CERTIFICATE

V.K KRISHNA MENON COLLEGE OF COMMERCE AND ECONOMICS

&

SHARAD SHANKAR DIGHE COLLEGE OF SCIENCE BHANDUP EAST, MUMBAI-400042

This is to certify that Mr. Manish Gupta _Roll No: 12 hassuccessfully completed **Cloud Computing** Practical of **Semester VI** for partial fulfilment of B.Sc. Degree course in Computer Science of University of Mumbai in academic year 2022-2023 under the guidance of **Dr. Deepa Nyayadhish**

DATE HEAD OF THE DEPARTMENT

Teacher-in-charge EXAMINER

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Practical No :- 1

Aim :- To study cloud architecture and cloud computing model.

Objectives :- From this experiment, the student will be able to

- To provide an overview of concepts of Cloud Computing .
- To encourage students to indulge into research in Cloud Computing.

Outcomes :- The learner will be able to

- To understand and appreciate cloud architecture.
- To analyze the local and global impact of computing on individuals, organizations, and society.
- To recognize the need for, and an ability to engage in life-long learning.

Theory :-

Cloud computing enables companies to consume compute resources as a utility -- just like electricity -- rather than having to build and maintain computing infrastructures in-house. Cloud computing promises several attractive benefits for businesses and end users.

Three of the main benefits of cloud computing include :-

- Self-service provisioning: End users can spin up computing resources for almost any type of workload on-demand.
- Elasticity: Companies can scale up as computing needs increase and then scale down again as demands decreases.
- Pay per use: Computing resources are measured at a granular level, allowing users to pay only for the resources and workloads they use.

Cloud computing services can be Private, Public or Hybrid.

- **Private cloud** services are delivered from a business' data center to internal users. This model offers versatility and convenience, while preserving management, control and security. Internal customers may or may not be billed for services through IT chargeback.
- In the **Public cloud** model, a third-party provider delivers the cloud service over the Internet. Public cloud services are sold on-demand, typically by the minute or the hour. Customers only pay for the CPU cycles, storage or bandwidth they consume. Leading public cloud providers include Amazon WebServices (AWS), Microsoft Azure, IBM/Soft Layer and Google Compute Engine.
- **Hybrid clou**d is a combination of public cloud services and on-premises private cloud – with orchestration and automation between the two Companies can run mission-critical workloads or sensitive applications on the private cloud

while using the public cloud for workloads that must scale on-demand. The goal of hybrid cloud is to create a unified, automated, scalable environment which takes advantage of all that a public cloud infrastructure can provide, while still maintaining control over mission-critical data

Types of cloud computing :-

IT people talk about three different kinds of cloud computing, where different services are being provided for you. Note that there's a certain amount of vagueness about how these thingsare defined and some overlap between them.

- **Infrastructure as a Service (IaaS)** means you're buying access to raw computing hardware over the Net, such as servers or storage. Since you buy what you need and pay-as-you-go, this is often referred to as utility computing. Ordinary web hosting is a simple example of IaaS: you pay a monthly subscription or a per- megabyte/gigabyte fee to have a hosting company serve up files for your website from their servers.
- **Software as a Service (SaaS)** means you use a complete application running on someone else's system. Web-based email and Google Documents are perhaps the best-known examples. Zoho is another well-known SaaS provider offering a variety of office applications online.
- **Platform as a Service (PaaS)** means you develop applications using Web- based tools so they run on systems software and hardware provided by another company. So, for example, you might develop your own ecommerce website but have the whole thing, including the shopping cart, checkout, and payment mechanism running on a merchant's server. Force.com (from salesforce.com) and the Google App Engine are examples of PaaS.

Advantages and disadvantages of cloud computing :-

Advantages :- The pros of cloud computing are obvious and compelling. If your business is selling books or repairing shoes, why get involved in the nitty gritty of buying and maintaining a complex computer system? If you run an insurance office, do you really want your sales agents wasting time running anti-virus software, upgrading word-processors, or worrying about hard-drive crashes? Do you really want them cluttering your expensive computers with their personal emails, illegally shared MP3 files, and naughty YouTube videos—when you could leave that responsibility to someone else? Cloud computing allows you to buy in only the services you want, when you want them, cutting the upfront capital costs of computers and peripherals. You avoid equipment going out of date and other familiar IT problems like ensuring system security and reliability. You can add extra services (or take them away) at a moment's notice as your busines needs change. It's really quick and easy to add new applications or services to your business without waiting weeks or months for the new computer(and its software) to arrive.

Disadvantages :- Instant convenience comes at a price. Instead of purchasing computers and software, cloud computing means you buy services, so one-off, upfront capital costs become ongoing operating costs instead. That might work out much more expensive in the long-term.

If you're using software as a service (for example, writing a report using an online word processor or sending emails through webmail), you need a reliable, high-speed, broadband Internet connection functioning the whole time you're working. That's something we take for granted in countries such as the United States, but it's much more of an issue in developing countries or rural areas where broadband is unavailable.

If you're buying in services, you can buy only what people are providing, so you may be restricted to off-the-peg solutions rather than ones that precisely meet your needs. Not only that, but you're completely at the mercy of your suppliers if they suddenly decide to stop supporting a product you've come to depend on. (Google, for example, upset many users when it announced in September 2012 that its cloud-based Google Docs would drop support for old but de facto standard Microsoft Office file formats such as .DOC, .XLS, and .PPT, giving a mere one week's notice of the change—although, after public pressure, it later extended the deadline by three months.) Critics charge that cloud-computing is a return to the bad-old days of mainframes and proprietary systems, where businesses are locked into unsuitable, long-termarrangements with big, inflexible companies. Instead of using "generative" systems (ones that can be added to and extended in exciting ways the developers never envisaged), you'reeffectively using "dumb terminals" whose uses are severely limited by the supplier. Good for convenience and security, perhaps, but what will you lose in flexibility? And is such arestrained approach good for the future of the Internet as a whole? (To see why it may not be, take a look at Jonathan Zittrain's eloquent book The Future of the Internet—And How to Stop It.)

Conclusion :- Cloud computing enables a convenient and on-demand network access to a wide range of resources. The different services and also the deployment models allow flexible service provider interaction with minimal human intervention. It saves costs but also can lead to risk issues and suspension of resources when in huge quantity.

Practical No : 2

Aim :- Installing and Configuration of virtualization using KVM.

Objectives : From this experiment, the student will be able to,

- Understand the concepts of virtualization.
- Understand KVM architecture and its configuration.

Outcomes : The learner will be able,

- To analyze user models and develop user centric interfaces
- To analyze the local and global impact of computing on individuals, organizations, and society.
- To engage in life-long learning development and higher studies.
- To understand, identify, analyze and design the problem, implement and validate the solution including both hardware and software.

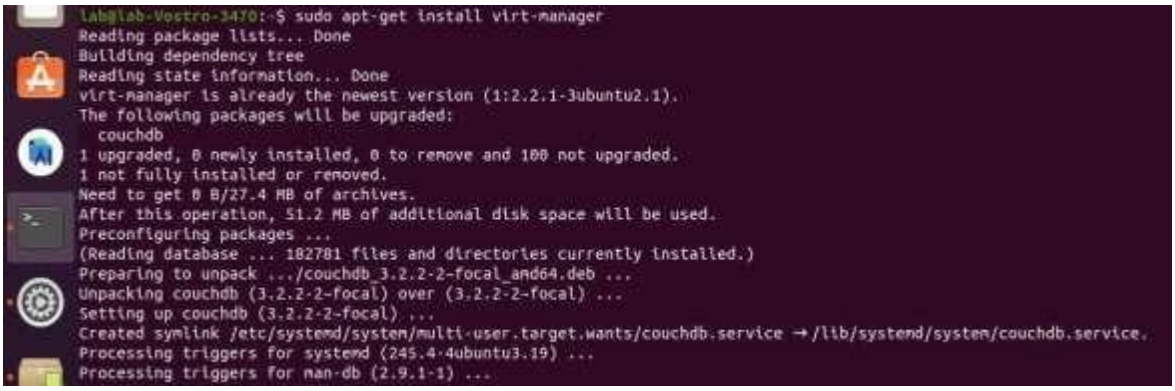
Steps :-

1. Open terminal in Ubuntu OS

2. Install TinyCore on Ubuntu OS https://distro.ibiblio.org/tinycorelinux/downloads.html

3. Write the following command

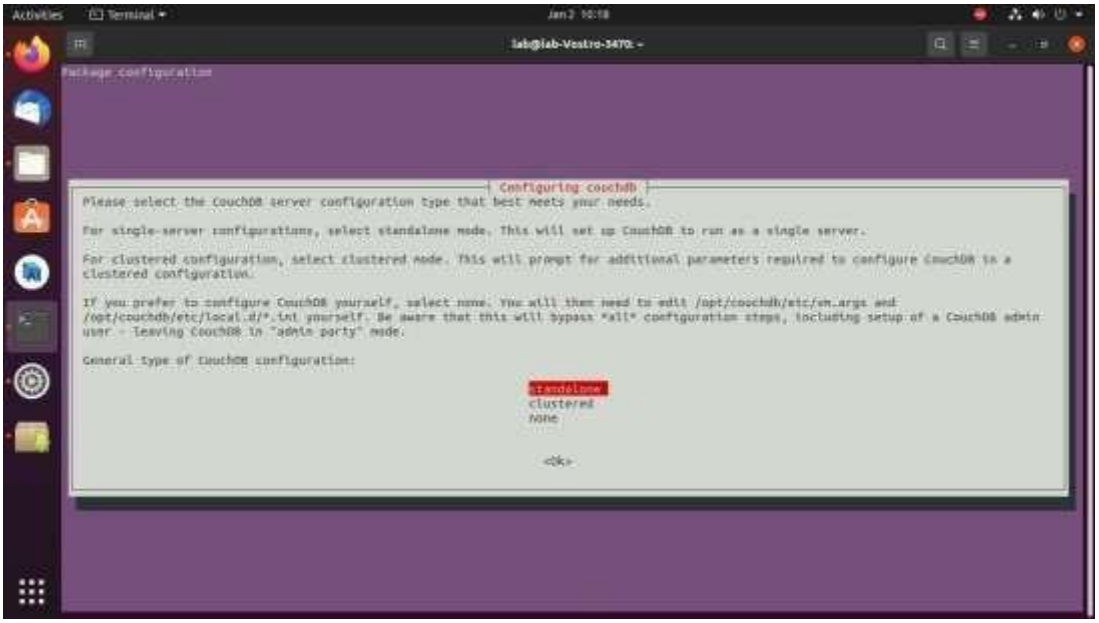
$sudo apt-get install virt-manager



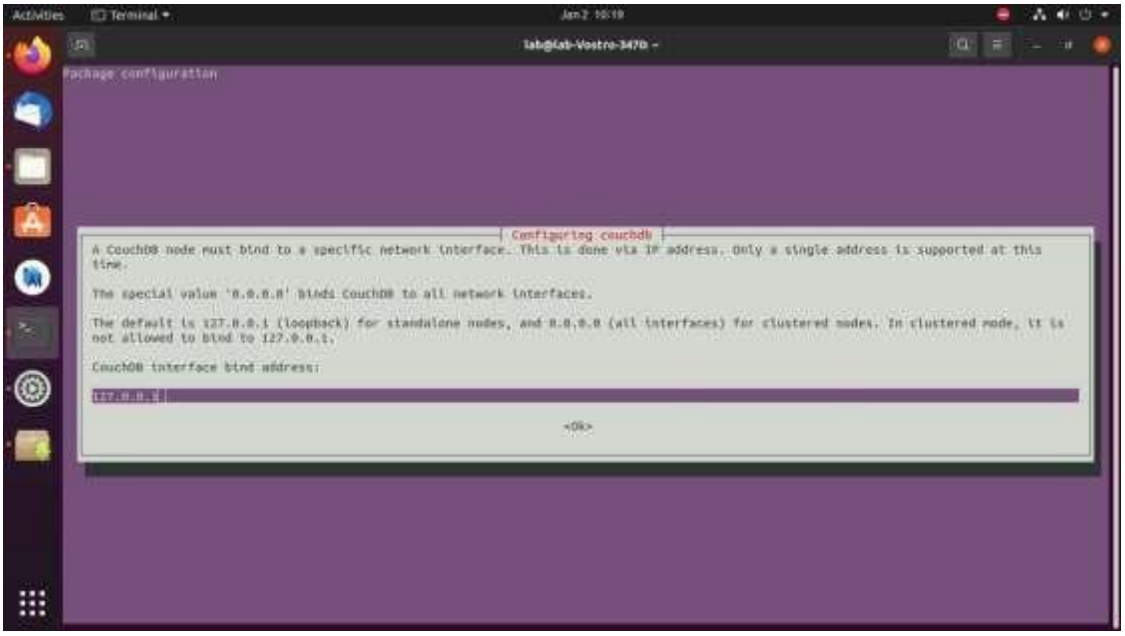
4. $sudovirt-manager

```
lab@lab-Vostro-3470:~$ sudo virt-manager
lab@lab-Vostro-3470:~$
```

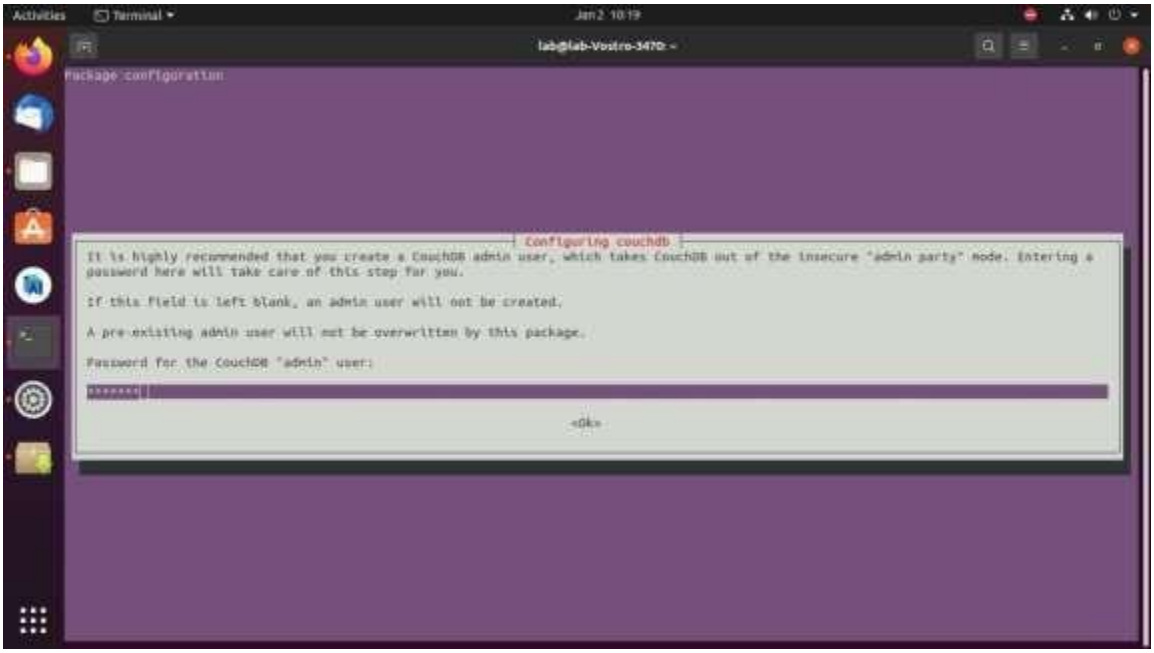
5. We will select Standalone and press enter.



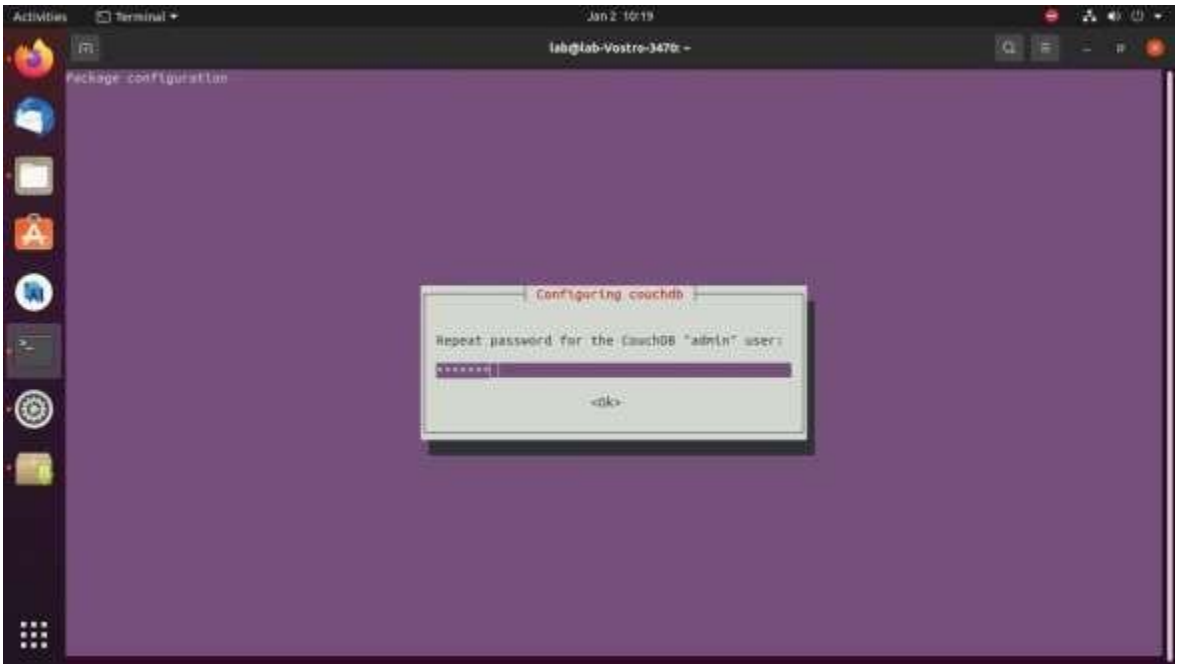
6. It will show CouchDB interface bind address.



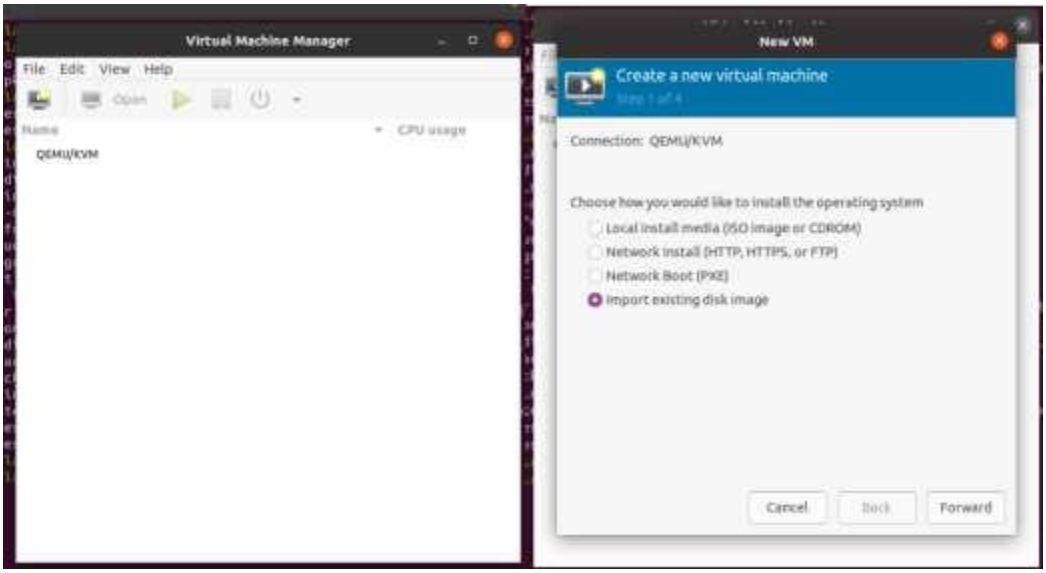
7. Now enter the password.



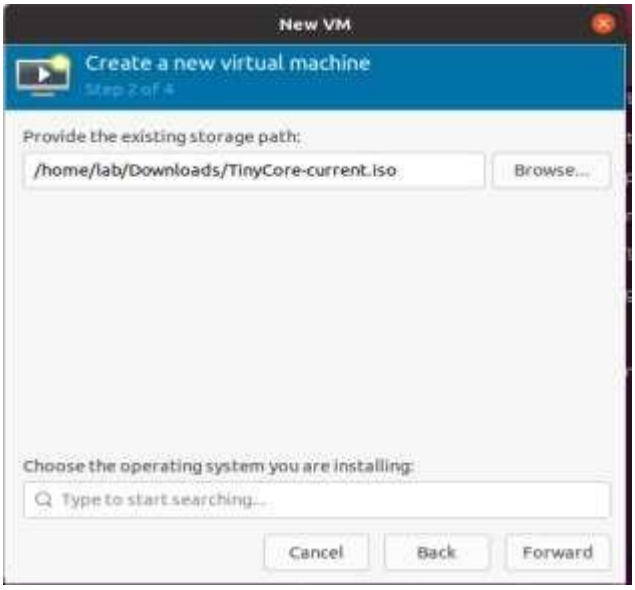
8. Then confirm password.



