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**AWS Academy Lab Project - Cloud Web Application Builder
Building a Highly Available, Scalable Web Application**

Supervise by: Eng. Merhan Adel

Badge Link



About Project

Deploy a web app on EC2, migrate the database to RDS, and ensure high availability and scalability using a load balancer and an Auto Scaling group.

Steps for the Project:

Phase 1: Planning the Design and Estimating Cost

1. **Creating an Architectural Diagram:**
 - o Design an architecture diagram illustrating the AWS services and their interactions.
2. **Developing a Cost Estimate:**
 - o Use the AWS Pricing Calculator to estimate the cost of running the solution in the us-east-1 region for 12 months.

Phase 2: Creating a Basic Functional Web Application

1. **Creating a Virtual Network:**
 - o Set up a virtual private cloud (VPC) and necessary subnets for hosting the application.
2. **Creating a Virtual Machine:**
 - o Deploy a virtual machine (EC2) with the latest Ubuntu AMI to host the web application.
3. **Testing the Deployment:**
 - o Ensure the web application is accessible from the internet and functions correctly (view, add, delete, modify records).

Phase 3: Decoupling the Application Components

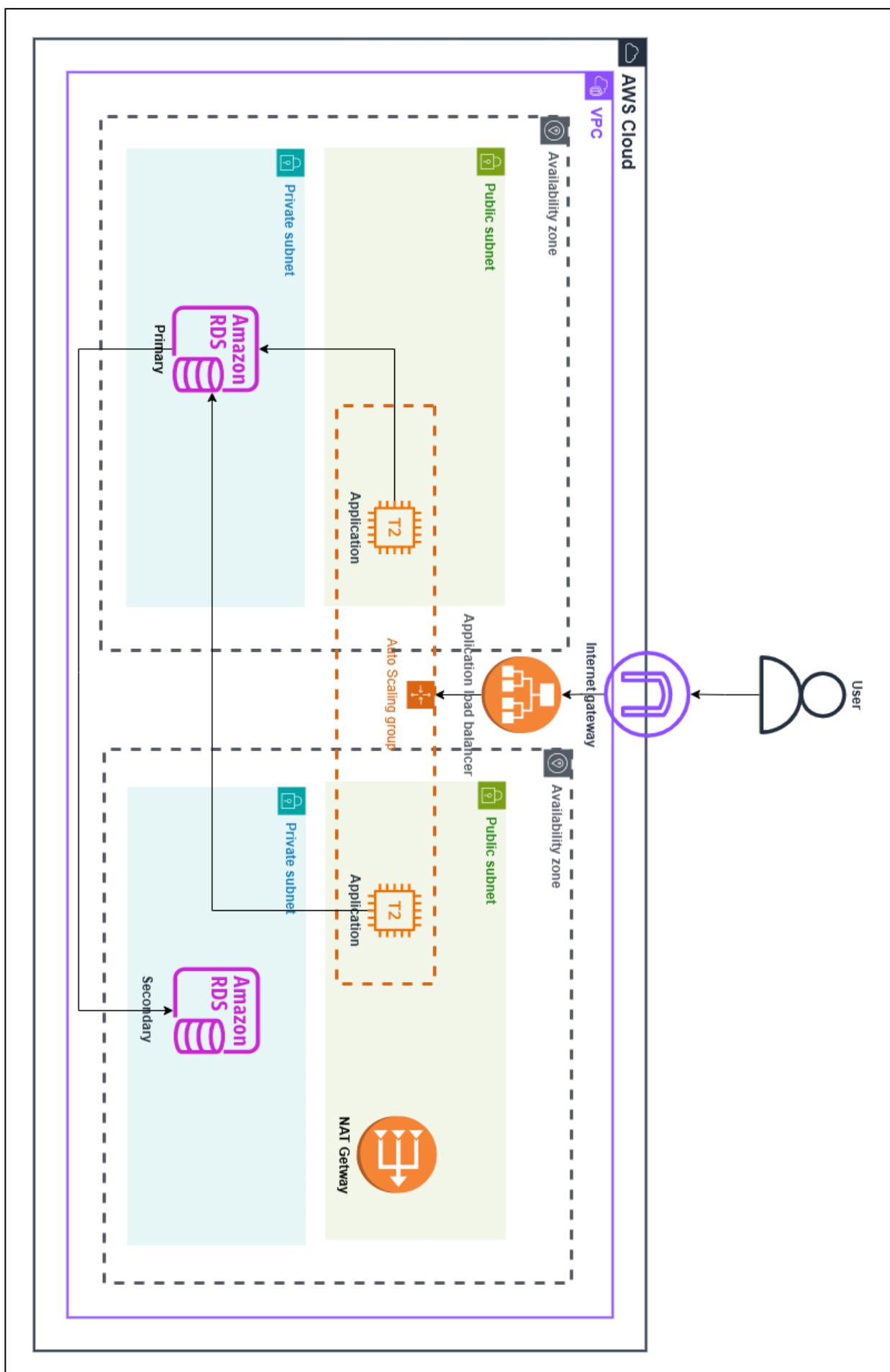
1. **Changing the VPC Configuration:**
 - o Update or recreate the VPC to support separate hosting for the database and web server.
2. **Creating and Configuring the Amazon RDS Database:**
 - o Set up an Amazon RDS instance running a MySQL engine, ensuring only the web application can access it.
3. **Configuring the Development Environment:**
 - o Provision an AWS Cloud9 environment for executing AWS CLI commands.
4. **Provisioning Secrets Manager:**
 - o Use AWS Secrets Manager to store database credentials securely and configure the web application to use these credentials.
5. **Provisioning a New Instance for the Web Server:**
 - o Deploy a new EC2 instance for the web application or reconfigure the existing instance to connect to Amazon RDS.
6. **Migrating the Database:**
 - o Migrate data from the original database on the EC2 instance to the new Amazon RDS database.
7. **Testing the Application:**
 - o Verify the application functionality by performing CRUD operations on student records.

