[ec2-user@proxy ~]$  sudo ssh -i north-v-key.pem ec2-user@10.0.37.184
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Thu Dec 25 13:07:42 2025 from 10.0.15.7
[ec2-user@db ~]$ exit
logout
Connection to 10.0.37.184 closed.
[ec2-user@proxy ~]$  sudo ssh -i north-v-key.pem ec2-user@10.0.24.119
   ,     #_
   ~\_  ####_        Amazon Linux 2023
  ~~  \_#####\
  ~~     \###|
  ~~       \#/ ___   https://aws.amazon.com/linux/amazon-linux-2023
   ~~       V~' '->
    ~~~         /
      ~~._.   _/
         _/ _/
       _/m/'
Last login: Thu Dec 25 12:49:21 2025 from 10.0.15.7
[ec2-user@app ~]$ sudo -i
[root@app ~]# cd /opt/apache-tomcat-9.0.113/lib/
[root@app lib]# ls
annotations-api.jar       catalina-tribes.jar  jasper.jar       tomcat-coyote-ffm.jar  tomcat-i18n-es.jar     tomcat-i18n-ru.jar     tomcat-util.jar
catalina-ant.jar          catalina.jar         jaspic-api.jar   tomcat-coyote.jar      tomcat-i18n-fr.jar     tomcat-i18n-zh-CN.jar  tomcat-websocket.jar
catalina-ha.jar           ecj-4.20.jar         jsp-api.jar      tomcat-dbcp.jar        tomcat-i18n-ja.jar     tomcat-jdbc.jar        websocket-api.jar
catalina-ssi.jar          el-api.jar           servlet-api.jar  tomcat-i18n-cs.jar     tomcat-i18n-ko.jar     tomcat-jni.jar
catalina-storeconfig.jar  jasper-el.jar        tomcat-api.jar   tomcat-i18n-de.jar     tomcat-i18n-pt-BR.jar  tomcat-util-scan.jar
[root@app lib]# curl -O https://s3-us-west-2.amazonaws.com/studentapi-cit/mysql-connector.jar
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100  983k  100  983k    0     0  1508k      0 --:--:-- --:--:-- --:--:-- 1509k
[root@app lib]# ls
annotations-api.jar       catalina-tribes.jar  jasper.jar           tomcat-api.jar         tomcat-i18n-de.jar   tomcat-i18n-pt-BR.jar  tomcat-util-scan.jar
catalina-ant.jar          catalina.jar         jaspic-api.jar       tomcat-coyote-ffm.jar  tomcat-i18n-es.jar   tomcat-i18n-ru.jar     tomcat-util.jar
```

2. Edit Tomcat context.xml to add resource