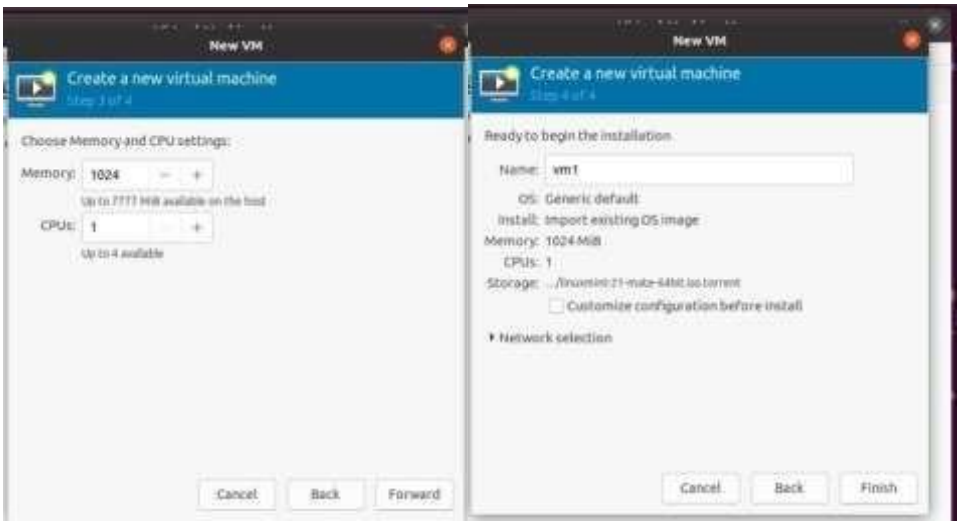
9. Select file -> New Virtual machine -> Import existing disk image -> Forward



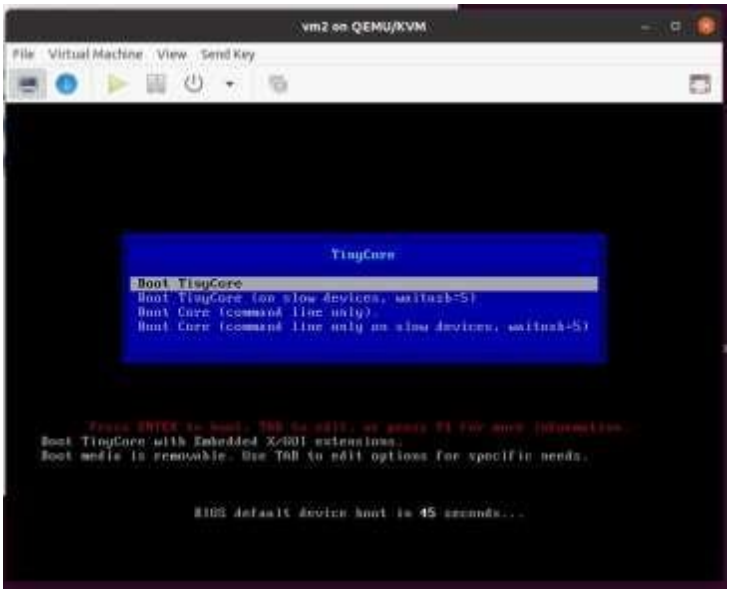
10. Browse the location OS type -> TinyCore and choose OS ->Generic defalt click on Forward.



11. Then click on forward



12. Now our virtual machine will started and press Enter.



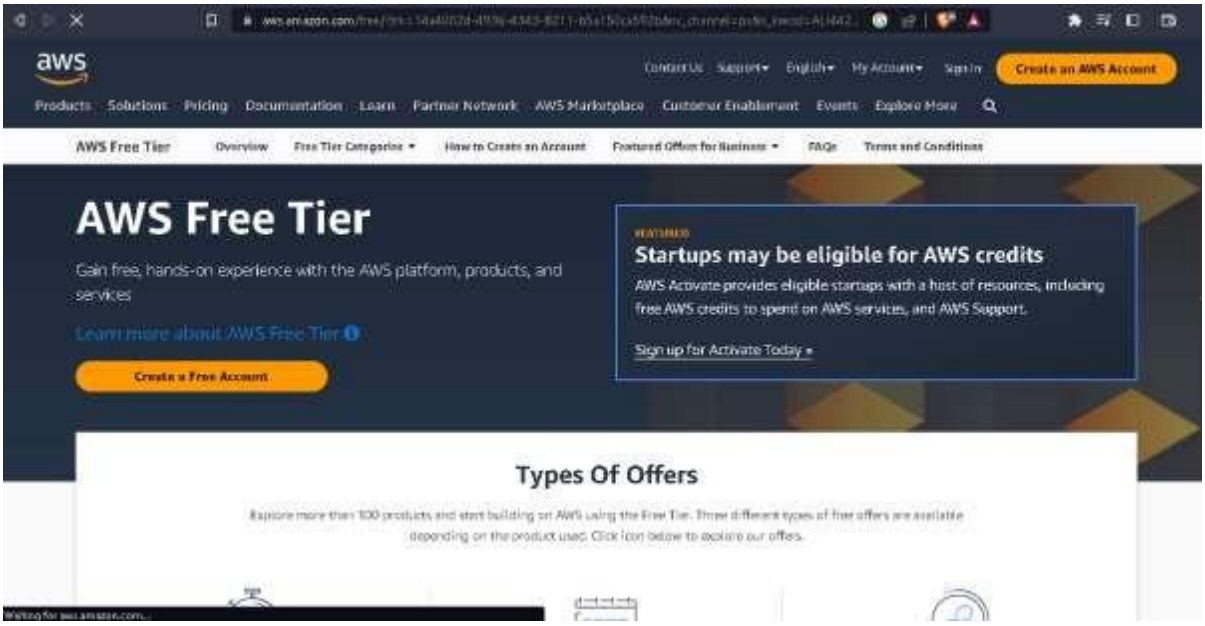
Conclusion :- Installation and configuration of KVM have been done successfully onto Ubuntu and users added. Like this we can create as many virtual machines as possible on OS and can install any windows onto it.

PRACTICAL-3

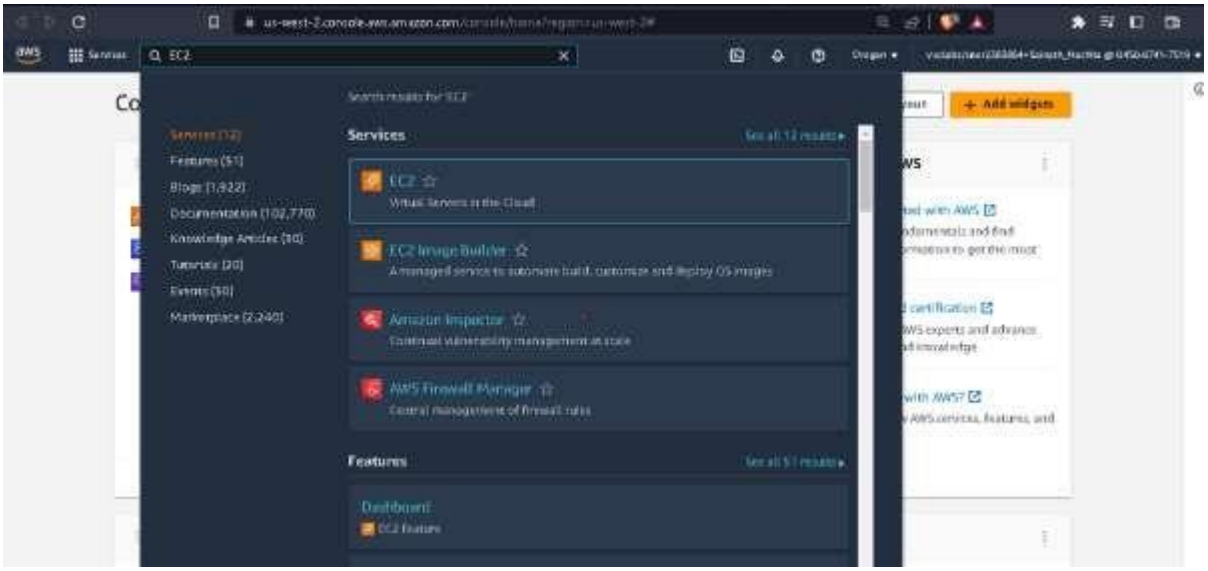
AIM: Study and implementation of Infrastructure as a Service.

Step1:First go to Amazon AWS Website(**https://aws.amazon.com/**)

Create an AWS Account if you don't have one, Login In if you already have an account.

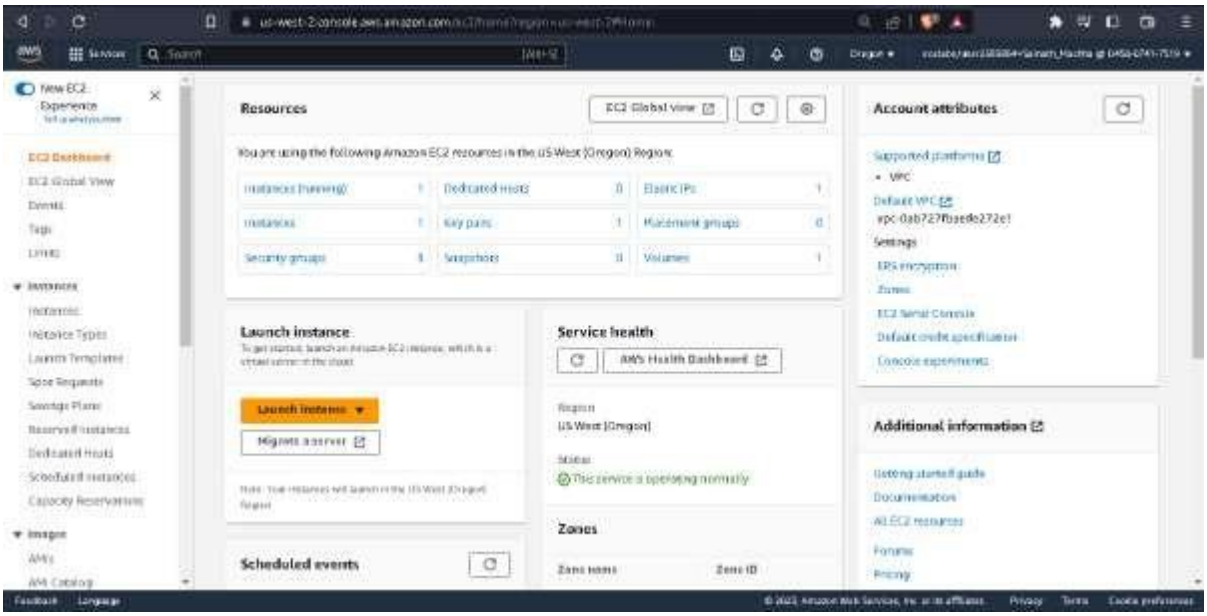


Step2: Search for EC2 in the search bar and select it.

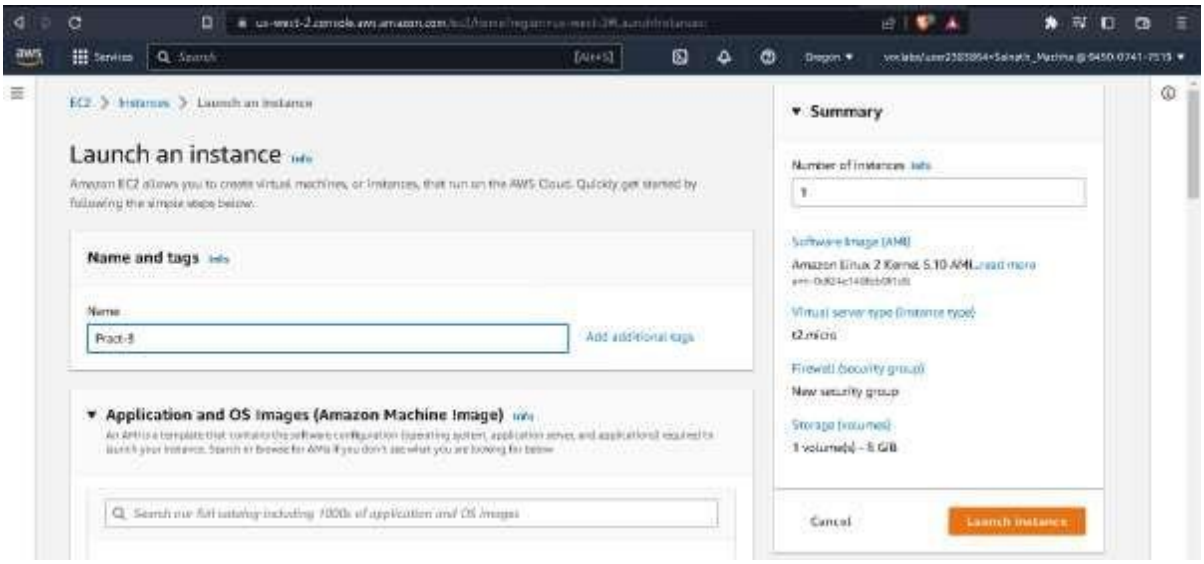


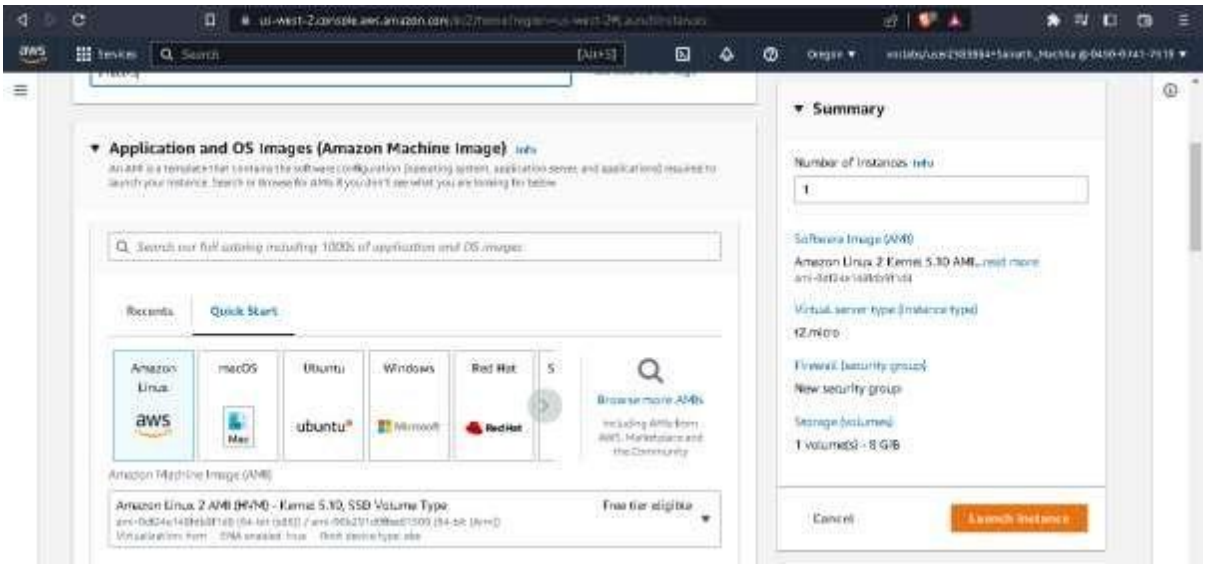
Step3: You will see this type of interface.

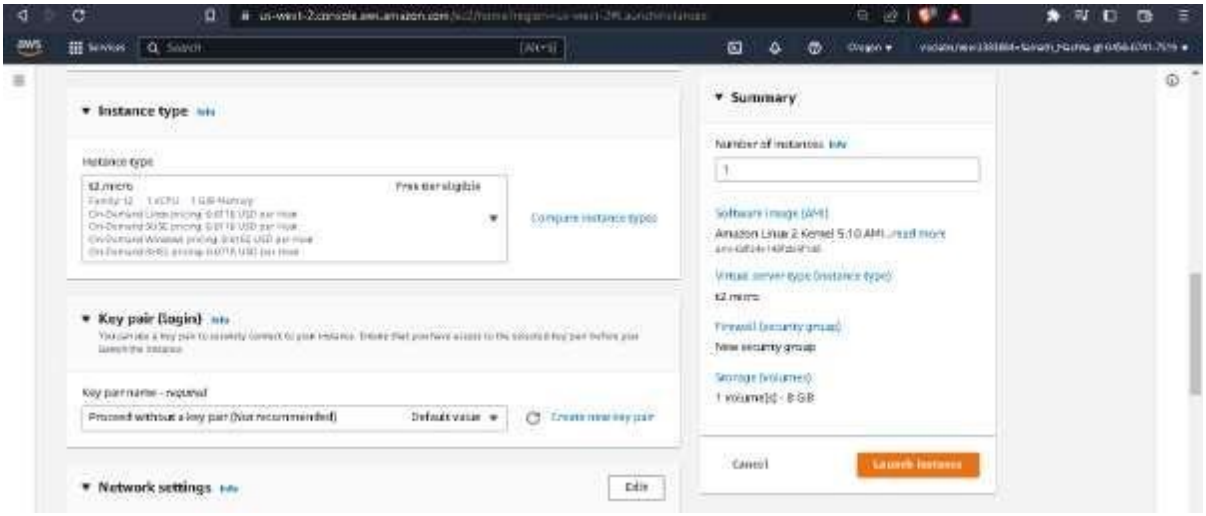
Click on Launch Instance.

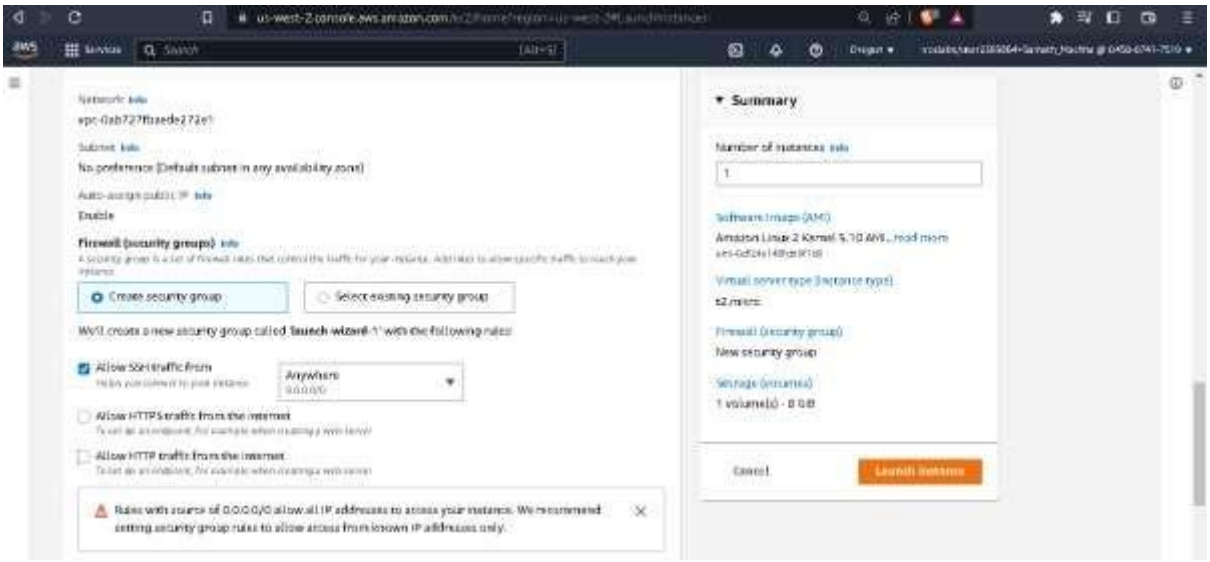


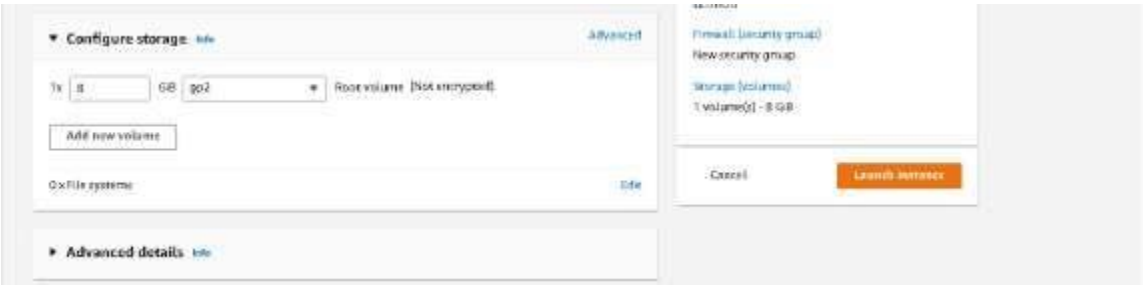
Step4: Fill the required Columns or Configurations.