Phase 4: Implementing High Availability and Scalability

1. **Creating an Application Load Balancer:**
 - o Set up an Application Load Balancer across at least two Availability Zones.
2. **Implementing Amazon EC2 Auto Scaling:**
 - o Create a launch template and an Auto Scaling group to manage EC2 instances hosting the web application.
3. **Accessing the Application:**
 - o Test application functionality by performing CRUD operations again.
4. **Load Testing the Application:**
 - o Conduct a load test using scripts to simulate 1,000 requests to evaluate performance under load.

Phase 1: Planning the design and estimating cost

Task 1: Creating an architectural diagram [Link Diagram](#)



Task 2: Developing a cost estimate [Link CSV File](#)

1. Application Load Balancer (ALB) :

- **Monthly Cost: \$16.46**
- **Annual Cost: \$197.52**
- **Quantity: 1**

2. Amazon EC2 :

- **Monthly Cost: \$40.16**
- **Annual Cost: \$481.92**
- **Configuration: 4 t2.micro instances running on Linux, utilizing 700 hours per month, with 20 GB of EBS storage.**

3. Amazon RDS for MySQL :

- **Monthly Cost: \$14.20**
- **Annual Cost: \$170.40**
- **Configuration: 1 db.t3.micro instance with 20 GB of gp3 SSD storage, deployed in a single availability zone.**

The Total Cost:

Monthly Payments:

- **Total Monthly Cost: \$70.82 USD**
You will pay \$70.82 each month for the services provided (Application Load Balancer, EC2 instances, and RDS for MySQL).

Yearly Payments:

- **Total Yearly Cost: \$849.84 USD**
If you choose to pay annually, the total amount due for the 12 months will be \$849.84 USD.

This setup assumes no upfront payments and is based on on-demand pricing.