```
 <Resource name="jdbc/TestDB" auth="Container"
   type="javax.sql.DataSource"
   maxTotal="500" maxIdle="30" maxWaitMillis="1000"
   username="admin" password="redhat123!"
   driverClassName="com.mysql.jdbc.Driver"
   url="jdbc:mysql://<RDS-ENDPOINT>:3306/studentapp?
useUnicode=yes&characterEncoding=utf8"/>
```

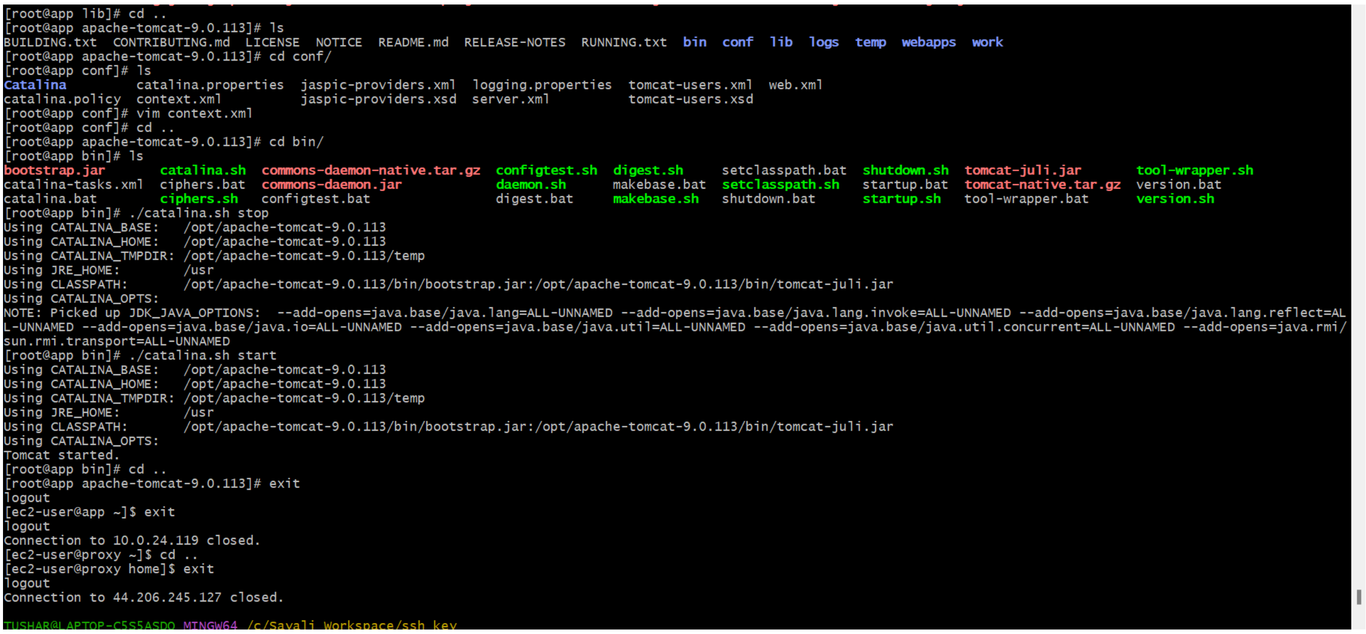


```
<?xml version="1.0" encoding="UTF-8"?>
<!--
  Licensed to the Apache Software Foundation (ASF) under one or more
  contributor license agreements.  See the NOTICE file distributed with
  this work for additional information regarding copyright ownership.
  The ASF licenses this file to You under the Apache License, Version 2.0
  (the "License"); you may not use this file except in compliance with
  the License.  You may obtain a copy of the License at

      http://www.apache.org/licenses/LICENSE-2.0

  Unless required by applicable law or agreed to in writing, software
  distributed under the License is distributed on an "AS IS" BASIS,
  WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
  See the License for the specific language governing permissions and
  limitations under the License.
-->
<!-- The contents of this file will be loaded for each web application -->
<Context>

    <!-- Default set of monitored resources. If one of these changes, the    -->
    <!-- web application will be reloaded.                                   -->
    <WatchedResource>WEB-INF/web.xml</WatchedResource>
    <WatchedResource>WEB-INF/tomcat-web.xml</WatchedResource>
    <WatchedResource>${catalina.base}/conf/web.xml</WatchedResource>

    <!-- Uncomment this to disable session persistence across Tomcat restarts -->
    <!--
    <Manager pathname="" />
    -->
    <Resource name="jdbc/TestDB" auth="Container" type="javax.sql.DataSource"
    maxTotal="500" maxIdle="30" maxWaitMillis="1000"
    username="admin" password="pRcIbCsgT8qNSESABbu3"
    driverClassName="com.mysql.jdbc.Driver"
    url="jdbc:mysql://threetierrds.coxmeum0047d.us-east-1.rds.amazonaws.com:3306/studentapp?useUnicode=yes&amp;characterEncoding=utf8"/>
</Context>
~
~
~
```

3. Restart Tomcat

