Part 1: Core Services (5 marks)

1. Differentiate between the following: (2 marks)

a. Security Group and NACL

Security groups act as a firewall to control the access of incoming and outgoing traffic of the resources that it is associated with by using specified inbound and outbound rules. In AWS02, the default security group came when we created a VPC. We additionally created security groups for EC2 instances, an elastic load balancer (ELB) and a database (RDS) to control the traffic of each resource.

NACL stands for Network Access Control List which acts as a firewall to control the traffic in and out of subnets. While security groups offer only the Allow rules, NACL supports both Allow and Deny rules. Deny rules mean NACL will block certain IP addresses to connect EC2 instances.

b. Auto Scaling and Load Balancing

Auto scaling is used to scale EC2 capacity automatically and ensure that the application will have a sufficient number of instances to handle the load of applications. Consumers can specify the minimum and the maximum number of instances that they desire. Auto scaling increases fault-tolerance and availability.

Load balancers automatically distribute incoming traffic across targets (e.g. EC2 instance) in multiple availability zones. It serves as a single point of contact for client requests, monitors the status of the targets, and then routes the requests to the healthy targets which has the Inservice status. Load balancer is designed to increase fault-tolerance and availability.
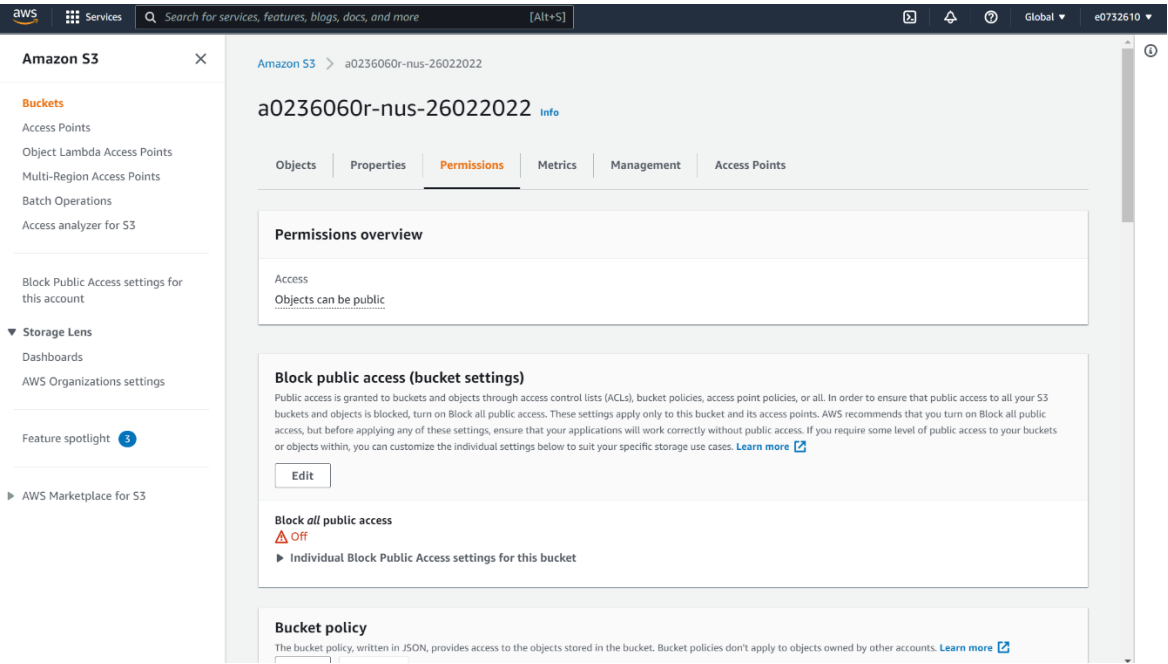
2. Create a S3 bucket and upload objects: (2 marks)