Phase 2: Creating a basic functional web application

Task 1: Creating a virtual network

The screenshot shows the AWS VPC dashboard. In the top navigation bar, the 'VPC' service is selected. The main area displays a table titled 'Your VPCs (1/2) Info'. A single row is present for the VPC 'WebApp-vpc', which has a VPC ID of 'vpc-08f782e6ac7591678'. The VPC is in an 'Available' state with an IPv4 CIDR of '10.0.0.0/16' and an IPv6 CIDR of '-'. It is associated with a DHCP option set 'dopt-0ce84d1bc2a3b92f4' and a main route table 'rtb-022014f59b59054f1'. Below the table, a detailed view for 'vpc-08f782e6ac7591678 / WebApp-vpc' is shown under the 'Details' tab. The details include the VPC ID, state, DNS hostnames, and various network configurations.

The screenshot shows the AWS VPC dashboard. The 'Internet gateways' section is visible, displaying a table titled 'Internet gateways (1/2) Info'. A single row is present for the Internet gateway 'WebApp-igw', which has an Internet gateway ID of 'igw-04b85407542376b6d'. The gateway is in an 'Attached' state, connected to the VPC 'vpc-08f782e6ac7591678 | WebApp-vpc'. The owner of the gateway is listed as '207526410461'. Below the table, a detailed view for 'igw-04b85407542376b6d / WebApp-igw' is shown under the 'Details' tab. The details include the Internet gateway ID, state, VPC ID, and owner.

Name	NAT gateway ID	Connectivity...	State	State message	Primary public I...	Primary private I...	Primary network int...	VPC
Project	nat-0711e9d0fd62579e9	Public	Available	-	34.238.29.16	10.0.13.36	eni-0eccc921c07308ec	vpc-08f782e6ac7591678

Security Groups [File Link](#)

1) EC2-SG (Security Group for EC2 Instances):

- Description:** This security group is used for EC2 instances, allowing inbound SSH (port 22) and HTTP (port 80) access. It is ideal for controlling remote access and web traffic to the EC2 instances.
- Inbound Rules:** 3 rules, likely including SSH, HTTP, and another service-specific rule.
- Outbound Rules:** 1 rule, usually allowing all outbound traffic.

2) DB-SG (Database Security Group):

- Description:** This security group is designed for database instances, allowing inbound MySQL traffic on port 3306, ensuring secure database access.
- Inbound Rules:** 1 rule for MySQL (port 3306) access.
- Outbound Rules:** 1 rule, likely allowing all outbound traffic.

3) ELB-SG (Security Group for Elastic Load Balancer):

- Description:** This security group is for the Elastic Load Balancer (ELB), allowing inbound traffic for load-balanced services such as HTTP and HTTPS.
- Inbound Rules:** 2 rules, probably for HTTP (port 80) and HTTPS (port 443) traffic.
- Outbound Rules:** 1 rule, typically allowing all outbound traffic.

Task 2: Creating a virtual machine

The screenshot shows the AWS EC2 Instances page. The left sidebar includes links for EC2 Dashboard, EC2 Global View, Events, Console-to-Code, Instances (selected), Instance Types, Launch Templates, Spot Requests, Savings Plans, Reserved Instances, Dedicated Hosts, Capacity, Reservations, Images, AMIs, AMI Catalog, Elastic Block Store, Volumes, Snapshots, Lifecycle Manager, Network & Security, Security Groups, Elastic IPs, Placement Groups, Key Pairs, CloudShell, and Feedback. The main content area displays a table of instances with columns for Name, Instance ID, Instance state, Instance type, Status check, Alarm status, Availability Zone, Public IPv4 DNS, Public IPv4 IP, and Elastic IP. One instance, 'i-0a1570bc340f1deec', is selected and expanded, showing detailed information such as Public IPv4 address (34.224.80.209), Private IP DNS name (ip-10-0-15-235.ec2.internal), VPC ID (vpc-08f782e6ac7591678), Subnet ID (subnet-09e2572dc9014851f), Instance ARN (arn:aws:ec2:us-east-1:207526410461:instance/i-0a1570bc340f1deec), and IAM Role (WebApp). The bottom right corner of the page footer includes links for Monitoring, CloudWatch Metrics, CloudWatch Logs, and CloudWatch Metrics Insights.