```
cd /opt/<apache-tomcat-folder>/bin/
./catalina.sh stop
```

```
    ./catalina.sh start
```

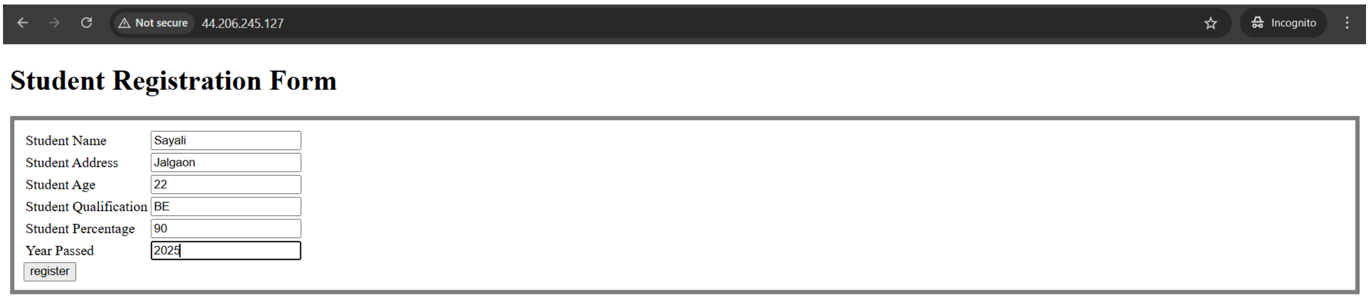


```
[root@app lib]# cd ..
[root@app apache-tomcat-9.0.113]# ls
BUILDING.txt  CONTRIBUTING.md  LICENSE  NOTICE  README.md  RELEASE-NOTES  RUNNING.txt  bin  conf  lib  logs  temp  webapps  work
[root@app apache-tomcat-9.0.113]# cd conf/
[root@app conf]# ls
Catalina         catalina.properties  jaspic-providers.xml  logging.properties  tomcat-users.xml  web.xml
catalina.policy  context.xml          jaspic-providers.xsd  server.xml          tomcat-users.xsd
[root@app conf]# vim context.xml
[root@app conf]# cd ..
[root@app apache-tomcat-9.0.113]# cd bin/
[root@app bin]# ls
bootstrap.jar       catalina.sh  commons-daemon-native.tar.gz  configtest.sh  digest.sh     setclasspath.bat  shutdown.sh  tomcat-juli.jar       tool-wrapper.sh
catalina-tasks.xml  ciphers.bat  commons-daemon.jar            daemon.sh      makebase.bat  setclasspath.sh   startup.bat  tomcat-native.tar.gz  version.bat
catalina.bat        ciphers.sh   configtest.bat                digest.bat     makebase.sh   shutdown.bat      startup.sh   tool-wrapper.bat      version.sh
[root@app bin]# ./catalina.sh stop
Using CATALINA_BASE:   /opt/apache-tomcat-9.0.113
Using CATALINA_HOME:   /opt/apache-tomcat-9.0.113
Using CATALINA_TMPDIR: /opt/apache-tomcat-9.0.113/temp
Using JRE_HOME:        /usr
Using CLASSPATH:       /opt/apache-tomcat-9.0.113/bin/bootstrap.jar:/opt/apache-tomcat-9.0.113/bin/tomcat-juli.jar
Using CATALINA_OPTS:
NOTE: Picked up JDK_JAVA_OPTIONS:  --add-opens=java.base/java.lang=ALL-UNNAMED --add-opens=java.base/java.lang.invoke=ALL-UNNAMED --add-opens=java.base/java.lang.reflect=AL
L-UNNAMED --add-opens=java.base/java.io=ALL-UNNAMED --add-opens=java.base/java.util=ALL-UNNAMED --add-opens=java.base/java.util.concurrent=ALL-UNNAMED --add-opens=java.rmi/
sun.rmi.transport=ALL-UNNAMED
[root@app bin]# ./catalina.sh start
Using CATALINA_BASE:   /opt/apache-tomcat-9.0.113
Using CATALINA_HOME:   /opt/apache-tomcat-9.0.113
Using CATALINA_TMPDIR: /opt/apache-tomcat-9.0.113/temp
Using JRE_HOME:        /usr
Using CLASSPATH:       /opt/apache-tomcat-9.0.113/bin/bootstrap.jar:/opt/apache-tomcat-9.0.113/bin/tomcat-juli.jar
Using CATALINA_OPTS:
Tomcat started.
[root@app bin]# cd ..
[root@app apache-tomcat-9.0.113]# exit
logout
[ec2-user@app ~]$ exit
logout
Connection to 10.0.24.119 closed.
[ec2-user@proxy ~]$ cd ..
[ec2-user@proxy home]$ exit
logout
Connection to 44.206.245.127 closed.