a. Bucket contents showing the "last modified" and "size" of object

b. Permissions granted on the bucket

c. Permissions granted on the image object

https://a0236060r-nus-26022022.s3.amazonaws.com/my_cat.jpg

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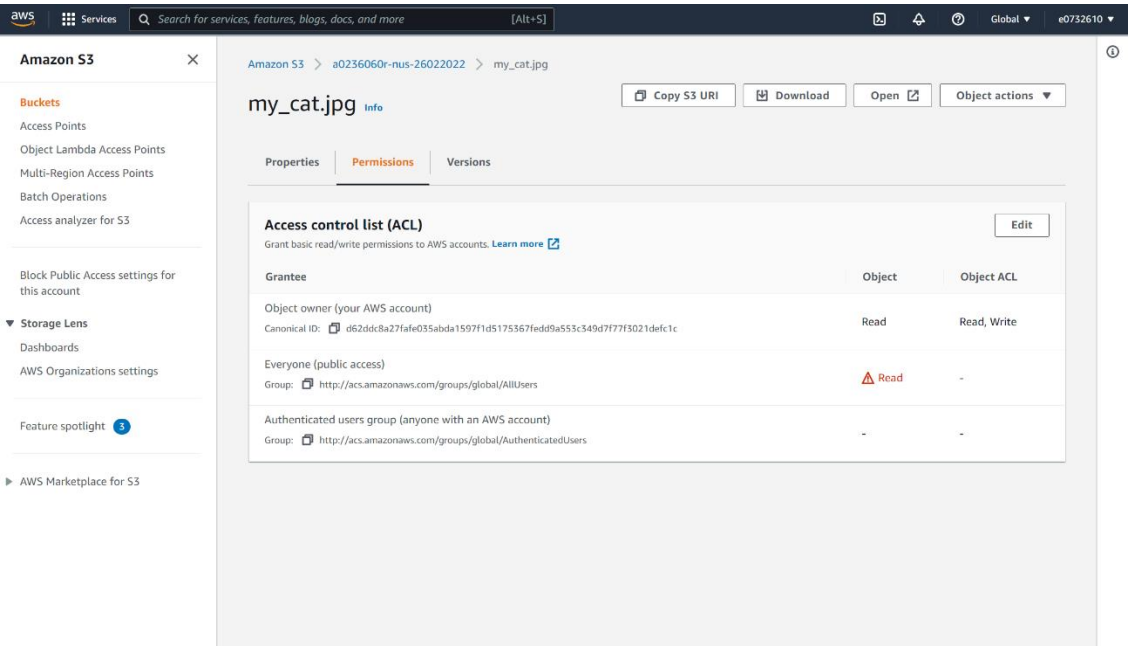
## 3. What are the advantages of using Amazon RDS instead of setting up MySQL database on an EC2 instance? (1 mark)

- Amazon RDS is easy to set up because the parameters and settings have been pre-configured. This allows consumers to focus on more important tasks such as the application development or the optimisation of the database
- Amazon RDS provides an automated backup feature which consumers can recover MySQL database any point of time up to 35 days. On the other hand, MySQL with EC2, consumers must set up recovery solutions in SQL servers.
- Amazon RDS enables an elastic scale out feature to increase capacity of a single database instance for heavy workload.

# Part 2: Set up Hello World webpage on EC2 instance (10 marks)
1. Draw a diagram showing your EC2 instances, along with the network, storage, and security components. (2 marks)