Application and OS Images (Amazon Machine Image)
Summary
Number of instances
Amazon Linux
macOS
Ubuntu
Windows
Red Hat
Browse more AMIs
Amazon Machine Image (AMI)
Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type
Free tier eligible
Cancel
Launch instance


Instance type
Summary
Instance type
t2.micro
Free tier eligible
Compare instance types
Key pair (login)
Key pair name - required
Proceed without a key pair (Not recommended)
Default value
Create new key pair
Network settings
Edit
Number of instances
Cancel
Launch instance

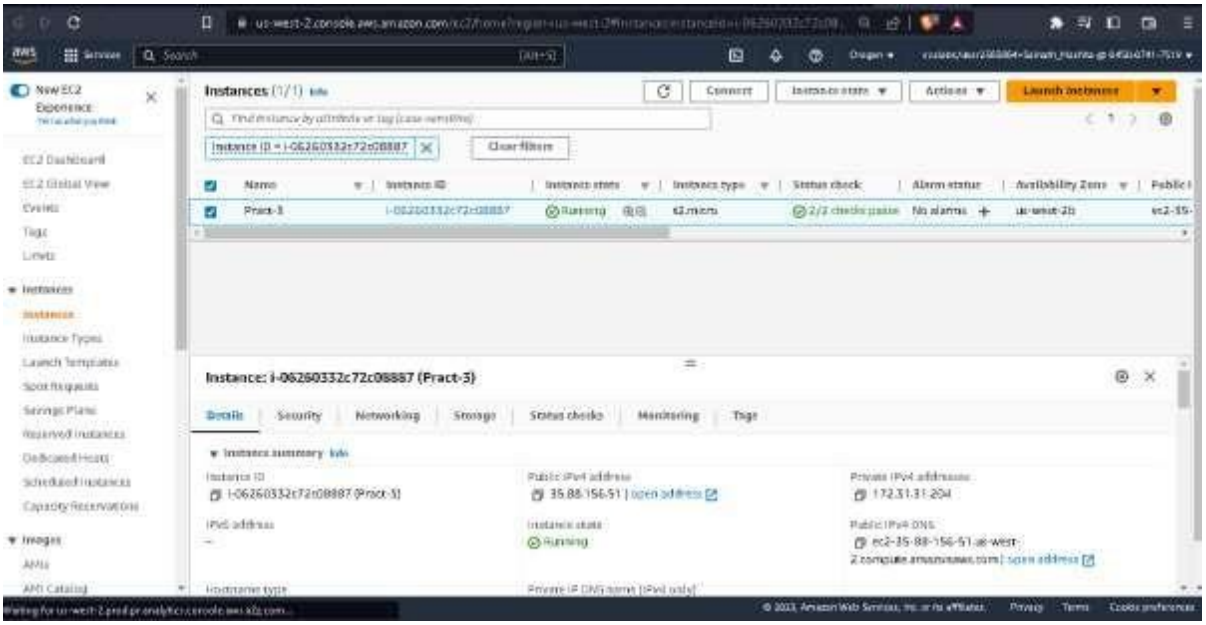

Summary
Number of instances
No preference (Default subnet in any availability zone)
Enable
Firewall (security groups)
Create security group
Select existing security group
Allow SSH traffic from
Anywhere
Allow HTTPS traffic from the internet
Allow HTTP traffic from the internet
Cancel
Launch instance



After completely configuring required specifications. Click on Launch Instance.

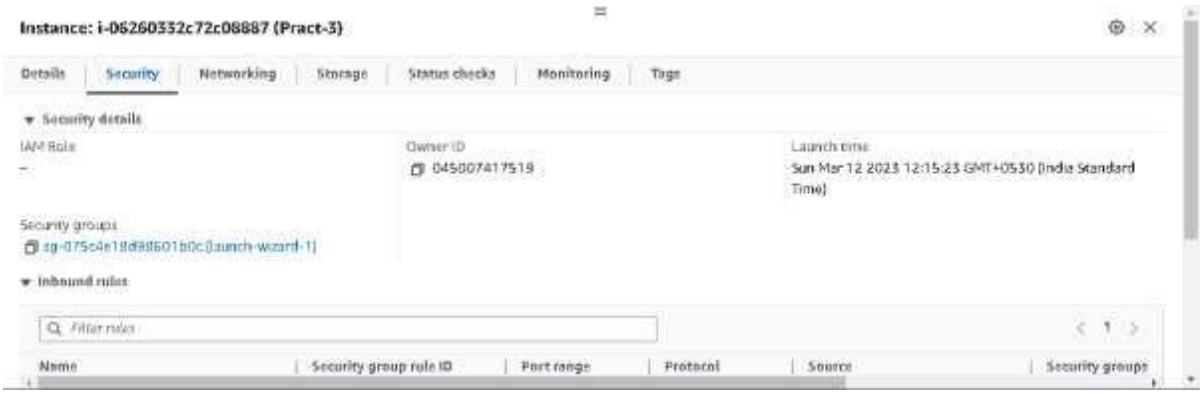
If instance is created successfully it will show success prompt and id of instance, click on instance Id it will redirect you to instance dashboard.

Step 5: Check the checkbox to see the instance details.



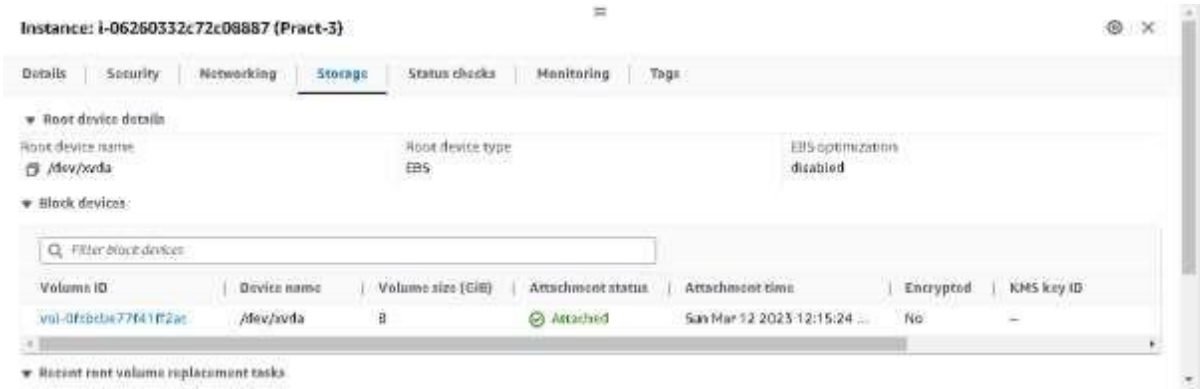
You can play with the tabs to know a specific detailed description of instance, such as:

Security:

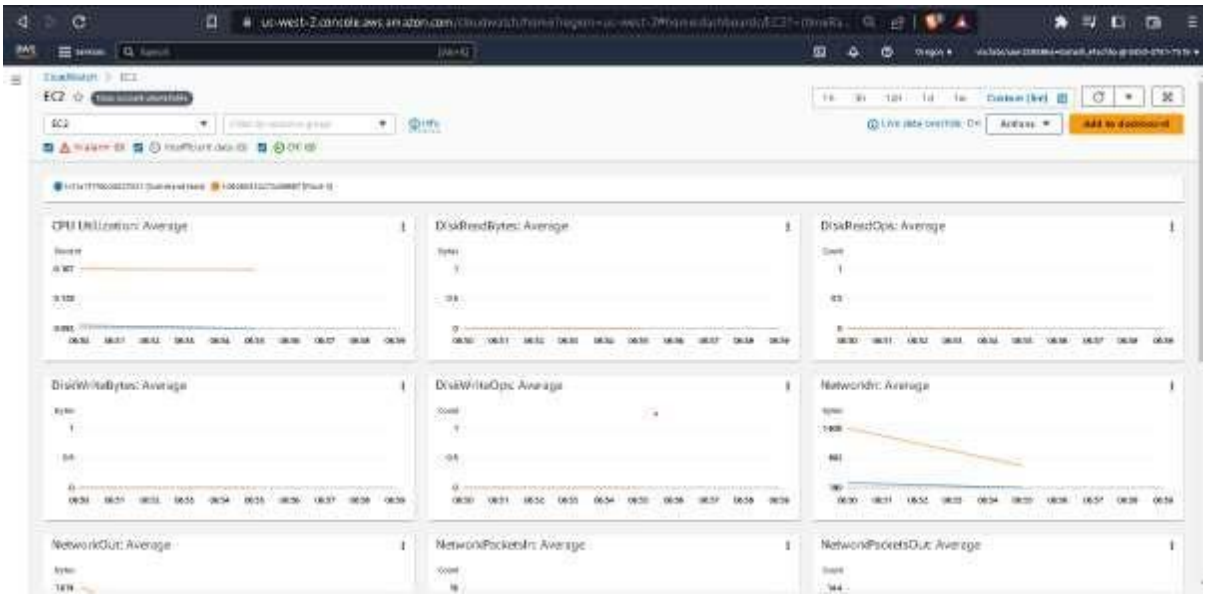


Networking:

Storage:



You can monitor the instance usage:


EC2
CPU Utilization: Average
DiskReadBytes: Average
DiskReadOps: Average
DiskWriteBytes: Average
DiskWriteOps: Average
NetworkIn: Average
NetworkOut: Average
NetworkPacketsIn: Average
NetworkPacketsOut: Average

Practical No :- 4

Aim :- To study and implementation of Storage as

a Service **Objectives** :- From this experiment, the

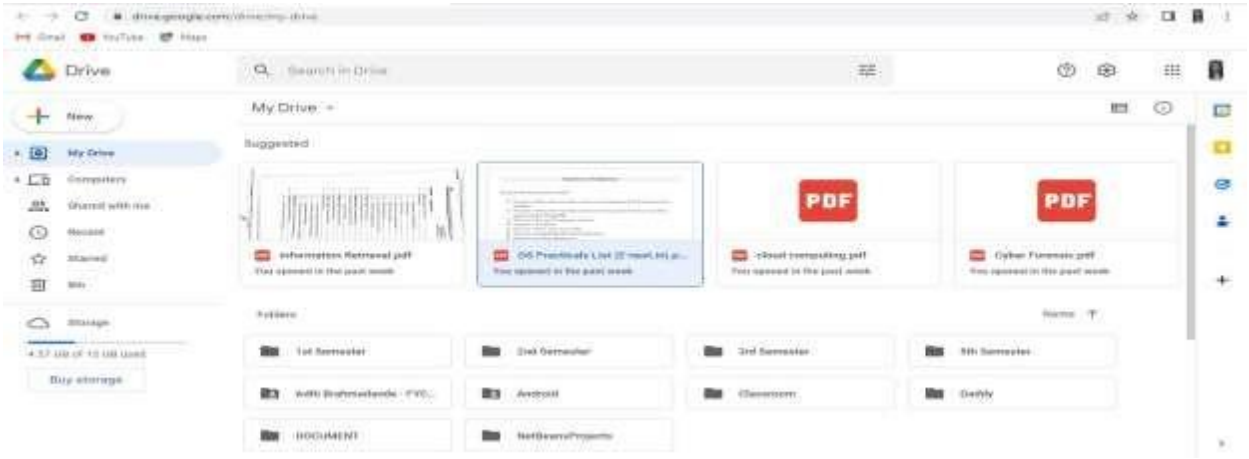
student will be able to :

- To make the students understand use of cloud as Platform, Storage as a Service.
- To learn the efficients tools to implement the

technique. Outcomes :- The Learner will able

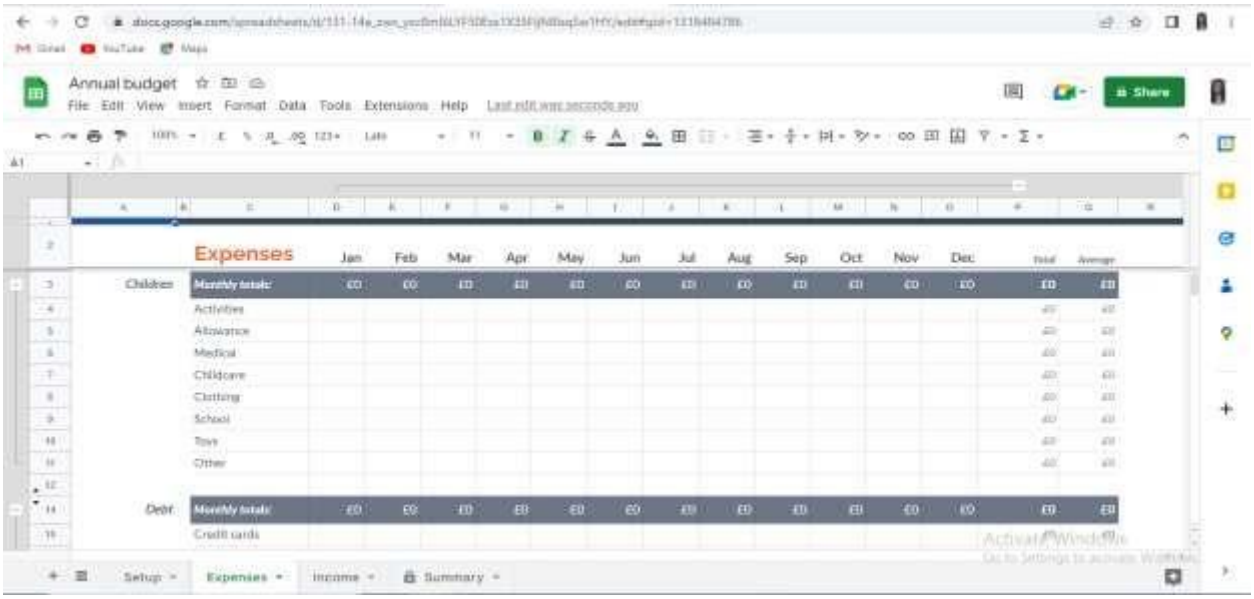
to

Google Drive :-

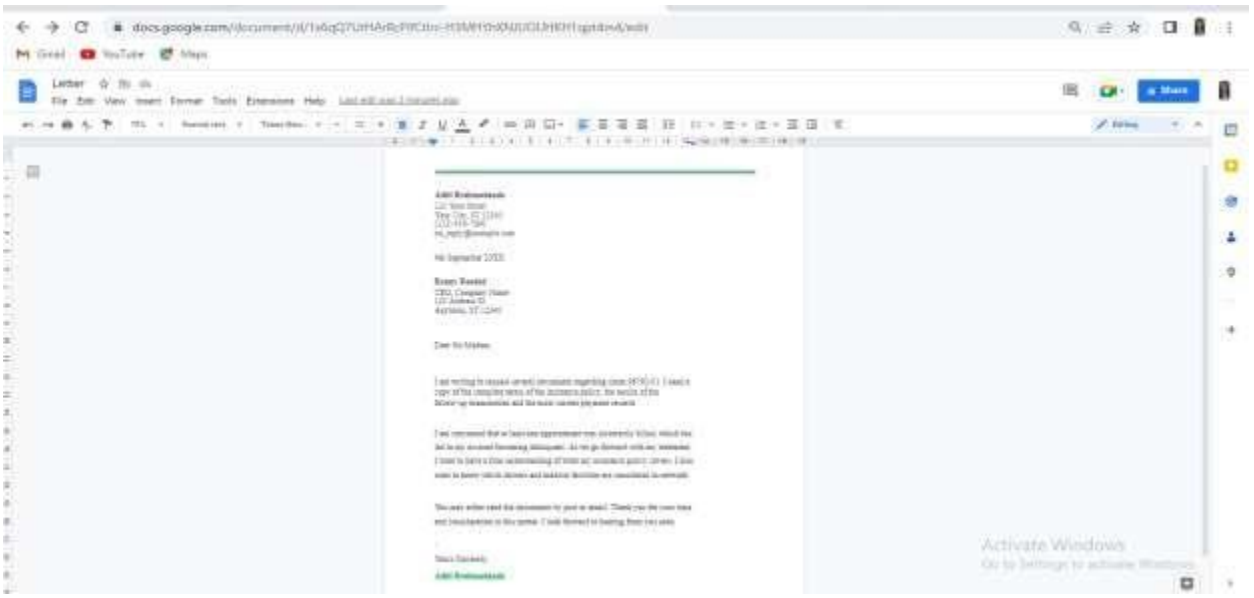


Google Forms :-

Google Sheets :-



Google Docs :-



Conclusion :- Google doc provides an efficient way for storage of data. It fits well in storage as a service (SaaS). It has varied options to create documents, presentation and also spreadsheets. It saves documents automatically after a few seconds and can be shared anywhere on the internet at the click of a button.

Practical No :- 5

AIM: Study and implementation of idedntity management

Objectives: From this experiment, the student will be able to,

Understand concepts of virtualization and to use cloud as Infrastructure as a services.

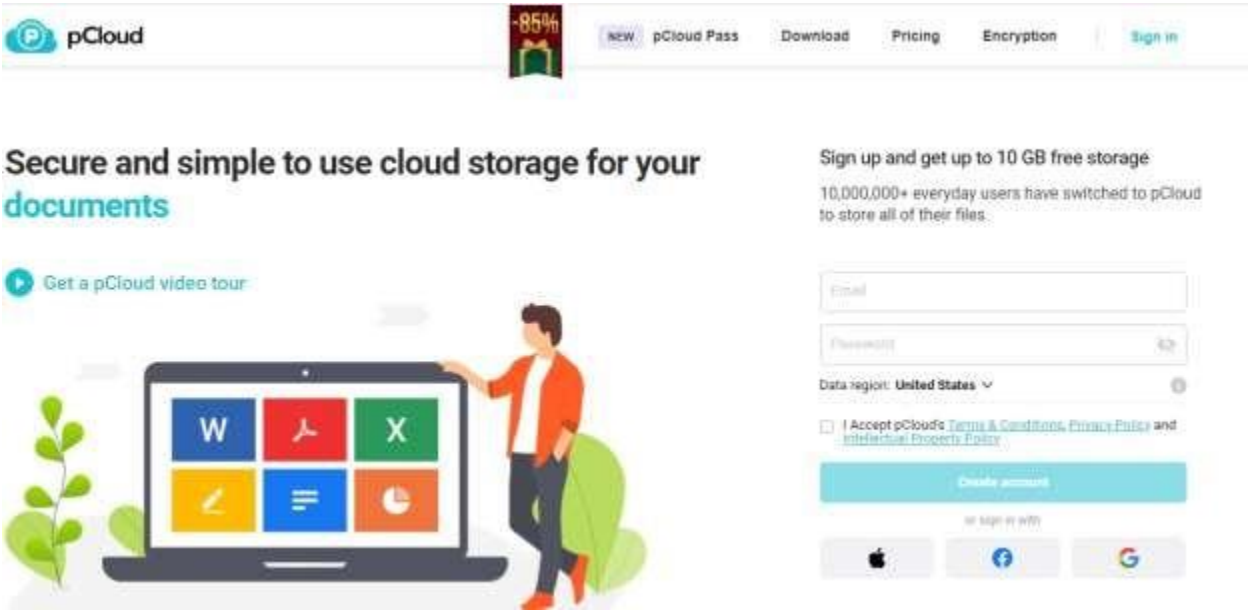
Learn the technique and its complexity.

Understand the importance of this technique from application point of view.

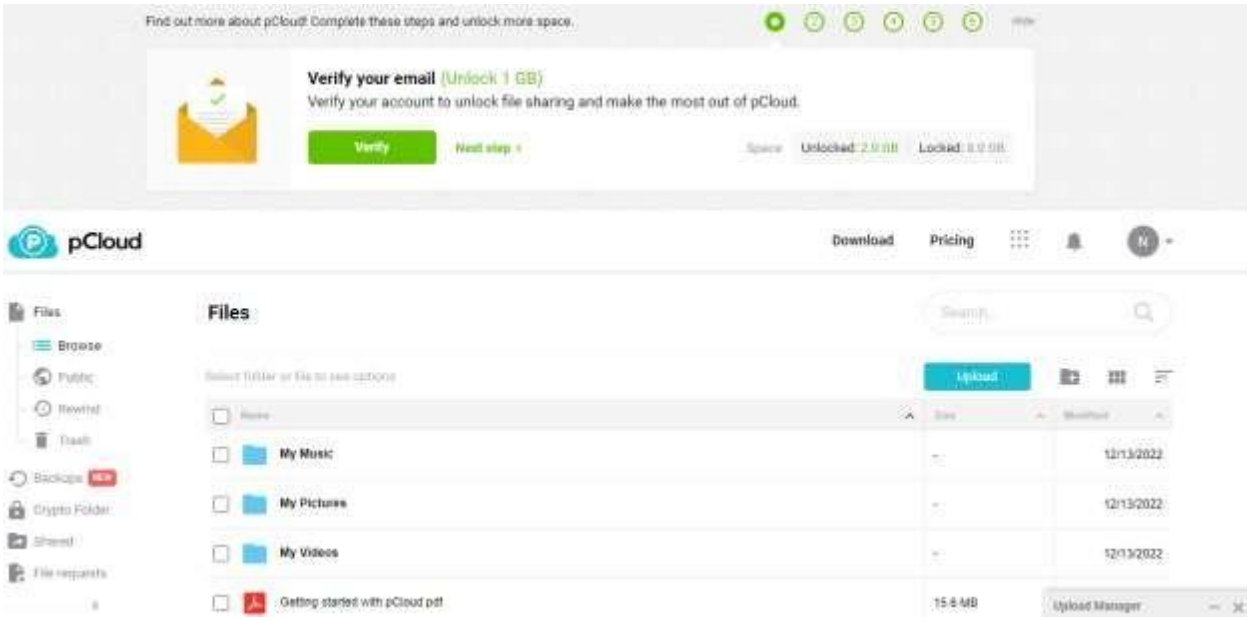
What is pCloud?

pCloud is your personal cloud space where you can store all your files and folders. It has a user-friendly interface that clearly shows where everything is located and what it does. The software is available for almost any devices and platforms – iOS and Android devices, MacOSX, Windows OS, and all Linux distributions. By installing pCloud on your computer (through its desktop application pCloud Drive), the app creates a secure virtual drive which expands your local storage space. Every change you make in your pCloud can be seen immediately on your computer, phone or tablet. All your devices are instantly synchronized and you have direct file access to any update you make.