TUSHAR@LAPTOP-C5S5ASDO MINGW64 /c/Sayali Workspace/ssh key
```

17. Verify Output

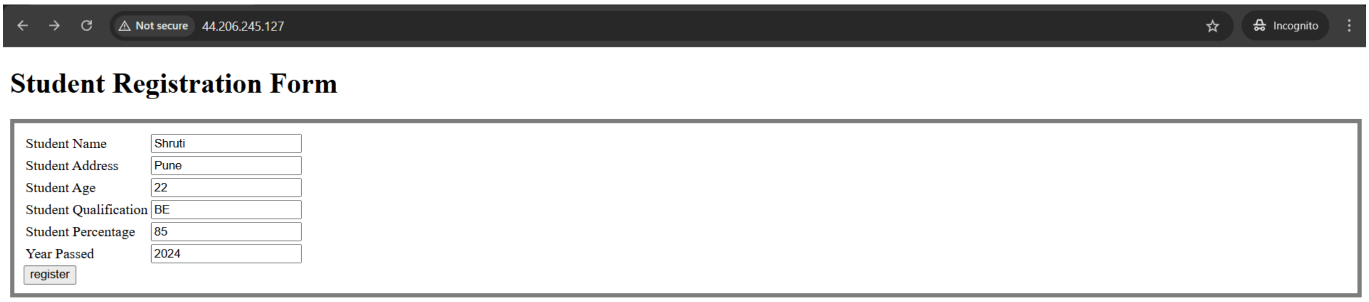
1. Copy and Paste the Proxy Public IP in a browser: http:///

- Fill the Student Registration Form



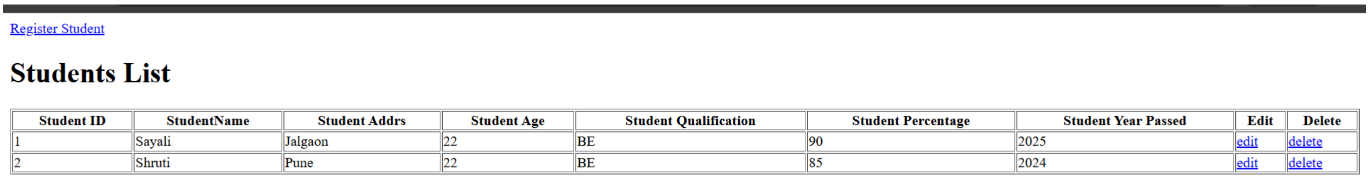
Student Registration Form

Student Name	Sayali
Student Address	Jalgaon
Student Age	22
Student Qualification	BE
Student Percentage	90
Year Passed	2025



Student Registration Form

Student Name	Shruti
Student Address	Pune
Student Age	22
Student Qualification	BE
Student Percentage	85
Year Passed	2024



Register Student

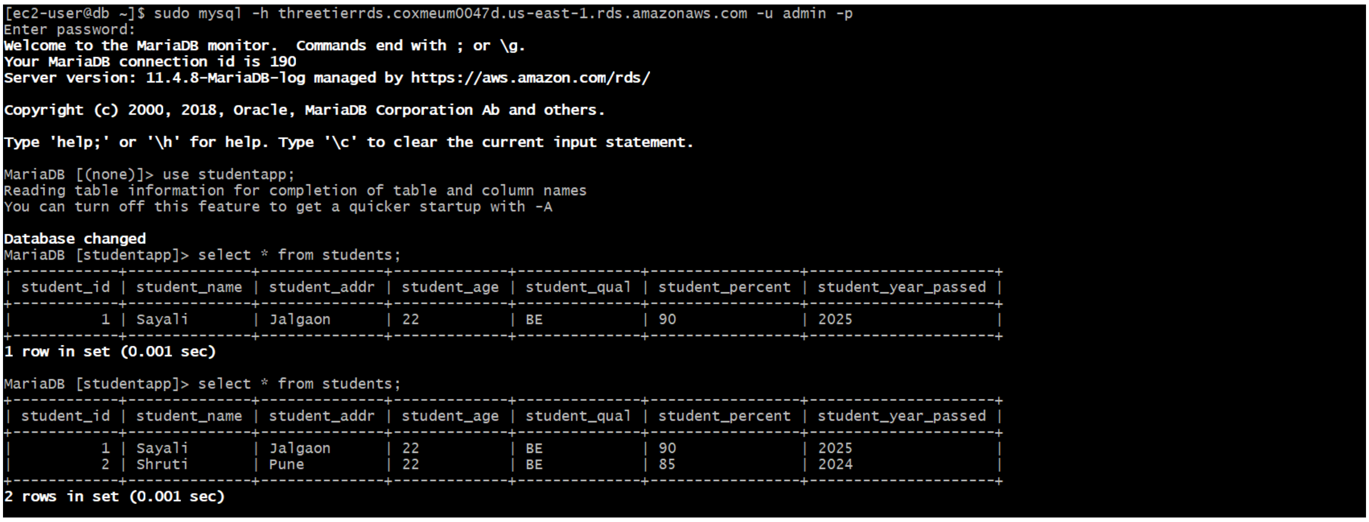
Students List

Student ID	StudentName	Student Addrs	Student Age	Student Qualification	Student Percentage	Student Year Passed	Edit	Delete
1	Sayali	Jalgaon	22	BE	90	2025	edit	delete
2	Shruti	Pune	22	BE	85	2024	edit	delete

2. Verify entries in the RDS