I did not create Elastic Load Balancer and RDS as in AWS02 for this problem because it asks for a simple hello world page and the resources in architecture below are enough to run the result.
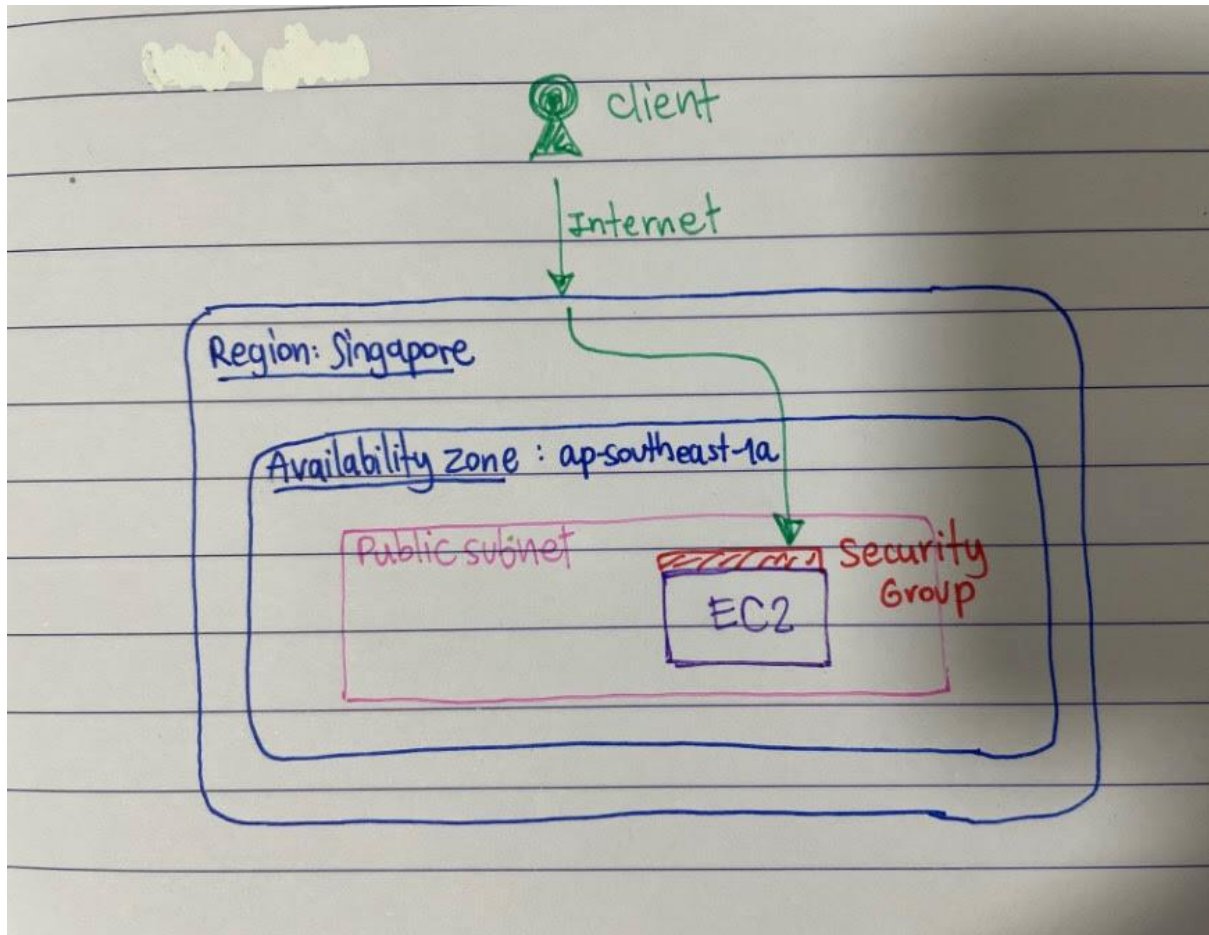
2. Set up the environment mentioned in (1), and