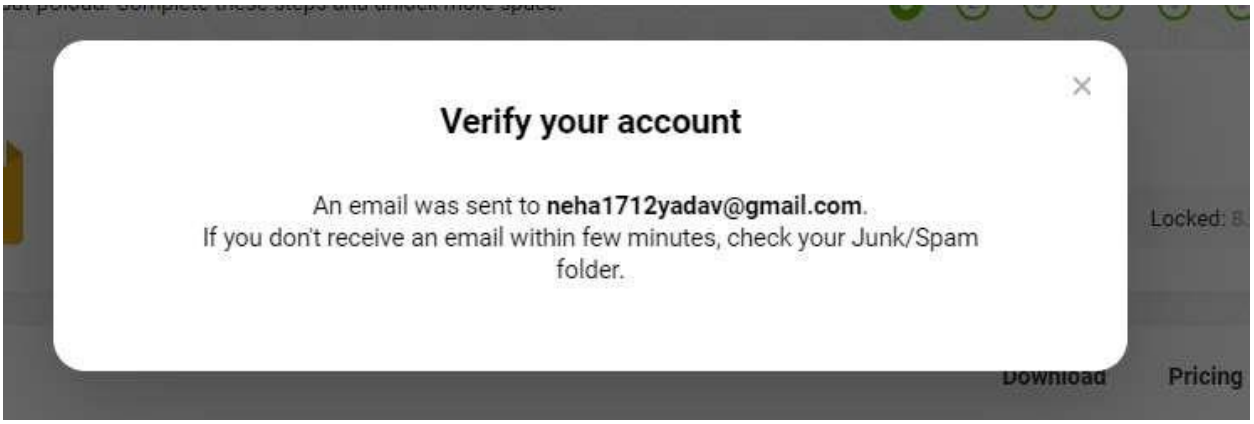
Step 1: Open website https://www.pcloud.com/



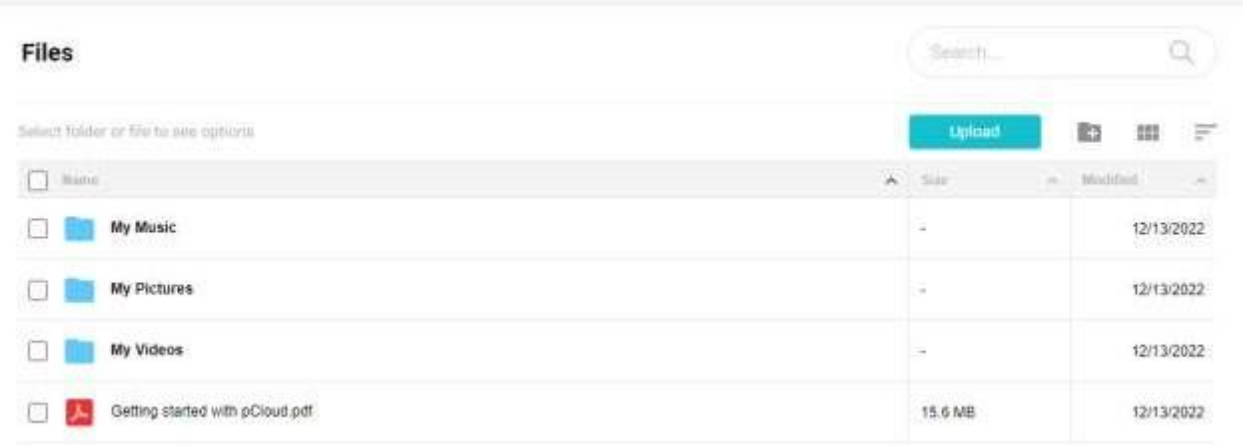
Step 2: Create an account using your email.

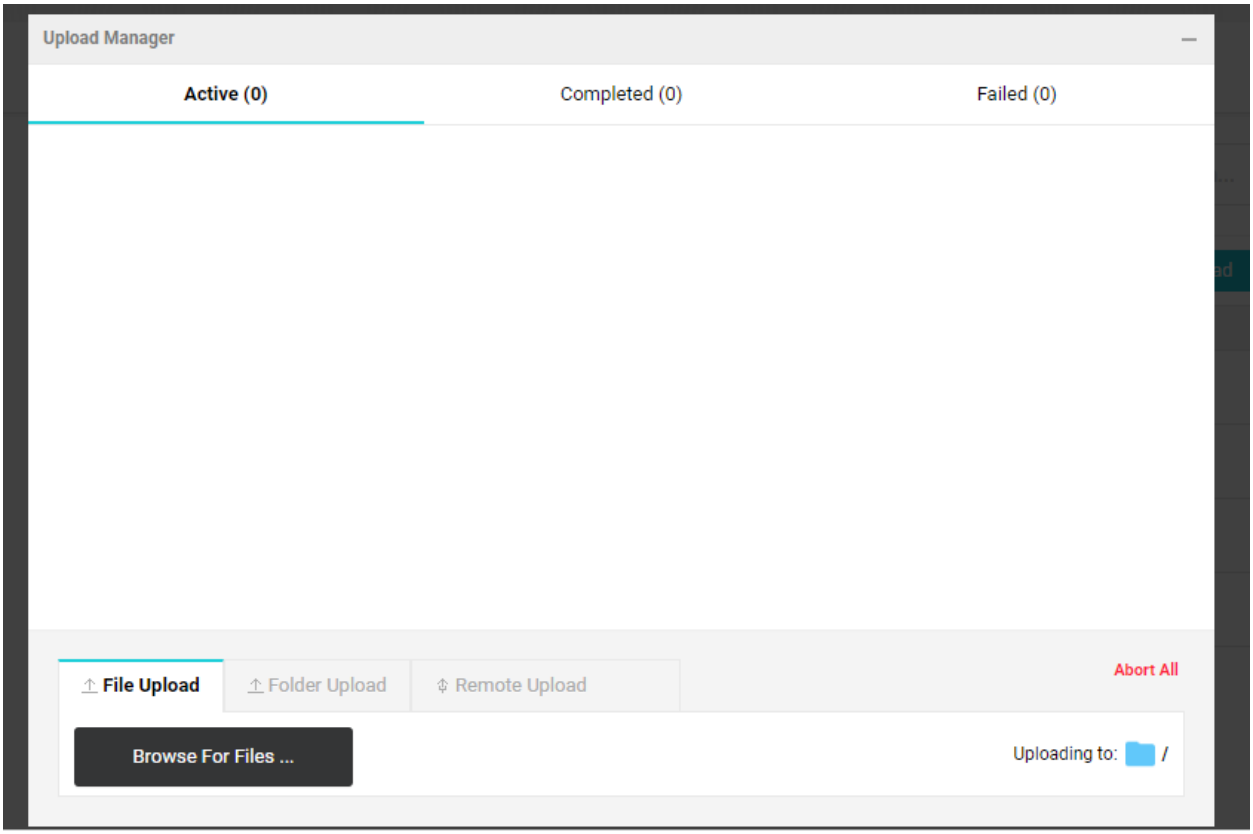


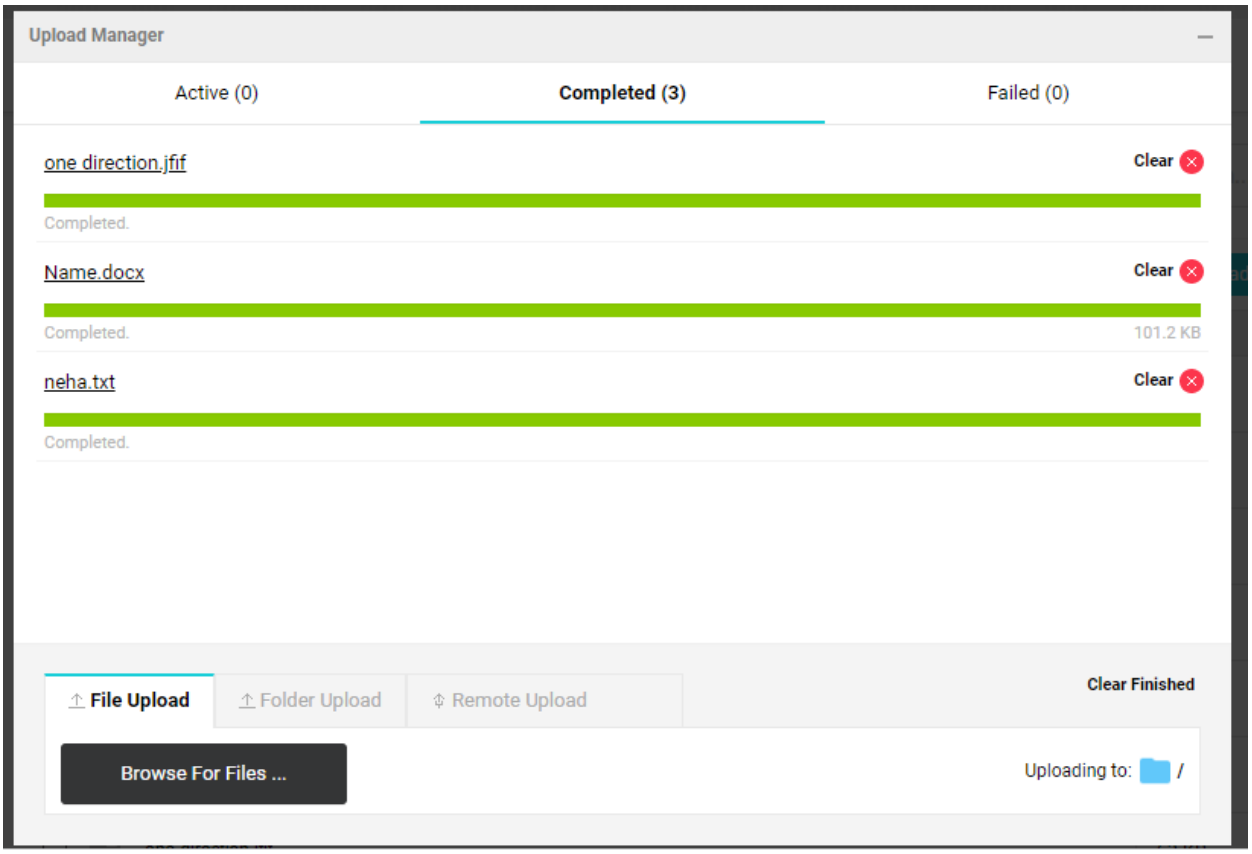
Step 3: Verify your account.



Step 4: Upload files to your account.


Files
Search...
Upload
My Music
My Pictures
My Videos
Getting started with pCloud.pdf
15.6 MB
12/13/2022


Upload Manager
Active (0)
Completed (0)
Failed (0)
File Upload
Folder Upload
Remote Upload
Abort All
Browse For Files ...
Uploading to: /



Conclusion:

We have studied how to use pCloud for ensuring identity management of the users. We can create multiple groups and provide privileges to view or modify data as per defined permissions. It also enables simplified look and feel to be used by anyone.

Practical No :- 6

Aim :- Study Cloud Security management

Objectives :- From this experiment, the student will be able,

§ To understand the security features of Cloud.

§ To learn the technique of application security management and its complexity

§ To understand the importance of cloud security management from application point of view

Outcomes :- The learner will be able to

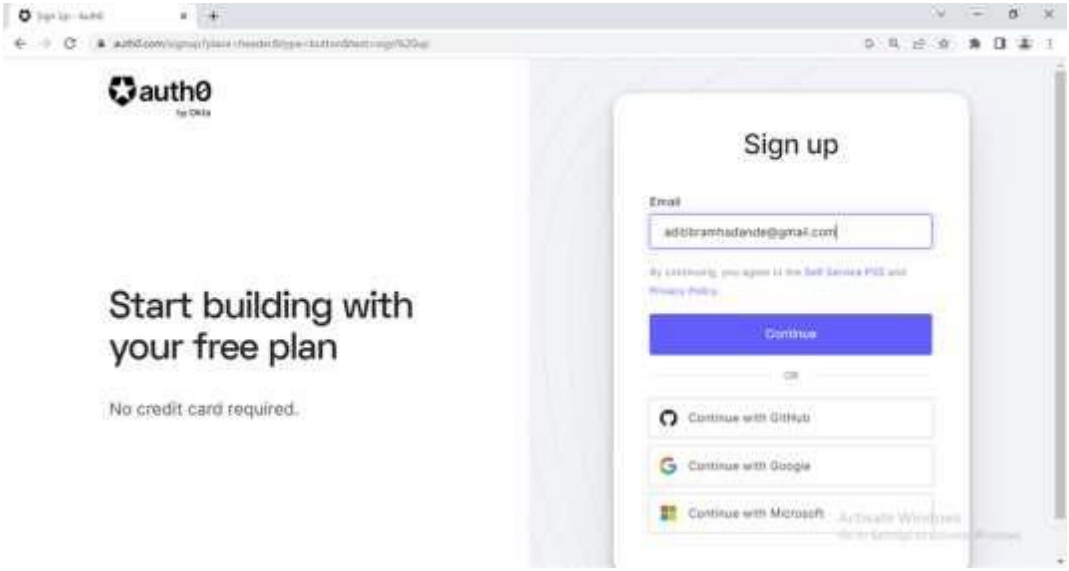
§ Student can study and implement single-sign-on.

§ To use current techniques, skills, and tools necessary for computing practice.

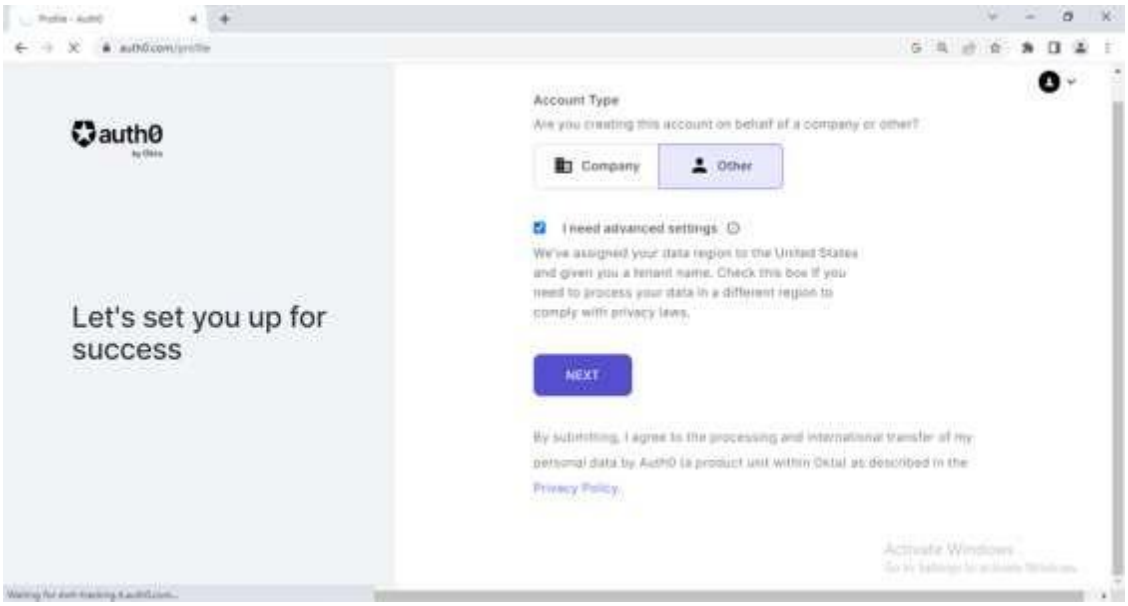
§ To match the industry requirements in the domains of Database management, Programming and Networking with the required management skills.

Steps :-

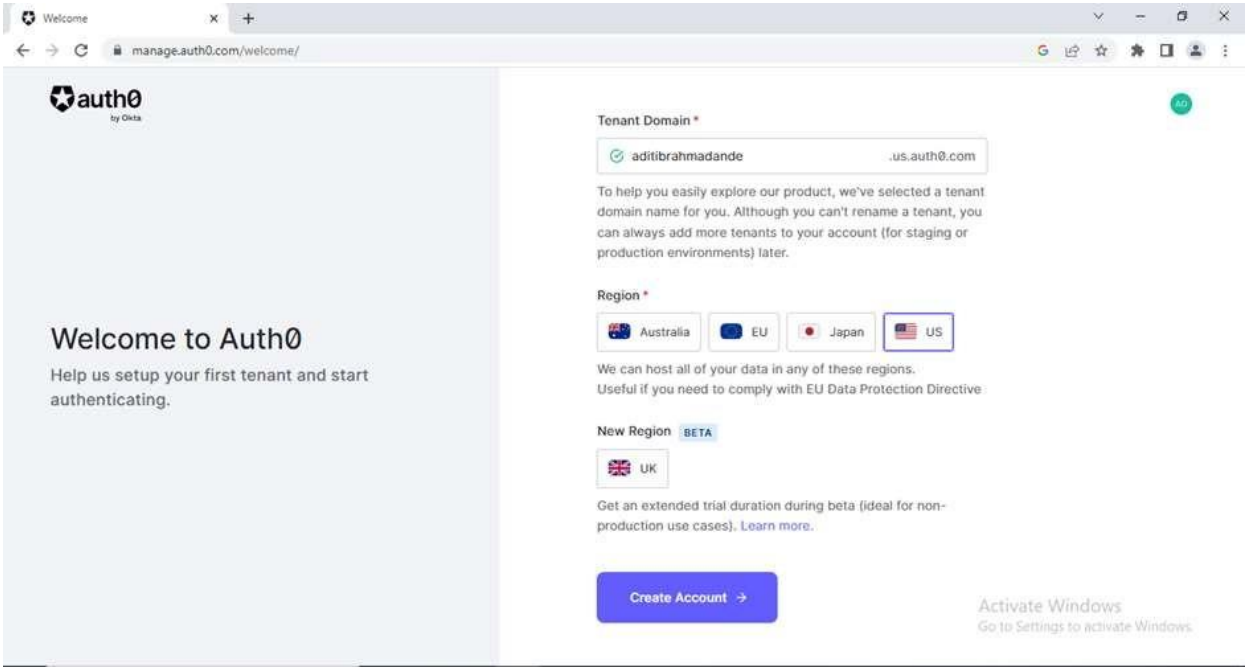
1. Go to Auth0(https://auth0.com/) and create an account



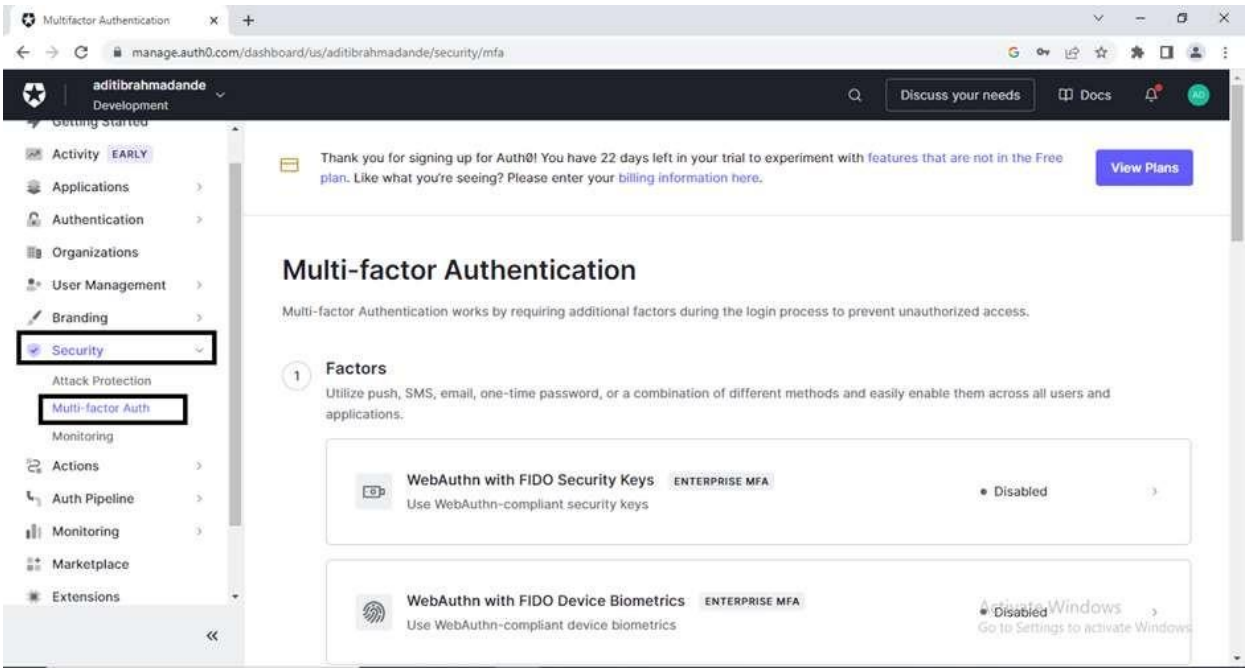
2. Select account type as others and click on next.