Task 3: Testing the deployment

The screenshot shows a web browser window with the URL 'Not secure | 3.84.187.185'. The page title is 'Students'. The content includes a header with the 'XYZ University' logo and navigation links for 'Home' and 'Students list'. Below the header is a large image of students in graduation caps. The main content area features a 'Welcome' message and a note: 'Use this app to keep track of your student inquiries'. At the bottom left, there is a link 'List of students'.

Phase 3: Decoupling the application components

Task 1: Changing the VPC configuration

Note: You need private subnets in a minimum of two Availability Zones.

The screenshot shows the AWS VPC Subnets dashboard. On the left, there's a sidebar with various VPC-related options like EC2 Global View, Virtual private cloud, Security, DNS firewall, and Network Firewall. The main area displays a table of subnets:

Name	Subnet ID	State	VPC	IPv4 CIDR	IPv6 CIDR	IPv6 CIDR association
WebApp-subnet-private1-us-east-1a	subnet-05b5421eef52d0de3	Available	vpc-08f782e6ac7591678 WebApp-vpc	10.0.128.0/20	-	-
WebApp-subnet-public1-us-east-1a	subnet-09e2572dc9014851f	Available	vpc-08f782e6ac7591678 WebApp-vpc	10.0.0.0/20	-	-
WebApp-subnet-private2-us-east-1b	subnet-0f3c791425e2afc1c	Available	vpc-08f782e6ac7591678 WebApp-vpc	10.0.144.0/20	-	-
WebApp-subnet-public2-us-east-1b	subnet-0b13ef0fdb60ff7f84	Available	vpc-08f782e6ac7591678 WebApp-vpc	10.0.16.0/20	-	-

Below the table, a specific subnet is selected: **subnet-05b5421eef52d0de3 / WebApp-subnet-private1-us-east-1a**. The details page shows the following configuration:

Details	Value
Subnet ID	subnet-05b5421eef52d0de3
Available IPv4 addresses	4090
Availability Zone ID	use1-az4
Network ACL	acl-04d13a25618b7c82c
Auto-assign customer-owned IPv4 address	No
IPv6 CIDR reservations	-
Subnet ARN	arn:aws:ec2:us-east-1:20726410461:subnet/subnet-05b5421eef52d0de3
IPv6 CIDR	-
Network border group	us-east-1
Default subnet	No
Customer-owned IPv4 pool	-
State	Available
VPC	vpc-08f782e6ac7591678 WebApp-vpc
Auto-assign public IPv4 address	No
Outpost ID	-
Hostname type	IP name
IPv4 CIDR	10.0.128.0/20
Availability Zone	us-east-1a
Route table	rtb-01abed6036ac519d WebApp-rtb-private1-us-east-1a
Auto-assign IPv6 address	No
IPv4 CIDR reservations	-
Resource name DNS A record	-

The screenshot shows the AWS VPC Your VPCs dashboard. The main area displays a table of VPCs:

Name	VPC ID	State	IPv4 CIDR	DHCP option set	Main route table
WebApp-vpc	vpc-08f782e6ac7591678	Available	10.0.0.0/16	dopt-0ce84d1bc2a3b92f4	rtb-022014f59b59054f1

Below the table, a specific VPC is selected: **vpc-08f782e6ac7591678 / WebApp-vpc**. The Resource map page shows the following network components and their connections:

- VPC**: Your AWS virtual network (WebApp-vpc)
- Subnets (4)**:
 - us-east-1a: WebApp-subnet-public1-us-east-1a, WebApp-subnet-private1-us-east-1a
 - us-east-1b: WebApp-subnet-public2-us-east-1b, WebApp-subnet-private2-us-east-1b
- Route tables (4)**:
 - WebApp-rtb-public
 - WebApp-rtb-private1-us-east-1a
 - rtb-022014f59b59054f1
 - WebApp-rtb-private2-us-east-1b
- Network connections (2)**:
 - WebApp-igw
 - Project

Connections are shown as dashed lines between the subnets and route tables, and between the route tables and network connections.