list down the steps you used to setup the instance. Only include final screenshots of the following: (4 marks)
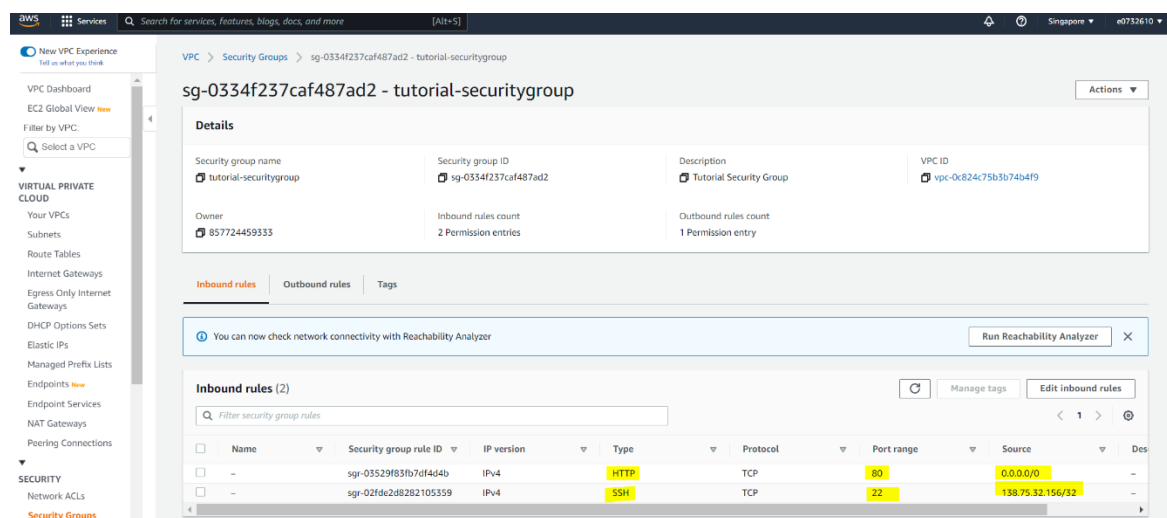
a. Route table of the subnet
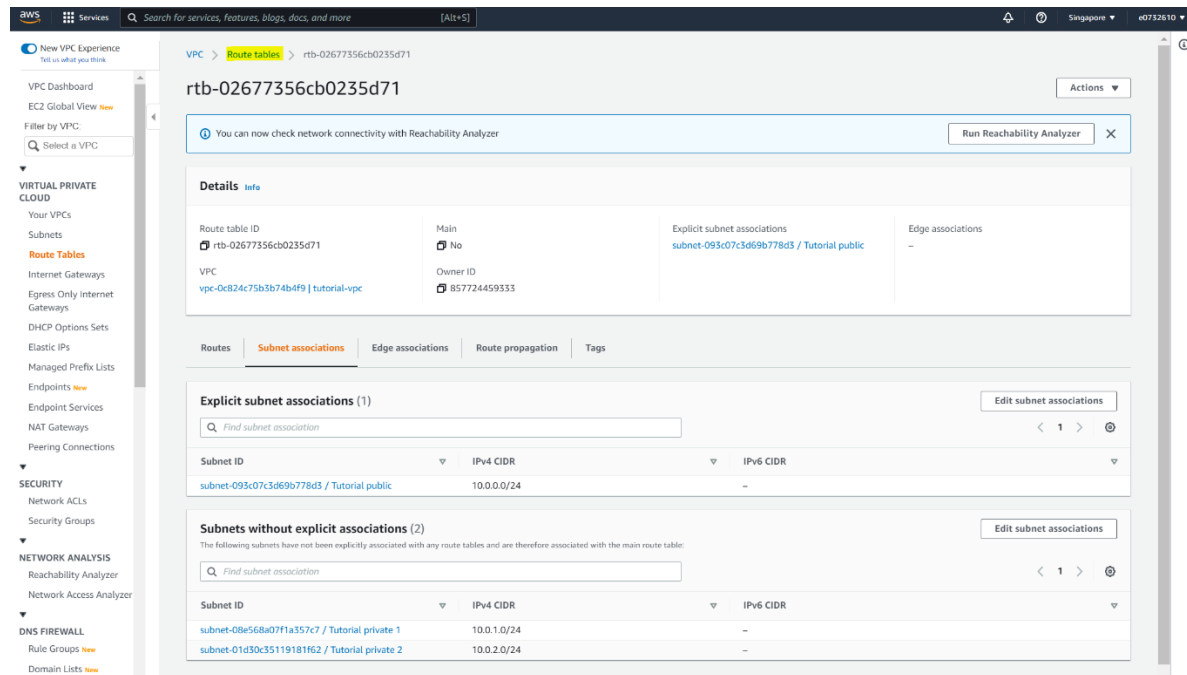
b. Inbound and outbound rules in the EC2 Security Group