```
USE studentapp;
SELECT * FROM students;
```

3. You will be able to view the inserted entries



```
[ec2-user@db ~]$ sudo mysql -h threetierrds.coxmeum0047d.us-east-1.rds.amazonaws.com -u admin -p
Enter password:
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MariaDB connection id is 190
Server version: 11.4.8-MariaDB-log managed by https://aws.amazon.com/rds/

Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

MariaDB [(none)]> use studentapp;
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
MariaDB [studentapp]> select * from students;
+------------+--------------+--------------+-------------+--------------+-----------------+---------------------+
| student_id | student_name | student_addr | student_age | student_qual | student_percent | student_year_passed |
+------------+--------------+--------------+-------------+--------------+-----------------+---------------------+
|          1 | Sayali       | Jalgaon      | 22          | BE           | 90              | 2025                |
+------------+--------------+--------------+-------------+--------------+-----------------+---------------------+
1 row in set (0.001 sec)

MariaDB [studentapp]> select * from students;
+------------+--------------+--------------+-------------+--------------+-----------------+---------------------+
| student_id | student_name | student_addr | student_age | student_qual | student_percent | student_year_passed |
+------------+--------------+--------------+-------------+--------------+-----------------+---------------------+
|          1 | Sayali       | Jalgaon      | 22          | BE           | 90              | 2025                |
|          2 | Shruti       | Pune         | 22          | BE           | 85              | 2024                |
+------------+--------------+--------------+-------------+--------------+-----------------+---------------------+
2 rows in set (0.001 sec)
```

Troubleshooting

If the application is not accessible, verify the following:

- Security Groups: Ensure the inbound rules allow the required ports.
- Network ACLs: Confirm the subnets permit the necessary traffic.
- Route Tables: Check that the public subnet routes to the Internet Gateway (IGW) and the private subnet routes through the NAT gateway.
- Tomcat Server: Verify that Tomcat is running and review the catalina.out logs for errors.
- NGINX Logs: Inspect /var/log/nginx/error.log for any issues.
- RDS Access: Make sure the database's inbound rules allow connections from the application's security group on port 3306.

Final Thoughts

This project demonstrates the successful deployment of a Three-Tier Web Application on AWS, featuring:

- Secure network architecture using a VPC, subnets, and routing
- Scalable computing resources with EC2 instances
- Managed database services via Amazon RDS
- Layered traffic flow from proxy to application server to database

It highlights essential AWS concepts, including networking, EC2 setup, and the integration of compute and database layers, reflecting a real-world cloud architecture.