Task 2: Creating and configuring the Amazon RDS database

The screenshot shows the AWS RDS console for the 'app-db' database. The 'Summary' tab is selected, displaying basic information: DB identifier (app-db), Status (Available), Role (Instance), Engine (MySQL Community), and Region & AZ (us-east-1a). The 'Connectivity & security' tab is also visible, showing the endpoint (app-db.cvco408ue4fy.us-east-1.rds.amazonaws.com), port (3306), availability zone (us-east-1a), VPC (WebApp-vpc), and subnet group (default-vpc-08f782e6ac7591678).

Task 4: Provisioning Secrets Manager

The screenshot shows the AWS Secrets Manager console for the 'Mydbsecret' secret. The 'Secret details' tab is selected, showing the encryption key (aws/secretsmanager), secret name (Mydbsecret), and secret ARN (arn:aws:secretsmanager:us-east-1:207526410461:secret:Mydbsecret-HrREnz). The 'Secret value' tab is also visible, showing the secret values for user (admin), password (X?5Vo1C6*5KpAc2tv-M%r2LuMQs), host (app-db.cvco408ue4fy.us-east-1.rds.amazonaws.com), and db (STUDENTS).

Task 5: Provisioning a new instance for the web server

The screenshot shows the AWS EC2 Instances page. On the left, a sidebar lists various services like EC2 Dashboard, Instances, Images, Elastic Block Store, Network & Security, and more. The main area displays a table of instances:

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IPv4 IP
webapp	i-01b3b2ac22e908017	Running	t2.micro	2/2 checks passed	View alarms	us-east-1a	ec2-54-225-38-160.co...	54.225.38.160
WebApp	i-0dd9ccfc4bafcff9e	Running	t2.micro	2/2 checks passed	View alarms	us-east-1a	ec2-54-196-138-174.co...	54.196.138.174
	i-073beef500327f761	Running	t2.micro	2/2 checks passed	View alarms	us-east-1b	ec2-107-22-1-137.com...	107.22.1.137

The 'WebApp' instance is selected. The details pane on the right provides specific information for this instance:

- Public IPv4 address: 54.196.138.174 | [open address](#)
- Instance state: Running
- Private IP DNS name (IPv4 only): ip-10-0-7-226.ec2.internal
- Instance type: t2.micro
- VPC ID: vpc-08f782e6ac7591678 (WebApp-vpc)
- Subnet ID: subnet-09e2572dc9014851f (WebApp-subnet-public1-us-east-1a)
- Instance ARN: arn:aws:ec2:us-east-1:207526410461:instance/i-0dd9ccfc4bafcff9e
- Public IPv4 DNS: ec2-54-196-138-174.compute-1.amazonaws.com | [open address](#)
- Private IPv4 addresses: 10.0.7.226
- Elastic IP addresses: -
- AWS Compute Optimizer finding: Opt-in to AWS Compute Optimizer for recommendations. | Learn more
- Auto Scaling Group name: -