Inbound rules:

- HTTP Port 80 for any IP address to connect
- SSH Port 22 for my IP address to connect via SSH

Outbound rules:

c. Status checks of the EC2 instance

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3. Connect to the EC2 instance with SSH and install Apache webserver. Ensure the service is running. List down the steps you used and include a screenshot of the command: service apache2 status. (2 marks)

I follow the steps below to install Apache webserver.

1. After the EC2 instance was created, I connect to the EC2 Ubuntu instance using SSH command below.
   - *ssh -i tutorial-key-pair.pem ubuntu@ec2-54-254-71-79.ap-southeast-1.compute.amazonaws.com*

   Here is Public IPv4 DNS of the EC2 instance

   Public IPv4 DNS

   ec2-54-254-71-79.ap-southeast-1.compute.amazonaws.com | open address
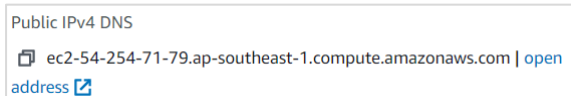
2. Install Apache and adjust firewall by using the following commands:
   - *sudo apt update*
   - *sudo apt install apache2*
   - *sudo ufw app list*
   - *sudo ufw app list*
   - *sudo ufw app list*

3. Set up virtual host and add helloworld.html to the server
   - *sudo mkdir /var/www/cs5224*
   - *sudo chown -R $USER:$USER /var/www/cs5224*
   - *sudo chmod -R 755 /var/www/cs5224*
   - *sudo nano /var/www/cs5224/helloworld.html*

4. Add a configuration file with the setting below
   - *sudo nano /etc/apache2/sites-available/cs5224.conf*

```
<VirtualHost *:80>
    ServerAdmin webmaster@localhost
    ServerName cs5224
    ServerAlias tutorial-db-instance.c3yyjoxsqfdj.ap-southeast-1.rds.amazonaws.com
    DocumentRoot /var/www/cs5224
    ErrorLog ${APACHE_LOG_DIR}/error.log
    CustomLog ${APACHE_LOG_DIR}/access.log combined
</VirtualHost>
```

   - *sudo a2ensite cs5224.conf*
   - *sudo a2dissite 000-default.conf*
   - *sudo apache2ctl configtest*
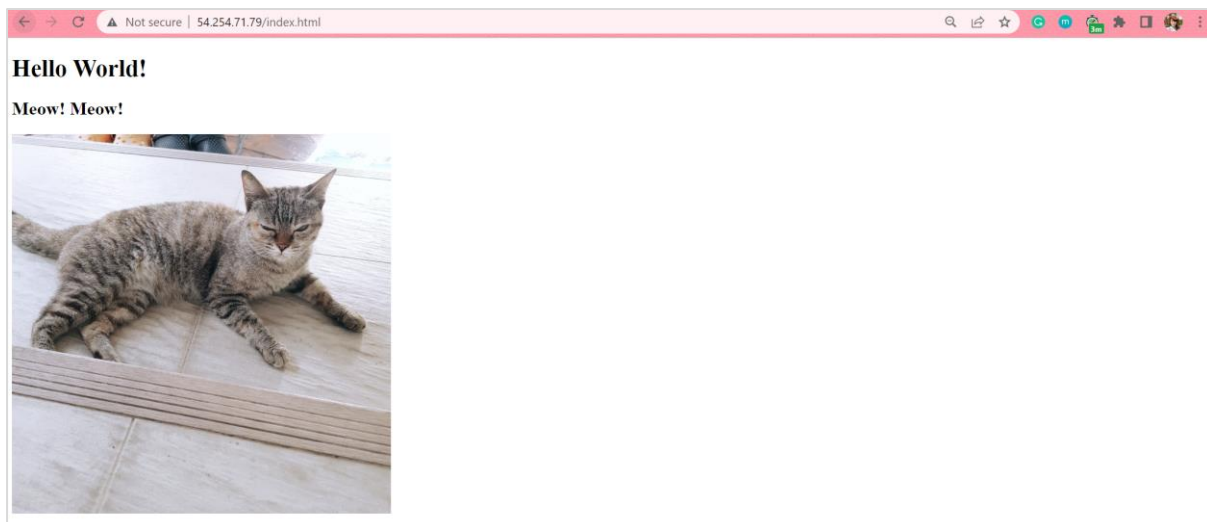
5. Start the server
   - *sudo systemctl start apache2*