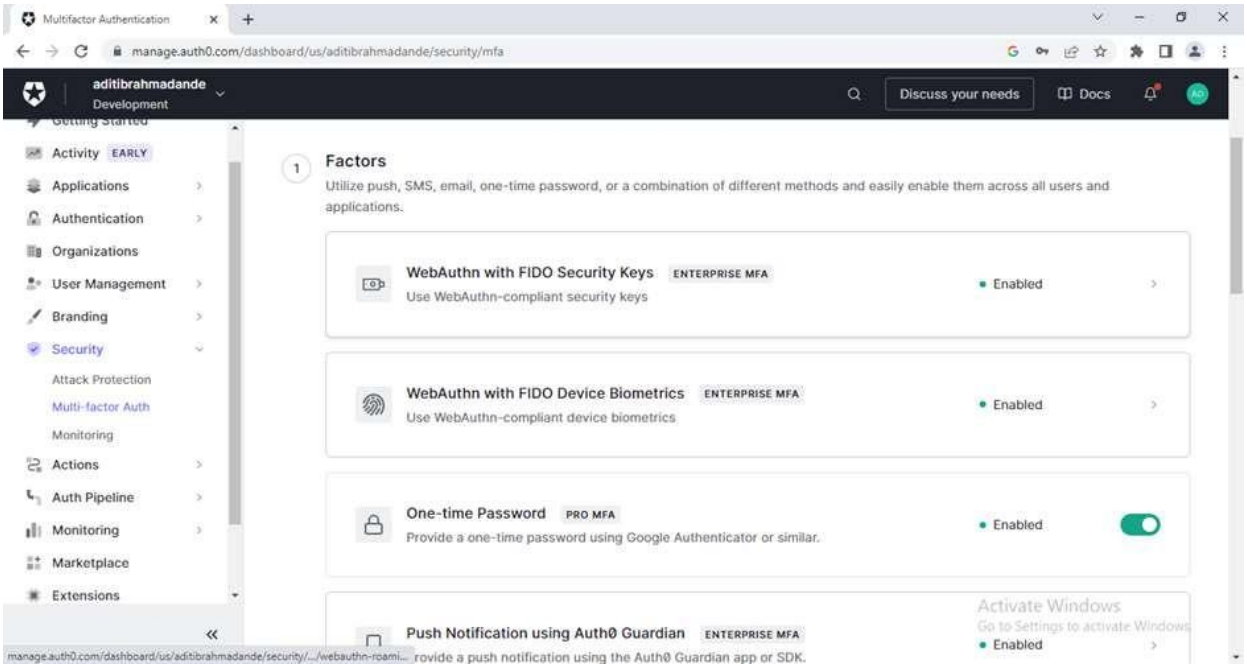


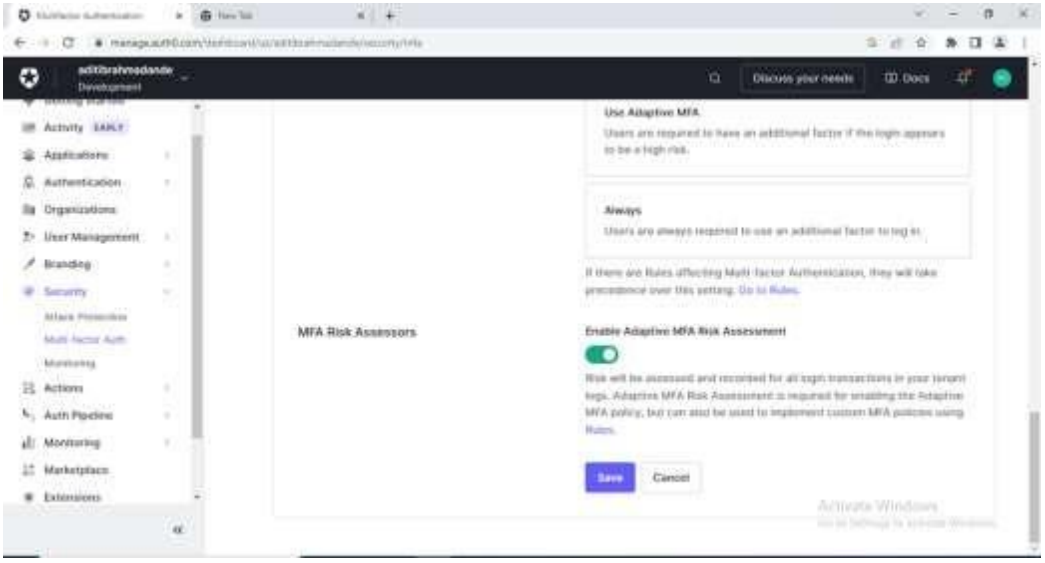
3. Give tenant domain name, select the region and click on Create Account.



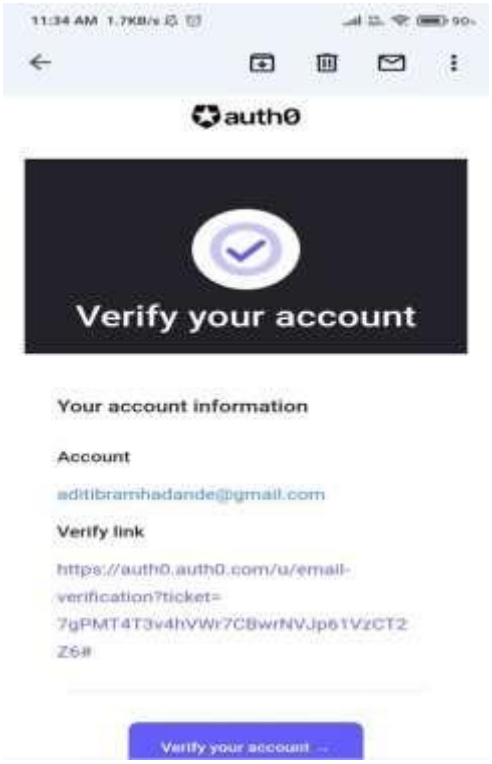
4. After creating your Account Go to Security Select Multi factor Authentication Enable all Factors and click on Save.


Multifactor Authentication
manage.auth0.com/dashboard/us/aditibrahmadande/security/mfa
aditibrahmadande
Development
Discuss your needs
Docs
Activity EARLY
Applications
Authentication
Organizations
User Management
Branding
Security
Attack Protection
Multi-factor Auth
Monitoring
Actions
Auth Pipeline
Monitoring
Marketplace
Extensions
Thank you for signing up for Auth0! You have 22 days left in your trial to experiment with features that are not in the Free plan. Like what you're seeing? Please enter your billing information here.
View Plans
Multi-factor Authentication
Multi-factor Authentication works by requiring additional factors during the login process to prevent unauthorized access.
1
Factors
Utilize push, SMS, email, one-time password, or a combination of different methods and easily enable them across all users and applications.
WebAuthn with FIDO Security Keys
ENTERPRISE MFA
Use WebAuthn-compliant security keys
Disabled
WebAuthn with FIDO Device Biometrics
ENTERPRISE MFA
Use WebAuthn-compliant device biometrics
Disabled


Multifactor Authentication
manage.auth0.com/dashboard/us/aditibrahmadande/security/mfa
aditibrahmadande
Development
Discuss your needs
Docs
Activity EARLY
Applications
Authentication
Organizations
User Management
Branding
Security
Attack Protection
Multi-factor Auth
Monitoring
Actions
Auth Pipeline
Monitoring
Marketplace
Extensions
1
Factors
Utilize push, SMS, email, one-time password, or a combination of different methods and easily enable them across all users and applications.
WebAuthn with FIDO Security Keys
ENTERPRISE MFA
Use WebAuthn-compliant security keys
Enabled
WebAuthn with FIDO Device Biometrics
ENTERPRISE MFA
Use WebAuthn-compliant device biometrics
Enabled
One-time Password
PRO MFA
Provide a one-time password using Google Authenticator or similar.
Enabled
Push Notification using Auth0 Guardian
ENTERPRISE MFA
Enabled
rovide a push notification using the Auth0 Guardian app or SDK.



5. Once you click on save You will receive a Verification Email on your registered E–mail ID Click on –verify your account‖.



Conclusion :- We have studied how to secure the cloud and its data. Amazon EWS provides the best security with its extended facilities and services like MFA device. It also gives you the ability to add your own permissions and policies for securing data more encrypted.

Practical:7

Aim: Write a program for web feed

RSS Builder is an easy to use program for creating and publishing news feeds and podcasts. You can use local RSS files, but there is also an option to edit the RSS feeds on your web site without keeping a local copy.

Steps:

- First, open Notepad and write the following XML code in it.

```
<?xml version="1.0" encoding="UTF-8" ?>
<rss version="2.0">
<channel>
 <title>W3Schools Home Page</title>
 <link>https://www.w3schools.com</link>
 <description>Free web building tutorials</description>
 <item>
 <title>RSS Tutorial</title>
 <link>https://www.w3schools.com/xml/xml_rss.asp</link>
 <description>New RSS tutorial on W3Schools</description>
 </item>
 <item>
 <title>XML Tutorial</title>
 <link>https://www.w3schools.com/xml</link>
 <description>New XML tutorial on W3Schools</description>
 </item>
</channel>
</rss>
```

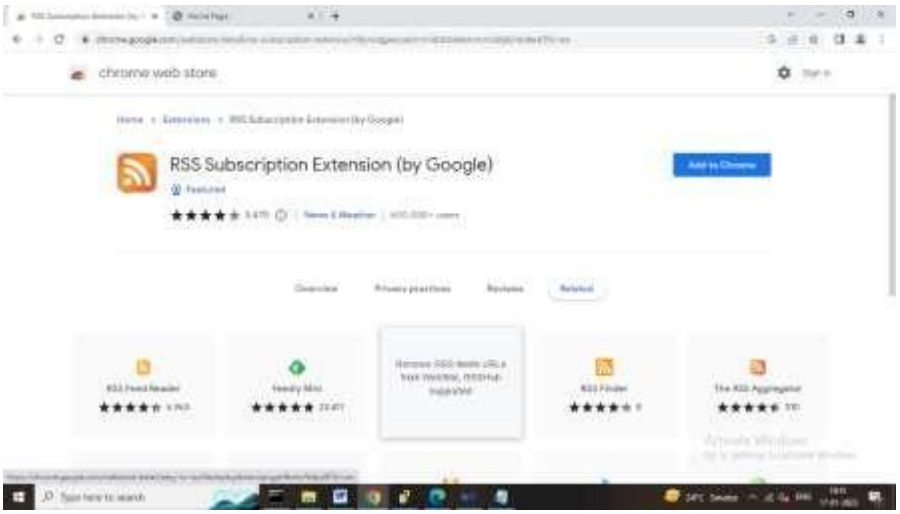
- Save the as **"nikita.xml"**

- Now open Chrome(If not Installed than install it and open)

- Go to Link https://chrome.google.com/webstore/detail/rss-subscriptionextensio/nlbjncdgjeocebhnmkbbbdekmmmcbfjd?hl=en

OR

- Search for chrome.google.com and go to Extension



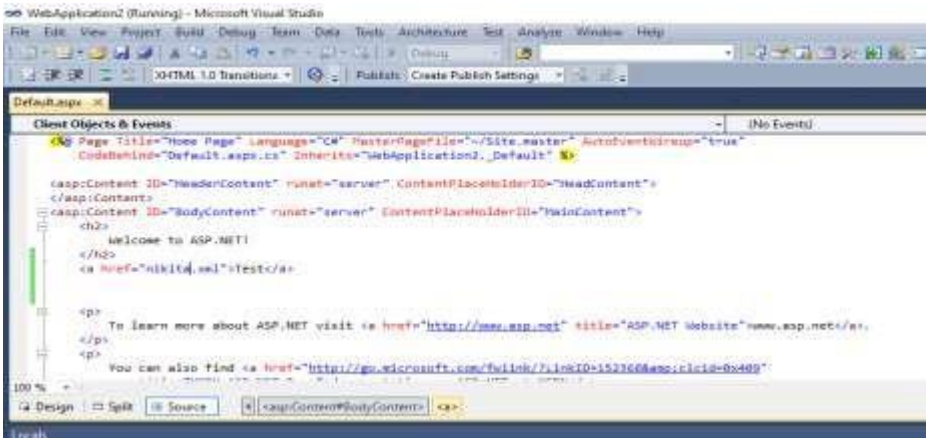
- After that Open Visual Studio 2010 → New Project → Web Site → ASP.NET Web

Site

- Now Copy-Paste the test.xml file in this project.

- Open file –Default.aspx‖ and add a single line on it.

<a href="nikita.xml">Test</a>



- Now for Run the application

- Chrome window will be appear

- Select Test

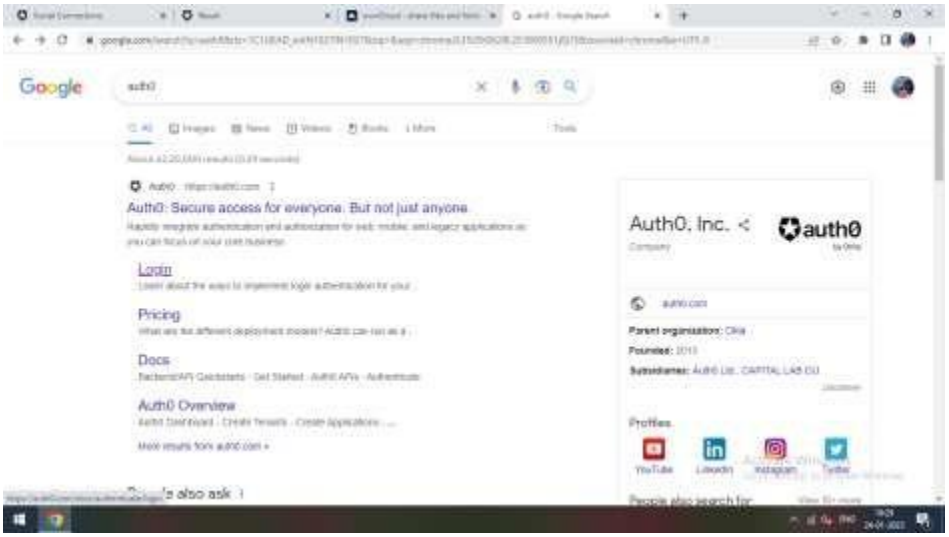
- Final output

Practical:8

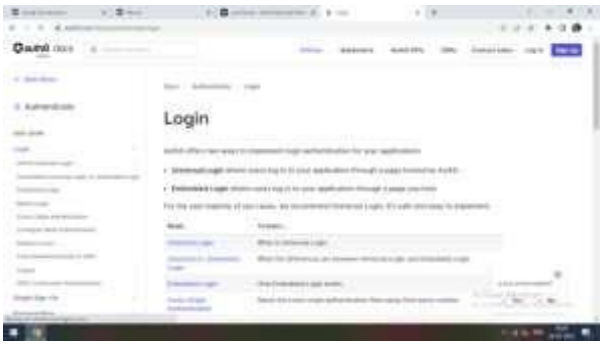
Aim: Study and Implementation of Single-Sing-On

Step1:First go to Auth0

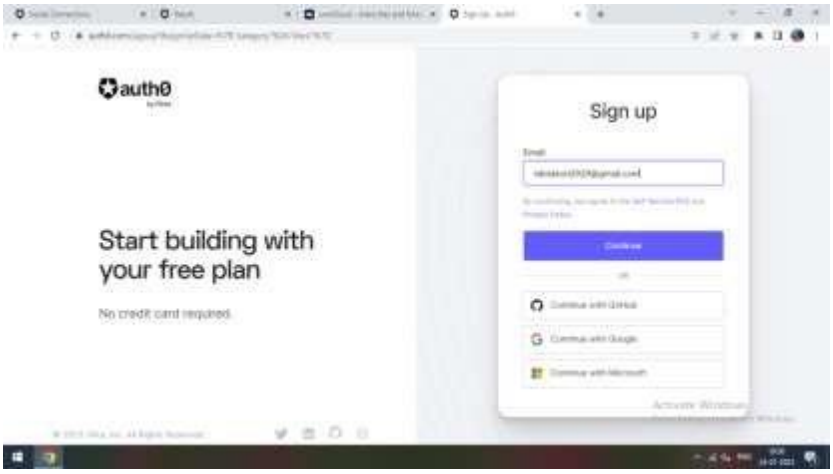
Step2: Click On Login



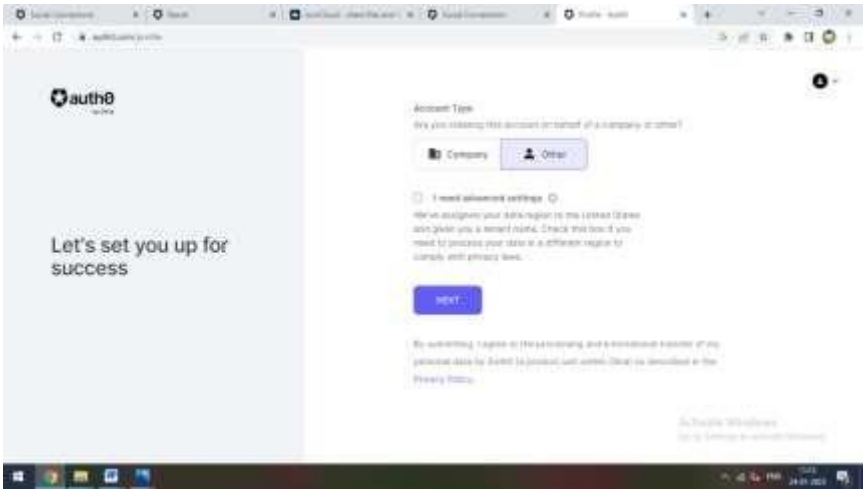
Step3: Sing-Up



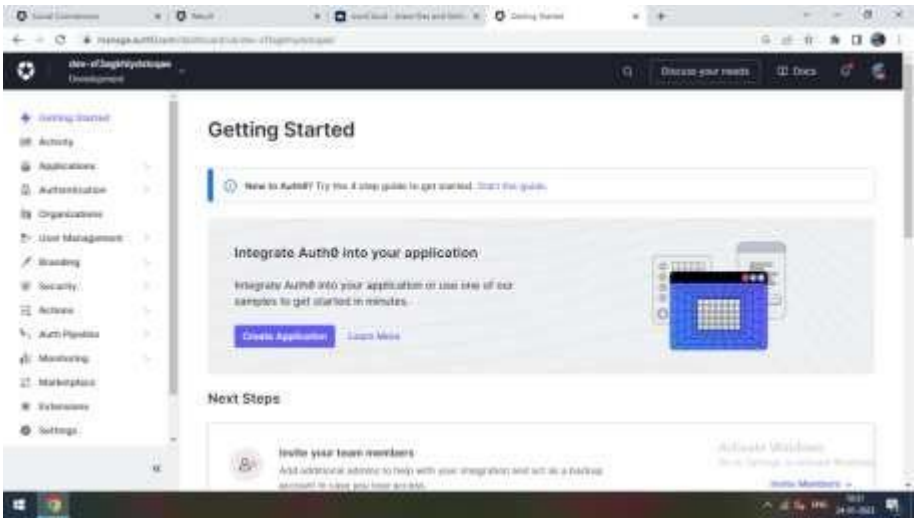
Step4: Enter Your E-mail & Continue With Google