Task 6: Migrating the database

```
54.221.137.124 (ubuntu) (1)
Terminal Sessions View Xserver Tools Games Settings Macros Help
Session Servers Tools Games Sessions View Split MultiExec Tunneling Packages Settings Help
Quick connect...
7.6.221.137.124 (ubuntu) (1) X server Exit
/home/ubuntu/
Name Size (kB)
.. 1
.cache 1
.ssh 1
aws 1
resources 1
.bash_history 1
.bash_logout 1
.bashrc 3
.profile 1
.sudo_as_admin_successful 0
.Xauthority 1
awscli2.zip 64 445
code.zip 397
code.exe 1 369
ubuntu@ip-10-0-7-14:~$ mysqldump -h 10.0.7.14 -u nodeapp -p --databases STUDENTS > data.sql
Enter password:
ubuntu@ip-10-0-7-14:~$ ls
code.zip 1 data.sql resources
ubuntu@ip-10-0-7-14:~$ mysql -h app-db.cvc0408ue4fy.us-east-1.rds.amazonaws.com -u admin -p < data.sql
Enter password:
ubuntu@ip-10-0-7-14:~$ mysql -h app-db.cvc0408ue4fy.us-east-1.rds.amazonaws.com -u admin -p
Welcome to the MySQL monitor. Commands end with ; or \g.
Your MySQL connection id is 1680
Server version: 8.0.35 Source distribution

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owners.

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

mysql> SHOW DATABASES;
+-----+
| Database |
+-----+
| STUDENTS |
| information_schema |
| mysql |
| performance_schema |
| sys |
+-----+
5 rows in set (0.00 sec)

mysql> USE STUDENTS;
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
mysql> SHOW TABLES;
+-----+
| Tables_in_STUDENTS |
+-----+
| students |
+-----+
1 row in set (0.00 sec)

mysql> SELECT * FROM students;
+----+----+----+----+----+----+
| id | name | address | city | state | email | phone |
+----+----+----+----+----+----+
| 1 | AbdelRahman | test | test | sss | abdulrahamanmoustafa2002@outlook.com | 1234567890 |
+----+----+----+----+----+----+
1 row in set (0.00 sec)

mysql> mysql>
```

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The screenshot shows a web application interface for XYZ University. At the top, there is a header with the university's logo (graduates in caps) and the text "XYZ University". Below the header, there are navigation links for "Home" and "Students list". The main content area is titled "All students" and displays a table of student data. The table has columns: Name, Address, City, State, Email, and Phone. One row is visible in the table:

Name	Address	City	State	Email	Phone
AbdelRahman	test	test	sss	abdulrahamanmoustafa2002@outlook.com	1234567890

Below the table, there is a green button labeled "Add a new student".

Task 7: Testing the application



XYZ University

Home
Students list

All students

Name	Address	City	State	Email	Phone	Action
AbdelRahman	test	test	sss	abdulrahamanmoustafa2002@outlook.com	1234567890	edit
عبدالرحمن مصطفى محمد	test	Alexandria	sss	abdulrahmanmoustafa2002@gmail.com	01121435744	edit

[Add a new student](#)

Phase 4: Implementing high availability and scalability

Task 1: Creating an Application Load Balancer

The screenshot shows the AWS Management Console interface for the Elastic Load Balancing service. The left sidebar navigation includes services like Services, Billing and Cost Management, EC2, S3, Elastic Beanstalk, and VPC. Under the EC2 section, 'Load balancers' is selected, and under it, 'APP-ELB' is shown. The main content area displays the 'APP-ELB' configuration details. The 'Details' tab is active, showing the following information:

Load balancer type	Status	VPC	Load balancer IP address type
Application	Active	vpc-08f782e6ac7591678	IPv4
Scheme	Hosted zone	Availability Zones	Date created
Internet-facing	Z355XD0TRQ7X7K	subnet-09e2572dc9014851f us-east-1a (use1-az4) subnet-0b13efdfdb60f7f84 us-east-1b (use1-az6)	September 23, 2024, 12:22 (UTC+03:00)
Load balancer ARN	DNS name Info		
arn:aws:elasticloadbalancing:us-east-1:207526410461:loadbalancer/app/APP-ELB/d8eb33e5f5034d93	APP-ELB-1110004202.us-east-1.elb.amazonaws.com (A Record)		

Below the details, there are tabs for 'Listeners and rules', 'Network mapping', 'Resource map - new', 'Security', 'Monitoring', 'Integrations', 'Attributes', and 'Tags'. The 'Listeners and rules' tab is selected, showing one rule entry:

Protocol:Port	Default action	Rules	ARN	Security policy	Default SSL/TLS certificate	mTLS
HTTP:80	Forward to target group • Webapp-TG 1 (100%) • Target group stickiness: Off	1 rule	ARN	Not applicable	Not applicable	Not applicable

At the bottom of the page, there are links for CloudShell, Feedback, and a footer with copyright information.