Reference: Apache server set up

4. Display a helloworld webpage on port 80 of the instance. You should be able to access this page using the instance's Public IP through your browser. Include a screenshot of your browser window. (2 marks)

Click here to access the website: http://54.254.71.79/index.html

Part 3: Compare cost of EC2 pricing models (5 marks)

The table below shows the difference cost between three billing options by types of resources or service. We can see that the on-demand option does not include the cost of Reserved Instance and AWS Support, so the main cost occurs from the computation. On the other hand, the main cost of the 1-year and 3-year option is from Reserved Instance and AWS Support while the monthly cost is considered as a small number.

Billing Option	Compute	EBS Volume	Reserved Instance	AWS Support	One-time cost	Monthly cost
On demand	124.44	10	0	0	0	134.44
1-Year-All-Upfront-Reserved	0	10	876	0	876	10
3-Year-AllUpfront-Reserved	0	10	1629	163.90	1692.9	110

The table below compares the difference between billing options on monthly and annual and three-year basis. We observe that subscribing the cloud service with 3-Year-All-Upfront-Reserved is the most expensive, followed by the On-demand option. The 1-Year-All-Upfront-Reserved option offers the cheapest cost which is around half of the cost of 3-year option.

Billing Option	Monthly Cost	Annual Cost	Three -year Cost
On demand	134.44	1613.28	4839.84
1-Year-All-Upfront-Reserved	10	996	2988
3-Year-AllUpfront-Reserved	110	1884.3	5652.9

On Demand

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1-Year-All-Upfront-Reserved

Services	Estimate of your Monthly Bill ($ 10.00)		

Estimate of Your Monthly Bill
☑ Show First Month's Bill (include all one-time fees, if any)

Below you will see an estimate of your monthly bill. Expand each line item to see cost breakout of each service. To save this bill and input values, click on 'Save and Share' button. To remove the service from the estimate, jump back to the service and clear the specific service's form.

Export to CSV | | | Save and Share

	Service		Amount
⊖	Amazon EC2 Service (US East (N. Virginia))		$ 886.00
	Compute:	$	0.00
	EBS Volumes:	$	10.00
	EBS IOPS:	$	0.00
	EBS Throughput:	$	0.00
	Reserved Instances (one-time fee):	$	876.00
⊕	AWS Support (Basic)		$ 0.00
Total One-Time Payment:			$ 876.00
Total Monthly Payment:			$ 10.00

3-Year-AllUpfront-Reserved

Services	Estimate of your Monthly Bill ($ 110.00)		

Estimate of Your Monthly Bill
☑ Show First Month's Bill (include all one-time fees, if any)

Below you will see an estimate of your monthly bill. Expand each line item to see cost breakout of each service. To save this bill and input values, click on 'Save and Share' button. To remove the service from the estimate, jump back to the service and clear the specific service's form.

Export to CSV | | | Save and Share

	Service		Amount
⊖	Amazon EC2 Service (US East (N. Virginia))		$ 1639.00
	Compute:	$	0.00
	EBS Volumes:	$	10.00
	EBS IOPS:	$	0.00
	EBS Throughput:	$	0.00
	Reserved Instances (one-time fee):	$	1629.00
⊕	AWS Support (Business)		$ 163.90
Total One-Time Payment:			$ 1692.90
Total Monthly Payment:			$ 110.00