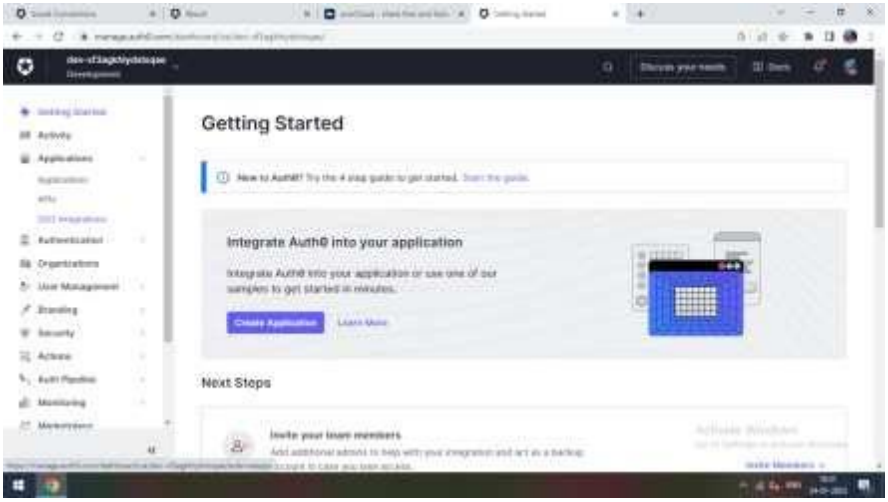
Step5: Select Others



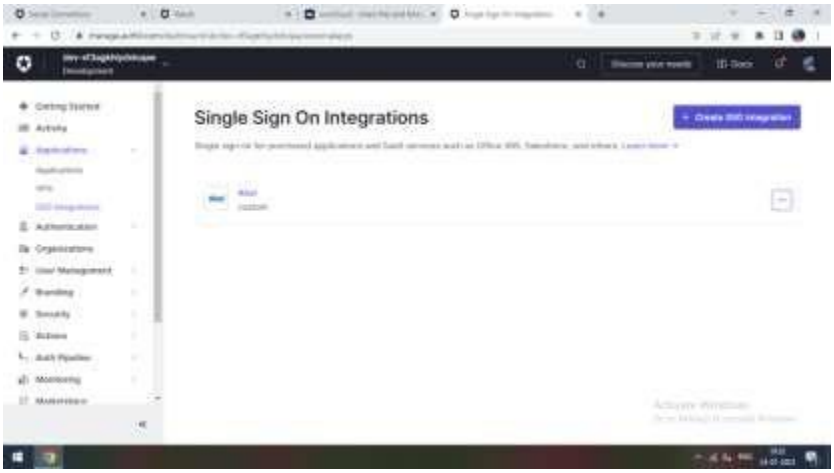
Step6: This Will appear



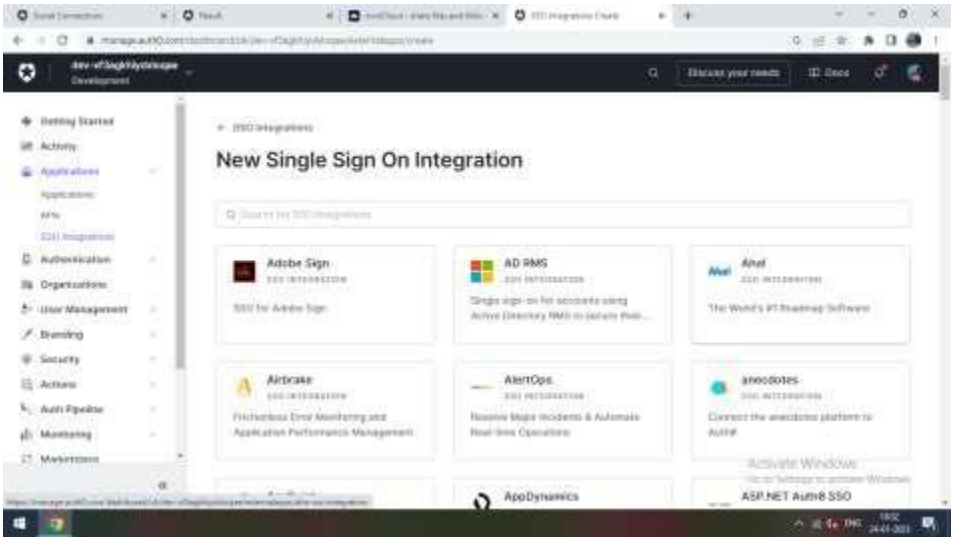
Step7: Then go to Application Select SSO Integration



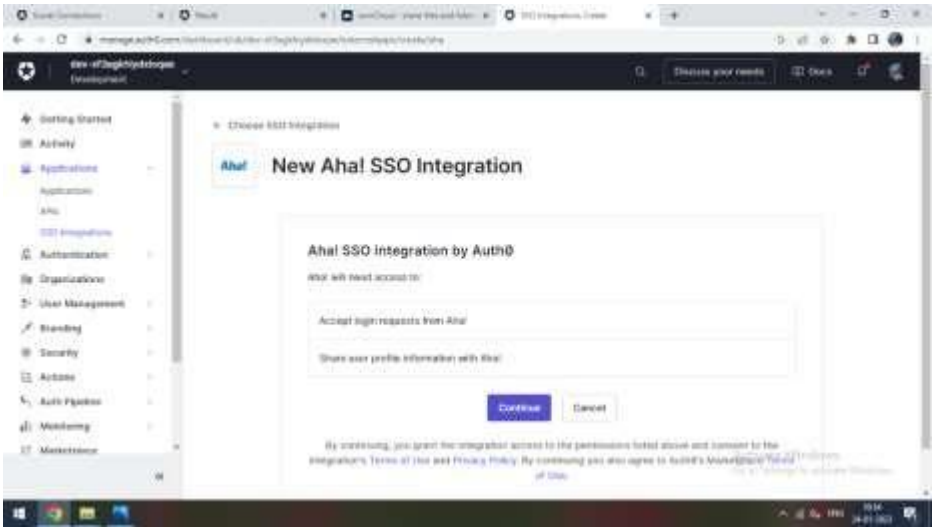
Step8:Create SSO integration



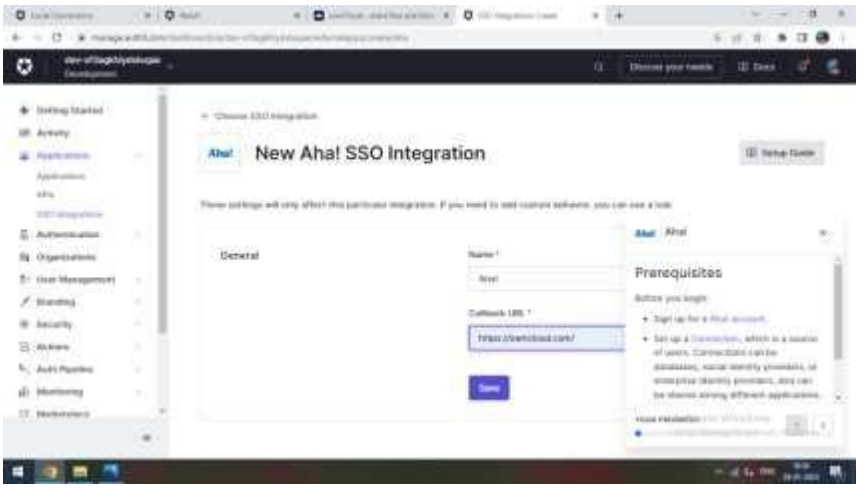
Step9: Select Anyone to Sign On Integration



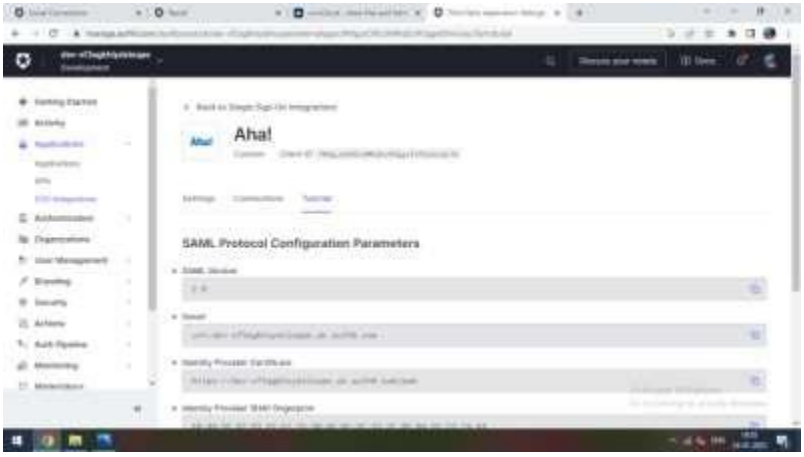
Step10:We Select Aha! Click on Continue



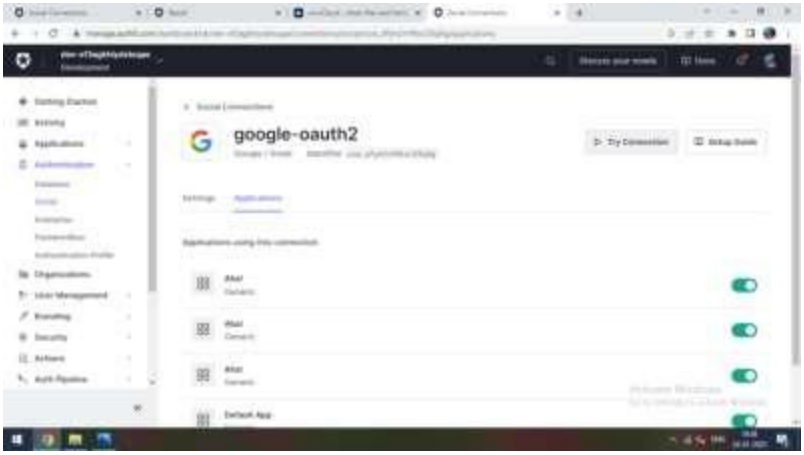
Step11: Fills the Details Enter the URL any and Save it



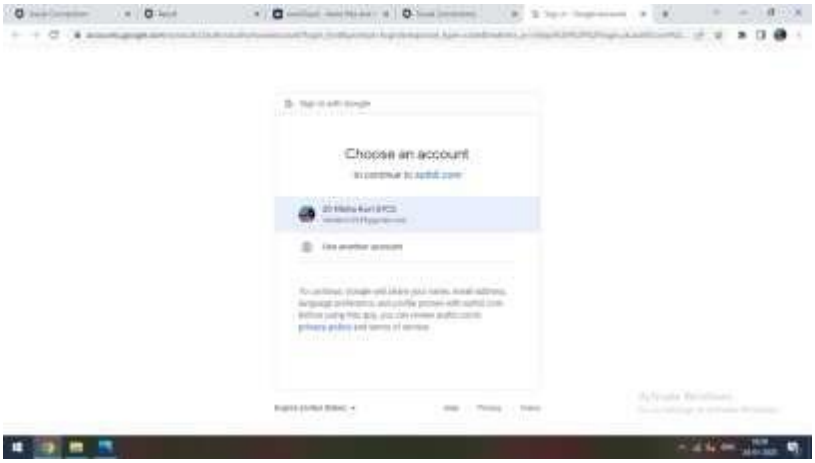
Step12: This Page will appear



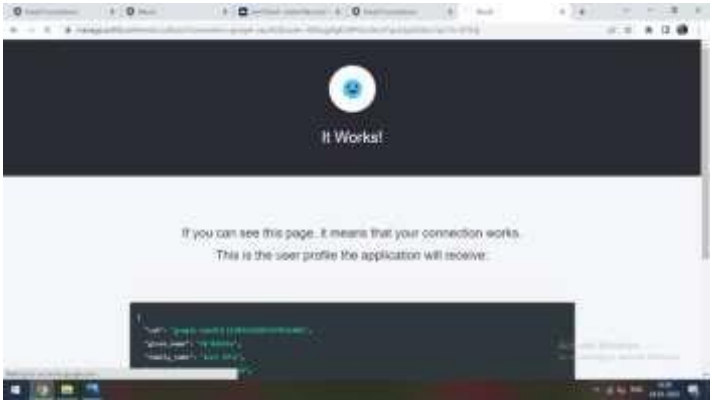
Step13: Go to Authentication in that Select the <Social>



Step14: Verify your E-mail



Step15: Then you will get the Output When this page apper




```
{
  "sub": "google-oauth2|112092281093679631096",
  "given_name": "20 Nikita",
  "family_name": "Kori SYCS",
  "nickname": "nikitakori2929",
  "name": "20 Nikita Kori SYCS",
  "picture": "https://lh3.googleusercontent.com/a/AEdFTp4GcKNB4VOJOAxj-arNQbgs3h8wUo2S-iqM5w87uQ=s96-c",
  "locale": "en",
  "updated_at": "2023-01-24T05:09:46.893Z"
}
```

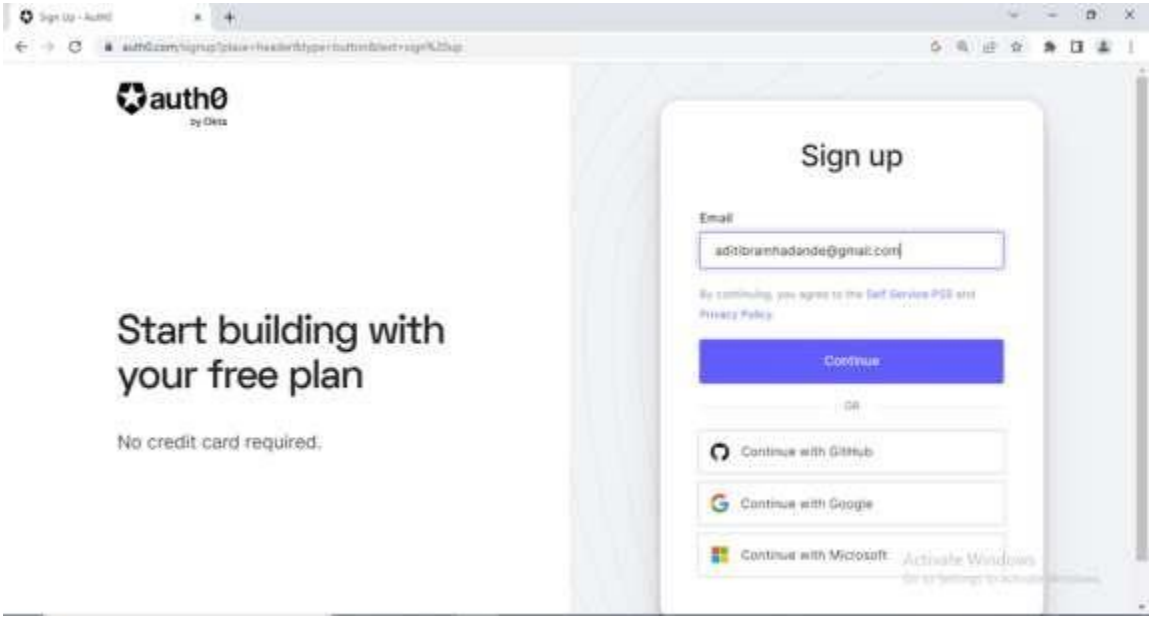
Practical No :- 9

Aim :- User management in Cloud

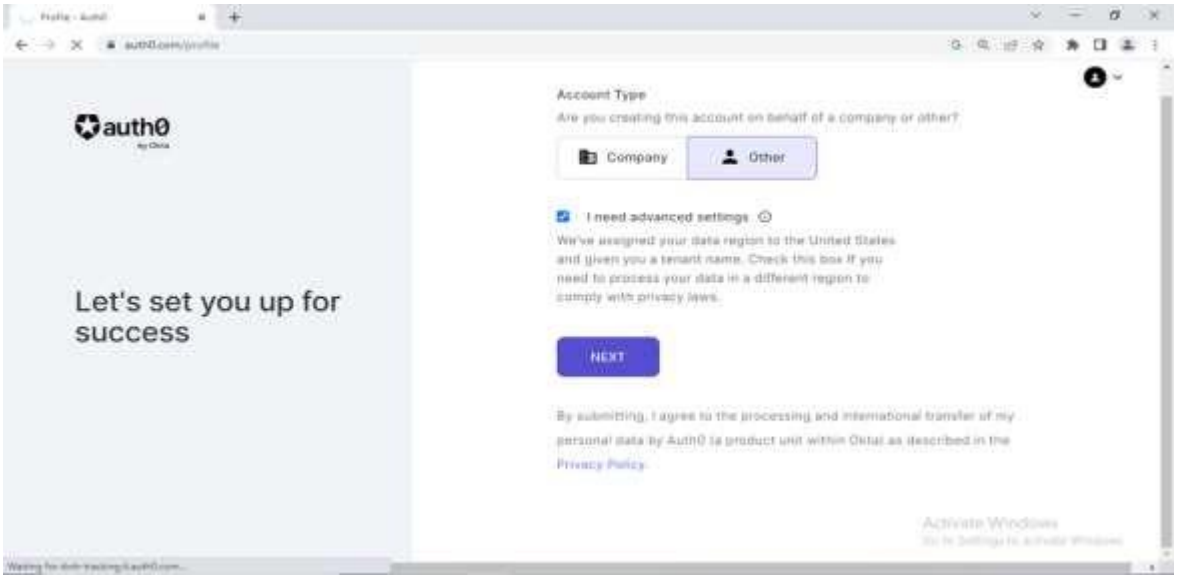
Objective :- It is to understand how to create, manage user and group of users accounts.

Steps :-

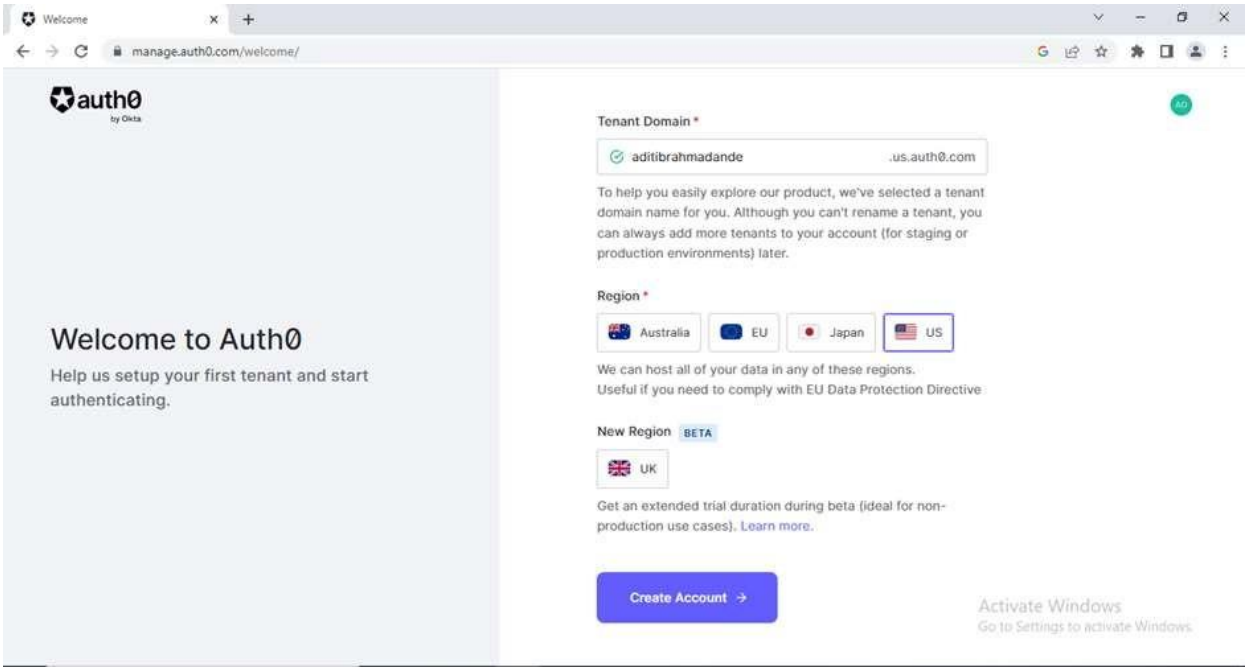
1. Go to Auth0(https://auth0.com/) and create an account.



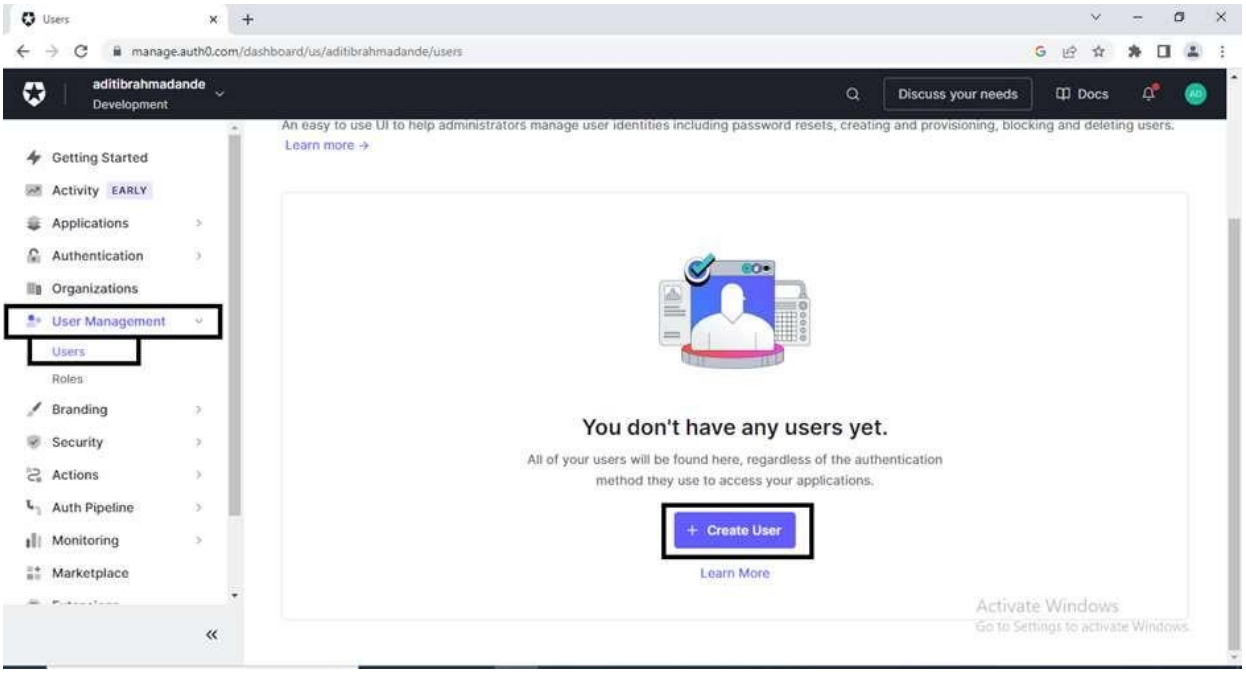
2. Select account type as others and click on next.