Task 2: Implementing Amazon EC2 Auto Scaling

AWS Services Search [Alt+S] N. Virginia vclabs/user3342491=Abdelrhman_Mostafa_Mohamed @ 2075-2641-0461

Console Home Billing and Cost Management EC2 S3 Elastic Beanstalk VPC

Reserved Instances Dedicated Hosts Capacity Reservations New

Images AMIs AMI Catalog

Elastic Block Store Volumes Snapshots Lifecycle Manager

Network & Security Security Groups Elastic IPs Placement Groups Key Pairs Network Interfaces

Load Balancing Load Balancers Target Groups Trust Stores New

Auto Scaling Auto Scaling Groups Settings

Group details

Auto Scaling group name WebApp-ASG	Desired capacity 2	Desired capacity type Units (number of instances)	Amazon Resource Name (ARN) arn:aws:autoscaling:us-east-1:207526410461:autoScalingGroup:42fb8dc63-d915-40dd-9a06-d443119544d6:autoScalingGroupName/WebApp-ASG
Date created Mon Sep 23 2024 12:26:17 GMT+0300 (Eastern European Summer Time)	Minimum capacity 2	Status -	
	Maximum capacity 2		

Launch template

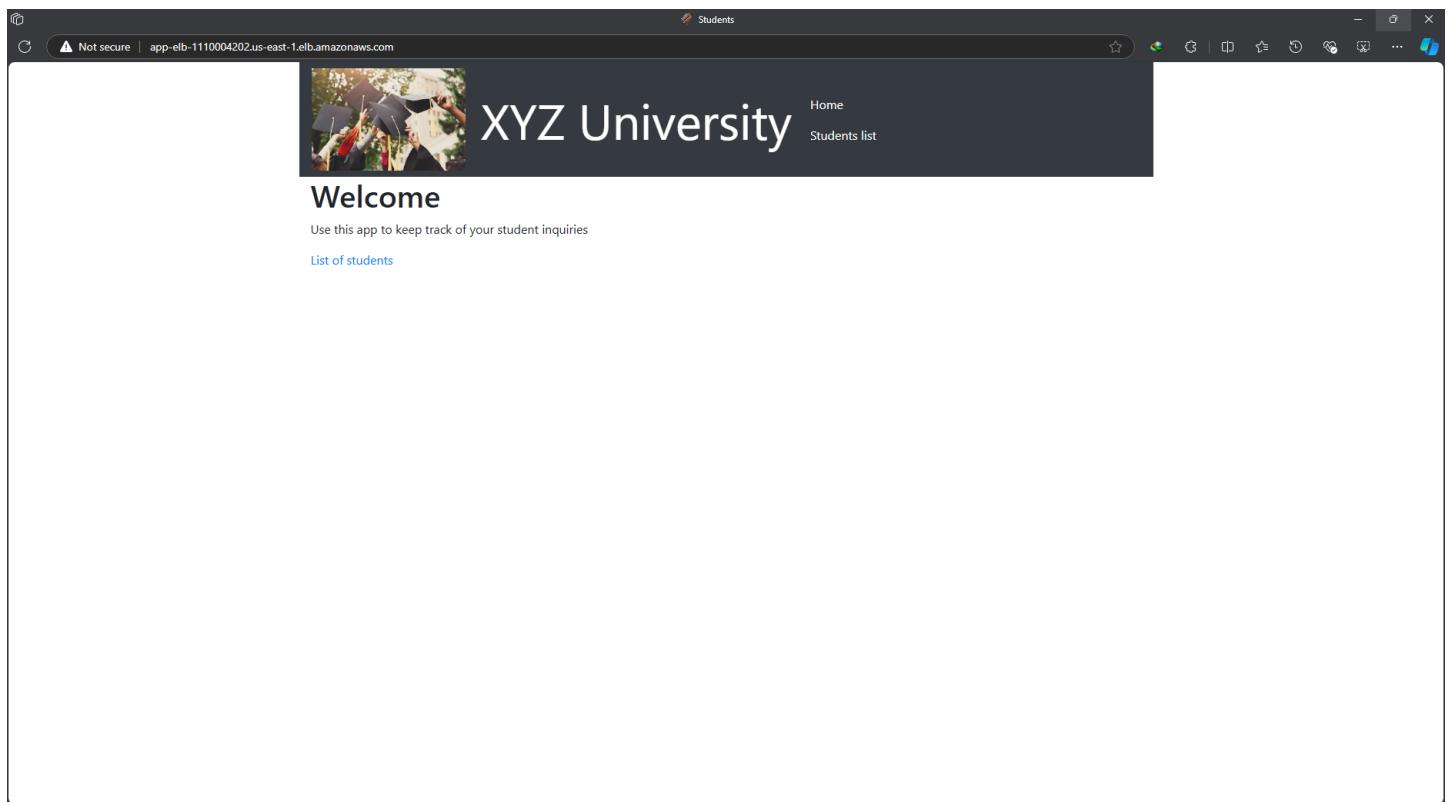
Launch template lt-0613e82d2297ec861 Webapp	AMI ID ami-0a0e5d9c7acc336f1	Instance type t2.micro	Owner arn:aws:ssts:207526410461:assumed-role/vclabs/user3342491=Abdelrhman_Mostafa_Mohamed
Version Latest	Security groups -	Security group IDs sg-02da46d2eed6655a1	Create time Mon Sep 23 2024 12:25:08 GMT+0300 (Eastern European Summer Time)
Description -	Storage (volumes) /dev/sda1	Key pair name vockey	Request Spot Instances No