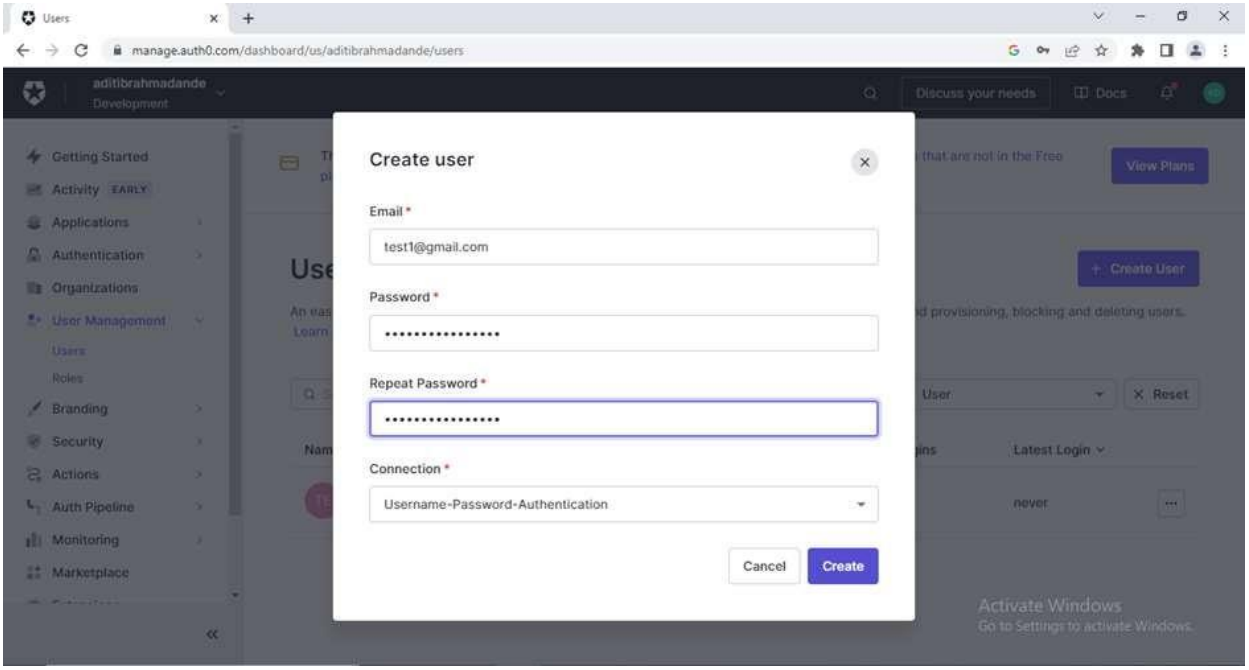


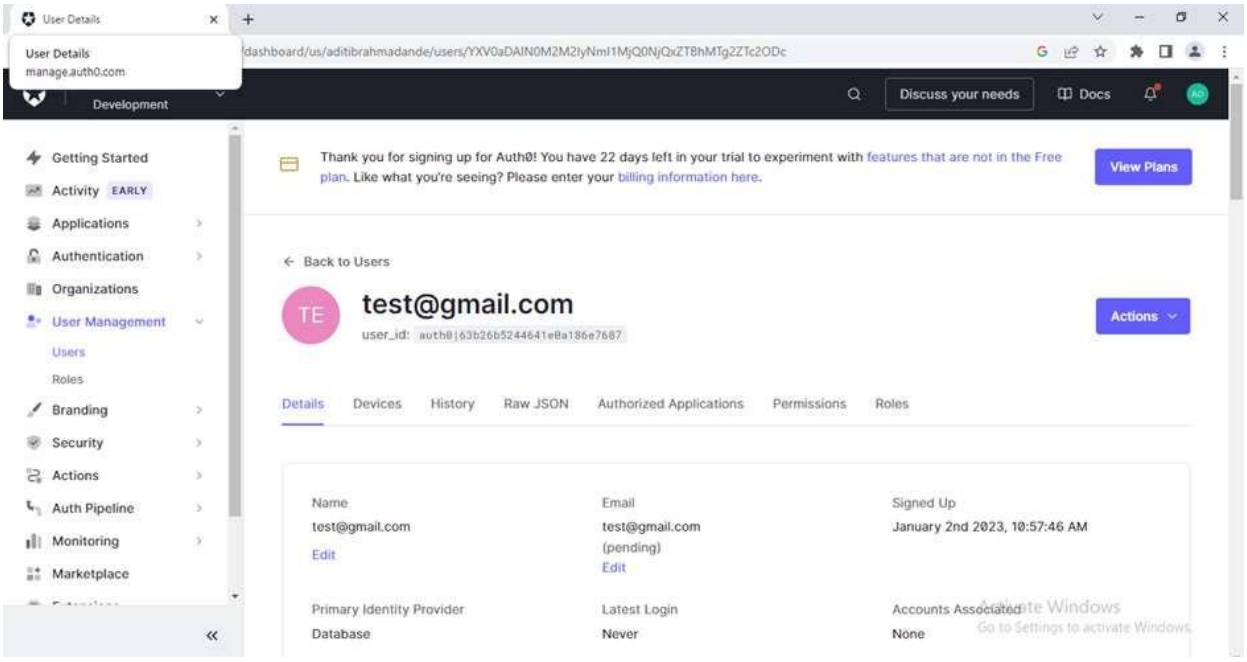
3. Give tenant domain name, select the region and click on create account.



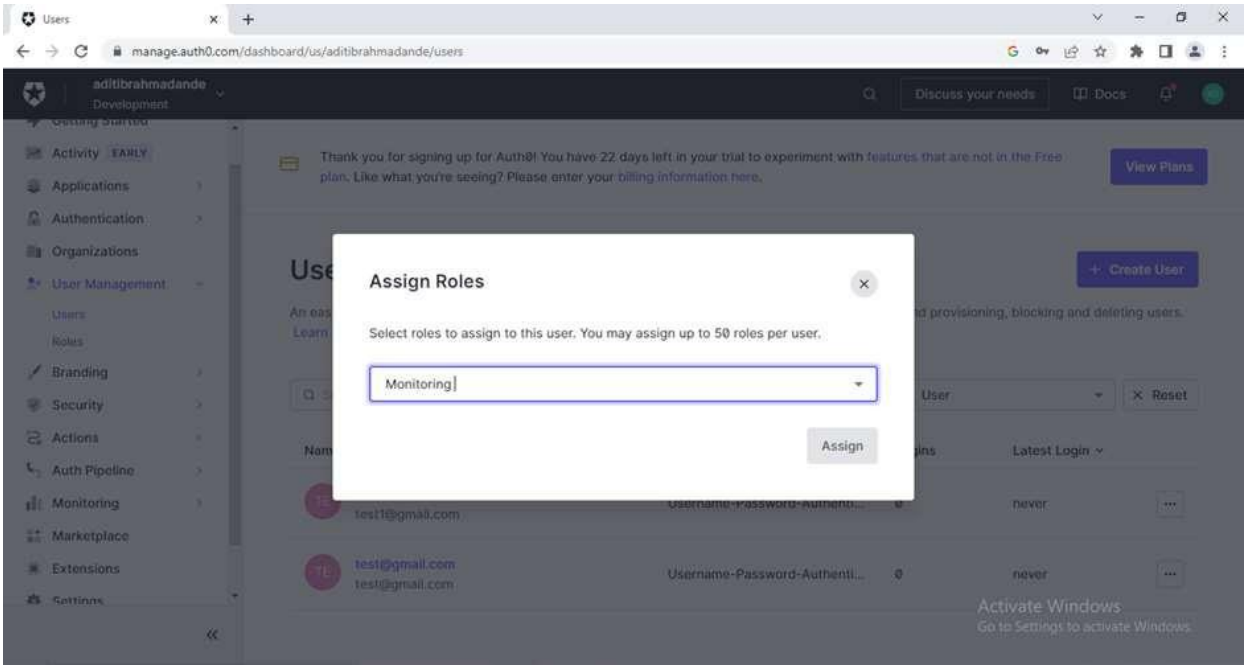
4. After creating your Account select User Management > User and Click on ‑Create Users‖.



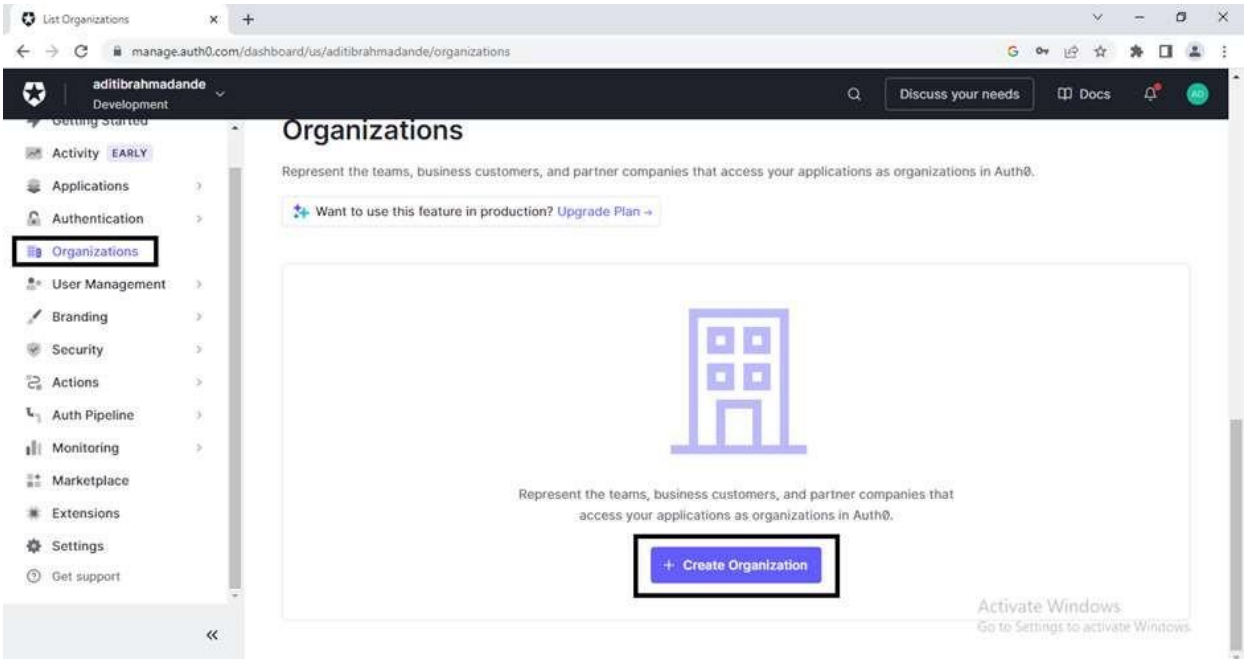


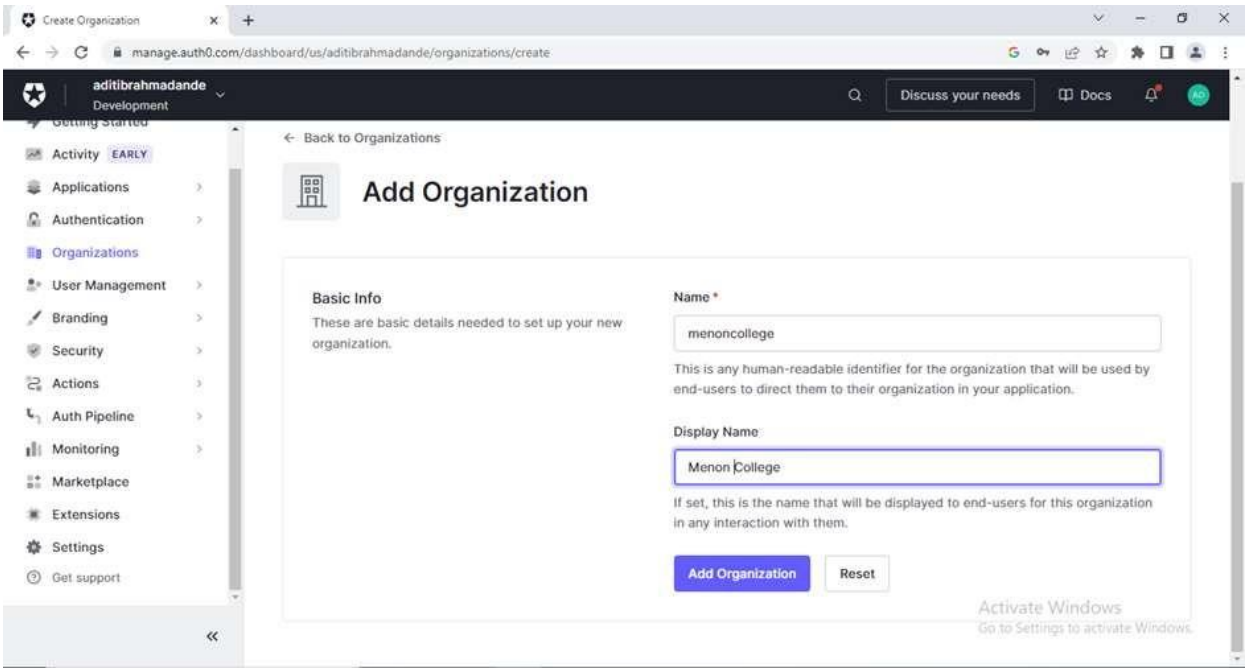


Also we can Assign Roles to the users.

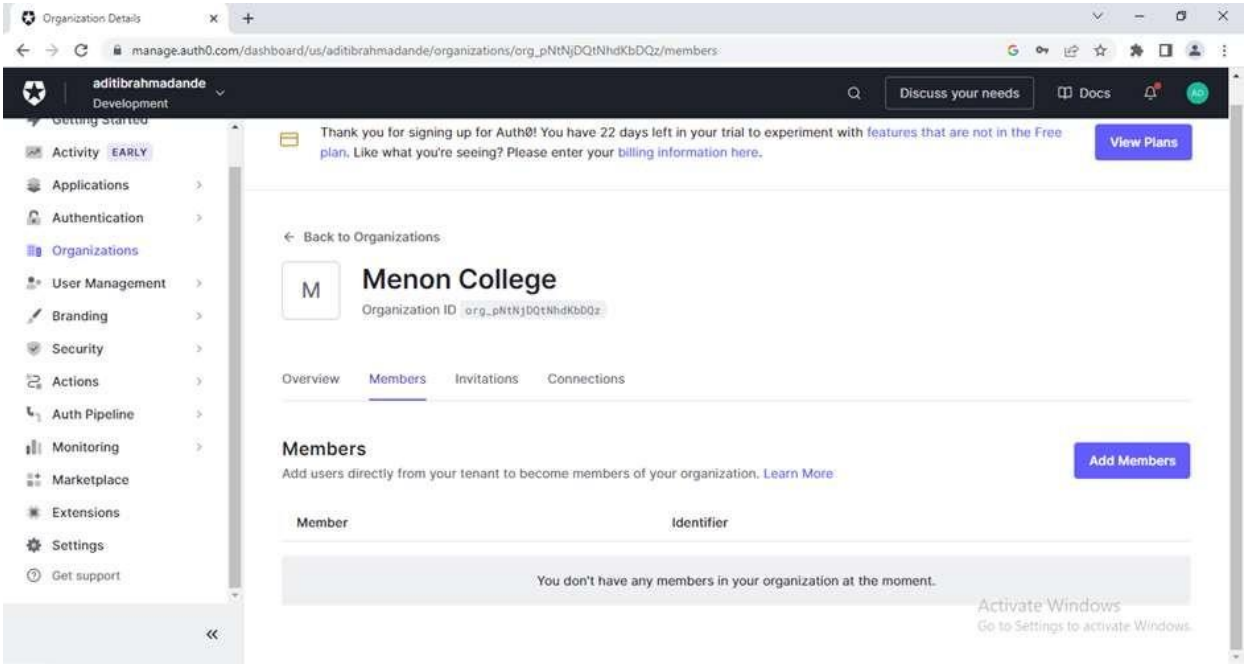


5. To create group Go to Organizations and Click on ― Create Organization ‖.

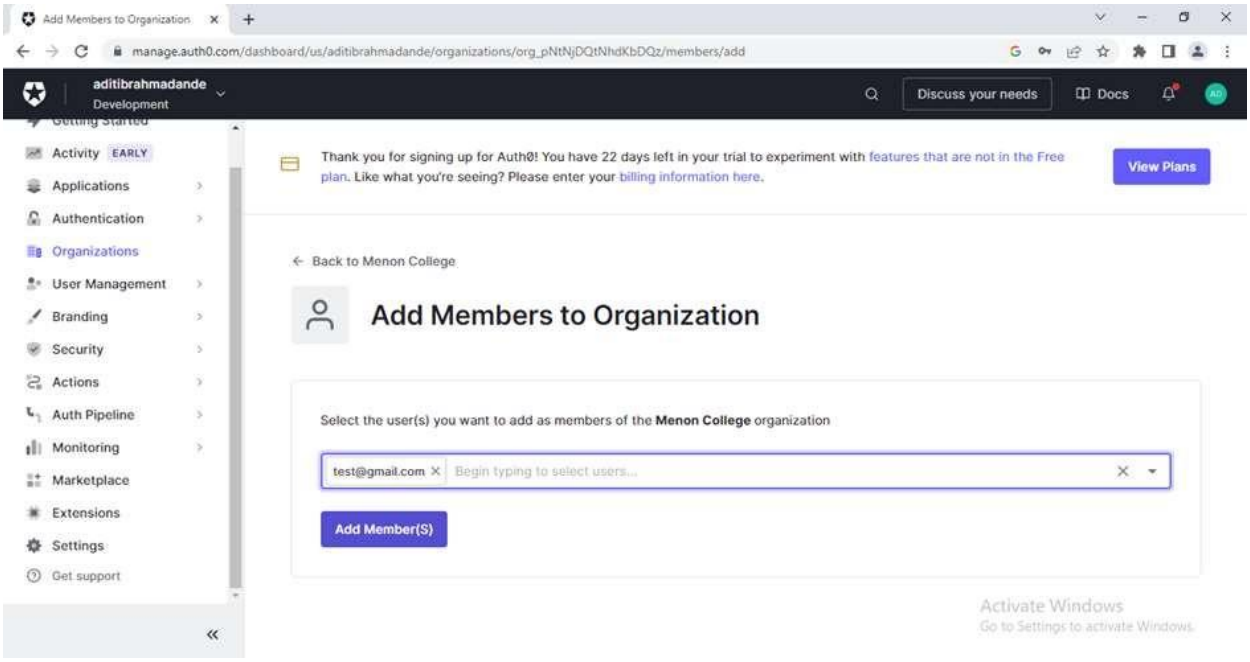


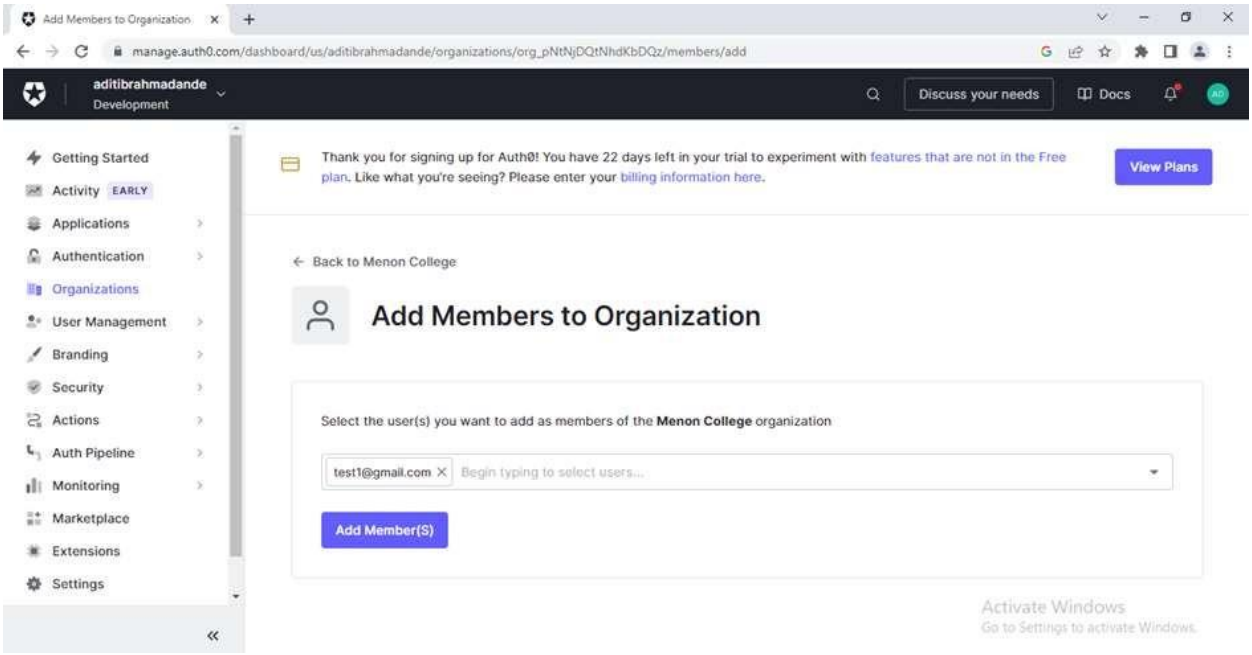


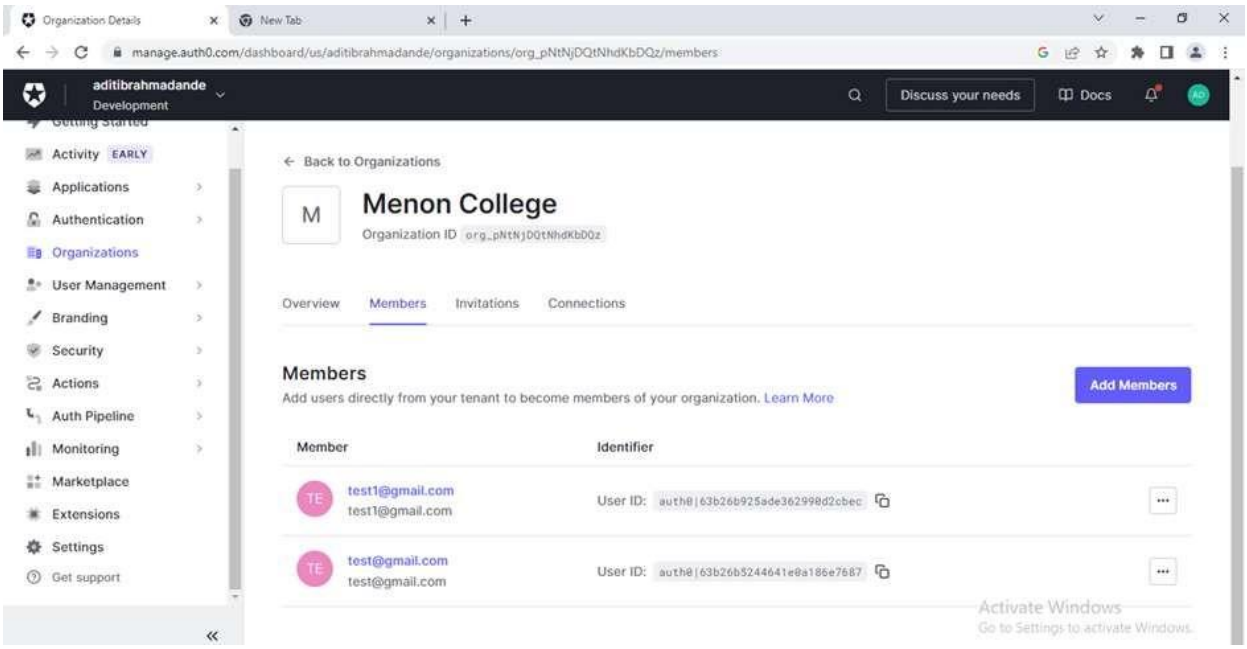
6. Now click on ― Add member ‖.



Add the users that you have created in user management.


Add Members to Organization
manage.auth0.com/dashboard/us/aditibrahmadande/organizations/org_pNtNjDQtNhdKbDQz/members/add
aditibrahmadande
Development
Discuss your needs
Docs
Activity EARLY
Applications
Authentication
Organizations
User Management
Branding
Security
Actions
Auth Pipeline
Monitoring
Marketplace
Extensions
Settings
Get support
Thank you for signing up for Auth0! You have 22 days left in your trial to experiment with features that are not in the Free plan. Like what you're seeing? Please enter your billing information here.
View Plans
Back to Menon College
Add Members to Organization
Select the user(s) you want to add as members of the Menon College organization
test@gmail.com
Begin typing to select users...
Add Member(S)
Activate Windows
Go to Settings to activate Windows.


Add Members to Organization
manage.auth0.com/dashboard/us/aditibrahmadande/organizations/org_pNtNjDQtNhdKbDQz/members/add
aditibrahmadande
Development
Discuss your needs
Docs
Getting Started
Activity EARLY
Applications
Authentication
Organizations
User Management
Branding
Security
Actions
Auth Pipeline
Monitoring
Marketplace
Extensions
Settings
Thank you for signing up for Auth0! You have 22 days left in your trial to experiment with features that are not in the Free plan. Like what you're seeing? Please enter your billing information here.
View Plans
Back to Menon College
Add Members to Organization
Select the user(s) you want to add as members of the Menon College organization
test1@gmail.com
Begin typing to select users...
Add Member(S)
Activate Windows
Go to Settings to activate Windows.


Organization Details
New Tab
manage.auth0.com/dashboard/us/aditibrahmadande/organizations/org_pNtNjDQtNhdKbDQz/members
aditibrahmadande
Development
Discuss your needs
Docs
Activity EARLY
Applications
Authentication
Organizations
User Management
Branding
Security
Actions
Auth Pipeline
Monitoring
Marketplace
Extensions
Settings
Get support
Back to Organizations
M
Menon College
Organization ID org_pNtNjDQtNhdKbDQz
Overview
Members
Invitations
Connections
Members
Add users directly from your tenant to become members of your organization. Learn More
Add Members
Member
Identifier
test1@gmail.com
test1@gmail.com
User ID: auth0|63b26b925ade362990d2cbec
test@gmail.com
test@gmail.com
User ID: auth0|63b26b5244641e0a186e7687
Activate Windows
Go to Settings to activate Windows.

Practical No :- 10

Aim :- Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform

Amazon Web Services (AWS)

Amazon Web Series or AWS as we abbreviate it is one of the leading Cloud Service providers in the market. It was initiated in 2002. Back then, it offered only a few sets of tools and services. It was in 2003 when Chris Pinkham and Benjamin Black presented a paper that helped automate and revolutionize the AWS platform. They believed that the retail platform, Amazon, could serve a bigger and better purpose. This is when Amazon started looking at it from a larger business perspective, and we had services like Cloud Storage and Computation that came into existence by the end of 2004. It was Christopher Brown and his team that made this possible and Amazon services was cherished across the globe. The popularity of AWS is unfathomable, and we will understand what makes this 170+ Cloud Service Provider work well. Before that, let us go ahead and understand the Microsoft Azure Cloud Platform.

Microsoft Azure

Microsoft Azure, as the name suggests, is Microsoft's Cloud platform that lets you test, build, deploy, and even manage applications that are placed in Microsoft Azure's data centers or Availability Zones. It has all three service model solutions just like AWS, which are infrastructure as a Service, Platform as a Service, and Software as a Service. It lets you integrate with different open source and Microsoft Stack of products/tools and programming languages. It was announced in 2008 but was released on February 1, 2020, as Windows Azure and later on renamed to Microsoft Azure as we know it today. Azure is similar to AWS and offers a variety of products and solutions for app developers. The Azure platform offers good processing and computing power. It is capable of deploying and managing virtual machines at scale. Azure can also run large-scale "parallel batch computing" – a unique feature that it shares with AWS over the Google Cloud Platform.

Google Cloud Platform (GCP)

Google Cloud Platform (GCP), also known as Google Cloud, announced in 2008 its first Public Cloud Service Google App Engine which become public in 2011. It was the first Platform as a Service introduced by Google Cloud. Post that, Google introduced various service cloud services in the public domain. These services reside on the same cloud space where popular Google Services reside like Google Search, YouTube, Gmail, etc. Google is popularly known for its services in Machine Learning, Data Analytics, Compute, Storage, etc. I believe this is enough information about the Cloud Service providers we plan to compare. Let us go ahead and understand how these compare with each other.

Market Share :-

When we start with market share, what better way to see the numbers than to start by taking a look at the Gartner's Magic Quadrant for Cloud Infrastructure services.

This tells you that AWS is still leading the Cloud Market with a definitive edge. Yes, Azure and Google Cloud follow suit, but they do have some catching up to do.

Talking about the numbers, AWS had a clear head start in the market since it initiated quite early than others. But it still holds on top position in the market and by quite a margin, as Q4 in 2019, these were the respective market shares were as follows-

- Amazon Web Services: 33% of the market share
- Microsoft Azure: 18%
- Google Cloud Platform: 8% of the market share

But numbers can be deceptive. It was also revealed that AWS grew by just 41% last year. Whereas Google Cloud and Azure grew by 80% and 75% respectively. This suggests is that Azure and Google Cloud are catching up.

This was about the market share. Let us see how these Cloud Service Providers compare when it comes to their reach in terms of infrastructure.

Global Infrastructure :-

When we discuss the infrastructure that concerns these platforms, we have to consider two terms, those are, Regions and Availability Zones.

Regions

Here, regions mean a geographical location where a Cloud Data center resides.

Availability Zone

It is the data center that resides in a region. Regions may have more than one Data-center. Some regions, for certain services providers, have only one data center. Hence, we do not use the availability zone term in that case. That data center is called or known as region.

Here are some numbers to see how these platforms compare:

Amazon Web Services

- Regions: 24 Launched and 3 announced
- Availability Zones: 76
- Countries served: 245

Microsoft Azure

- Regions: 60+
- Countries served: 140

Google Cloud Platform

- Regions: 22
- Availability Zone: 61
- Countries served: 35

It is clear that Amazon Web Services has a wider reach and provides services to more countries than the other two platforms. Let us now move ahead and see what kind of customer base these platforms support.

Targeted Audience and Customers :-

AWS, Azure and Google Cloud all have high profile users and customers. Let us take a look at those.

Amazon Web Services

Amazon Web Series has the largest community support and customer base, and it has many profile customers in the market. To name a few, we have-

- McDonald's
- Netflix
- Unilever
- Samsung
- MI
- AirBnB
- BMW
- ESPN

Companies Like Netflix, LinkedIn spend $10-19 million a month on their instances. That tells you how much trust people have in this platform and also how large and high profile the customer base is. It also has a very widespread small scale industry customer base.

Microsoft Azure

Microsoft Azure is not far behind in this race. It also has a wide customer base and has gained a lot of popularity in most of the Top Fortune 500 companies. Around 70-80% of fortune 500 companies use Microsoft Azure. Some known brands that use this platform are:

- Ebay
- Apple
- Pixar
- HP
- Honeywell

Google Cloud Platform

Among the three, Google Cloud is the youngest and has a smaller customer base compared to others. But we should not forget Google Cloud is home to YouTube, and Gmail which are huge on their own. Here is a list of some other popular customers they have-

- HSBC
- Snapchat

- HTC
- Phillips

So this was about some of the customers these Cloud Service Providers have. Please not these are just some numbers and honorable mentions. If you visit the websites for these platforms you will find a large number of customer base and even many case studies that tell you how these service providers have solved problems for numerous businesses across the globe.

Now that we know what customers these platforms serve, let us see and compare the services provided by these platforms.

Service Comparison :-

Amazon Web Services, Microsoft Azure and Google Cloud Platform provide numerous cloud computing services that are there in the market. If we are to bluntly put out the numbers then this is how the service numbers appear.

Services	**AWS**	**Azure**	**GCP**
Number of Services	212	100+	60+

Since there are so many services these service providers provide, these services are classified into subcategories, or domains, let us dig deeper into some of these services.

Compute Services :-

When we compare compute services, AWS has all the praise for EC2 which is very popular in the market. It also supports various other compute services that touch PaaS, container, and even serverless computing service. Azure also has many services that match AWS in these domains.

Google Cloud, however, lacks a little when compared with these two platforms. Here is a list of some notable services these Service providers provide.

Services	Amazon Web Services	Microsoft Azure	Google Cloud
Infrastructure as a Service	Amazon EC2	Virtual Machines (VM)	Google Compute Engine
Platform as a Service	AWS Elastic Beanstalk	App Service and Cloud Services	Google App Engine
Container Services	Amazon Elastic Container Service	Azure Kubernetes Service or AKS	Google Kubernetes Engine
Serverless Computing	Amazon Lambda	Azure Functions	Cloud Functions

Storage Services :-

Storage is a very important service when it comes to Cloud Computing because it is only after you store data you can think of other services that can help process your data. Let us see how these Service Providers take care of Storage on Cloud.

Amazon Web Services

No matter if you are looking for object, Block or file storage, AWS covers it all. Not just that, it takes storage to a different level as it provides services like Amazon Storage Gateway, Snowball and Snowmobile. These services ensure you covered even if your requirement are for hybrid storage, or even if you actually want to move your data physically. Hence Amazon Web Services has you covered here.

Microsoft Azure

Microsoft Azure's is equally good when it comes to storing your data on cloud. It covers you with basic storage services like Blob Storage for object storage which maybe unstructured data. It provides Queue Storage if you ate dealing with large-volume storage workloads. it also provides File and Disk Storage. It covers you Big Data Application needs with Data Lake Store.

Google Cloud Platform

Google Cloud also limited in terms of Storage Services just as it is Compute domain. However it has unified object storage service, and even a Persistent Disk storage option.Just Amazon Snowball it provides Data Transfer Application, and also supports online Data transfer services.

Here is list of some popular services these platforms provide-

Services	**Amazon Web Services**	**Microsoft Azure**	**Google Cloud**
Object Storage	Amazon S3	Azure Disk Storage	Google Cloud Storage
Block Store	Amazon EBS	Azure Blob Storage	Google Compute Engine (Persistent Disks)
Archival/Cold Storage	Amazon Glacier	Azure Archive Blob Storage	Google Nearline

File System Storage	Amazon EFS	Azure File Storage	Google ZFS/Avere

Now that we know how Storage Services have fared. Let us go ahead and see how these Cloud giants fare with each other in terms of Cloud Database offerings.

Database Services :-

When it comes to databases and archiving, here too, Amazon has a plethora of Cloud Services to offer. It is SQL-compatible databases like Aurora or even databases that are Relational like the Relational Database Service (RDS). It has you covered on NoSQL Databases too, it offers service called Dynamo. Whereas, ElastiCache service provides an in-memory data store too. If your requirements need you to have a Data Warehouse, a graph database, or even services that meet data migration needs, it answers with services like Amazon Redshift, Neptune. As already mentioned in storage services, even if archival storage is to be handled even that is managed with Amazon Glacier.

Microsoft Azure

Microsoft Azure provides numerous extensive Database options. SQL database requirements are fullfilled using three database services.

- SQL DB
- DB for MySQL
- DB for PostGreSQL

It covers you for Data Warehouse requirements with Cosmos DB and their stable Storage for NoSQL. Redis Cache provides in-memory service and for Hybrid Storage requirements, there is Server Stretch Database. It is designed in such a way that it suites specific organizations that use Microsoft SQL Server for their data centers. Amazon Web Services lack a little in the backup domain. Microsoft Azure comparatively does better there and is equally adept when it comes to Archival storage.

Google Cloud Platform

It does provide SQL and NoSQL Database services. Google Cloud Spanner is a service for SQL based Databases that are designed for data critical workloads requirements. Cloud Bigtable and Cloud Datastore are its options for NoSQL database requirements. Again the number of services and options it provides in comparison to Microsoft Azure or Amazon Web Services is still less and limited. It does have services for Backup or archival. Here is a list of database services that work similarly for these cloud service providers.

Services	**Amazon Web Services**	**Microsoft Azure**	**Google Cloud**
Relation DB	Amazon RDS	SQL DB	Google Cloud SQL
NoSQL DB: Key- value	Amazon DynamoDB	Table Storage	Google Cloud DatastoreGoogle Cloud Bigtable
NoSQL DB: With Indexing	Amazon SimpleDB	Azure Cosmos DB	Google Cloud Datastore

So this was about Databases. Let us go ahead and compare these platforms based on Networking Domain.

Networking Domain :-

These services do fairly well against each other when compared and there is very little to choose when put head to head. Here is a list of services when compared head to head.

Services	Amazon Web Services	Microsoft Azure	Google Cloud
Virtual Network	Amazon VPC	Azure Vnet	Google VPC
Load Balancing	Amazon ELB	Azure Load Balancer	Google Cloud Load Balancing
Cloud Peering	Amazon Direct Connect	Azure ExpressRoute	Google Cloud Interconnect
Domain Name Services	Amazon Route 53	Azure Domain Name Service	Google Domain Name Service

Pricing :-

Pricing is easily the hardest measure to compare these Cloud Service Providers for. This is because pricing varies greatly when it comes to comparing them based on small-term investment or short sized services. However, let us try and do that.

When it comes to short term investments or small-sized resources, Google Cloud gives better pricing options. Here is one example for the same. Let us consider small-sized virtual instances with minimum RAM and Virtual CPU requirements. Google Cloud will cost around, $50-55 per month. Amazon Web Services will cost you $69 per month and Microsoft Azure will cost you around $70-75 per month.

But as we scale up the pricing models change a lot and give you a very different picture. Let us consider this example, if we opt for the largest instance these platforms provide different pricing, an instance with around 4 TB of RAM, and around 128 Virtual CPU's Amazon Web services offer the best pricing here, it costs around $2700 to $3000 per month. Microsoft Azure costs around $5000 per month, whereas Google Cloud costs $3800 to 4000 per month.

So it is clear that Google Cloud is cheaper when it comes to short term investments. Another point that supports the claim is Google Cloud charges on a per-second basis. Microsoft Azure gives you per minute billing. Amazon Web Services had hour billing, but in recent times it too has moved to per-minute billing.

Google Cloud ensures when it comes to small-term investments, it comes with various offers and discounts ensuring cheaper pricing. So as mentioned earlier choosing a provider based on pricing can be tricky and may vary on what sort of business requirements your business has.

Miscellaneous Comparison :-

We have already compared these platforms on quite a few pointers, however, there are quite a few other pointers these platforms can be compared on. Here is an overall miscellaneous comparison. Let us start with Amazon Web Services.

Amazon Web Services

What makes Amazon Web Services stand out? Firstly its head start, meaning it has had that extra valuable years to firm its dominance in the market. This can be proven with facts. Amazon Web Services has been the market leader in terms of Market share in IaaS services, it provides and Gartner supports that claim with numbers.

Another reason for this success is the number of services it provides, it almost provides double the services the second-best competitor provides in terms of the sheer number of services it has to offer. It is a highly mature platform and is ready to serve different enterprise-level requirements. It also has deep and precise capabilities.

But everything has weaknesses. Amazon is costly when it comes to short term investments and many find it tricky to opt for this platform due to the uncertainty on its pricing models. But the wide array of services it provides makes up for the lapse in pricing concerns. Certainly Amazon's strong points or pros overshadow Amazon's weaknesses.

Now let us go ahead and see how Microsoft Azure Fares when it comes to its strengths and weaknesses.

Microsoft Azure

Microsoft is a company that has overcome various hurdles in the IT and software industry it has ever come across. This ability has also transpired into Cloud offerings it provides.

Microsoft always had a stronghold and contributions to the On-Premise service market. It has ensured that services and offering it provided can be moved to the cloud and can be made Azure Cloud Compatible. Even though it had a late start, it is making up for it at a very good pace.

Another major reason why Microsoft Azure is so popular and is so widely used is because Microsoft Azure integrates with most of Microsoft stack of products with easy. Hence many companies and enterprises find it relevant to migrate to Microsoft Azure because then the deployment seems easy and effortless.

Microsoft Azure is claimed to be enterprise-ready. But one of the shortcomings that people or customers complain about is the shortcomings it comes with when it comes to supporting experience that face on an enterprise level. And customers complain it is little on the shorter side.

Let us see how this platform fares compared to others, and what are its pros and cons.

Google Cloud Platform

Let us start by taking a look at its strengths first.

It offers fairly strong offerings in containers, it has developed a standard for Kubernetes, and high computation capabilities in terms of Big Data Analytics, and even Machine Learning. it also offers decent enough load balancing and scalability.

If we are to compare it with Amazon web Services and Microsoft Azure, it lacks a little here with lesser market share, and lesser number of services.

By now, I assume we have discussed numerous pointers using which you can take a call on what platform will suit your needs best. All theseproviders have their strengths and weaknesses, and I am sure by now youcan choose one for your requirements. Before we all sign out, here are some final points.

- **Market Share:** Amazon Web Services is a clear winner here
- **Global Infrastructure:** In terms of number Amazon Web Services stands out here too
- **Growth:** GCP is a clear winner here
- **Service Comparison:** Amazon web Services wins for numbers whereas Microsoft Azure wins for integration capabilities
- **Pricing:** Small investments GCP wins, longer run costs Amazon Web Services is a winner

So this is, by now you should have a clear picture as to how these Cloud providers fare against each other. This brings us to the end of this article on AWS vs Azure vs Google Cloud.

Conclusion :-

Cloud Computing services has triggered a revolution in the IT industry. It has become a go-to factor for application implementation and hosting for all companies, whether big or small.

According to a Gartner Survey Report, the market for public cloud is predicted to reach around

$411 billion in 2020. This is bound to generate a wide range of job opportunities in this field. So, if you are planning to start a career in this domain, you are on the right track. Getting a cloud computing certification in this field will definitely help in learning and developing your skills. Become a cloud computing expert and join the elite group of highly paid IT professionals in the world.