[View details in the launch template console](#)

Network

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Task 3: Accessing the application



Task 4: Load testing the application

```
54.163.195.111 (ubuntu)
Terminal Sessions View Xserver Tools Games Settings Macros Help
Session Servers Tools Games View Split MultiExec Tunneling Packages Settings Help
X server Exit
Quick connect... 9: 54.163.195.111 (ubuntu) × ↗
/home/ubuntu/
Name Target URL: http://APP-ELB-1110004202.us-east-1.elb.amazonaws.com
.. Max time (s): 10
.cache Target rps: 100
.Concurrent clients: 3
.ssh Agent: keepalive
.bash_logout Completed requests: 1000
.bashrc Total errors: 0
.profile Total time: 10 s
.bashrc Mean latency: 2.6 ms
.profile Effective rps: 100
Percentage of requests served within a certain time
50% 2 ms
90% 4 ms
95% 4 ms
99% 6 ms
100% 20 ms (longest request)
ubuntu@ip-10-0-6-18:~$ sudo loadtest --rps 100 -c 50 -k http://APP-ELB-1110004202.us-east-1.elb.amazonaws.com
Requests: 500, requests per second: 100, mean latency: 2.7 ms
Target URL: http://APP-ELB-1110004202.us-east-1.elb.amazonaws.com
Max time (s): 10
Target rps: 1000
.Concurrent clients: 12
Agent: keepalive
Completed requests: 9996
Total errors: 0
Total time: 10 s
Mean latency: 2.6 ms
Effective rps: 1000
Percentage of requests served within a certain time
50% 2 ms
90% 4 ms
95% 5 ms
99% 8 ms
100% 21 ms (longest request)
ubuntu@ip-10-0-6-18:~$ █

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