



SRI SHAKTHI



INSTITUTE OF ENGINEERING AND TECHNOLOGY

COIMBATORE – 62

Autonomous Institution, Accredited by NAAC with “A” Grade



**POWERING THE YOUTH
EMPOWERING THE NATION**

21CS613 - CLOUD COMPUTING LABORATORY

**DEPARTMENT OF
COMPUTER SCIENCE AND ENGINEERING**

**SRI SHAKTHI INSTITUTE OF ENGINEERING AND
TECHNOLOGY**
(An Autonomous Institution)

**DEPARTMENT OF
COMPUTER SCIENCE AND ENGINEERING**

21CS613 - CLOUD COMPUTING LABORATORY

LABORATORY RECORD

NAME: _____ **ROLLNO:** _____

CLASS: _____ **BRANCH:** _____

ACADEMIC YEAR: _____ **BATCH:** _____ **SEMESTER:** _____

Certified and Bonafide record of work done by _____

Place: Coimbatore

Date:

Staff In-Charge

Head of the Department

University Register Number:

Submitted for the University Practical Examination held on.....

INTERNAL EXAMINER

EXTERNAL EXAMINER

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EX: NO: 01

**INSTALL VIRTUALBOX/VMWARE WORKSTATION WITH
DIFFERENT FLAVOURS OF LINUX OR WINDOWS OS ON TOP
OF WINDOWS**

AIM:

Install Virtual box/VMware Workstation with different flavours of Linux or windows OS on top of windows7 or 8.

PROCEDURE:

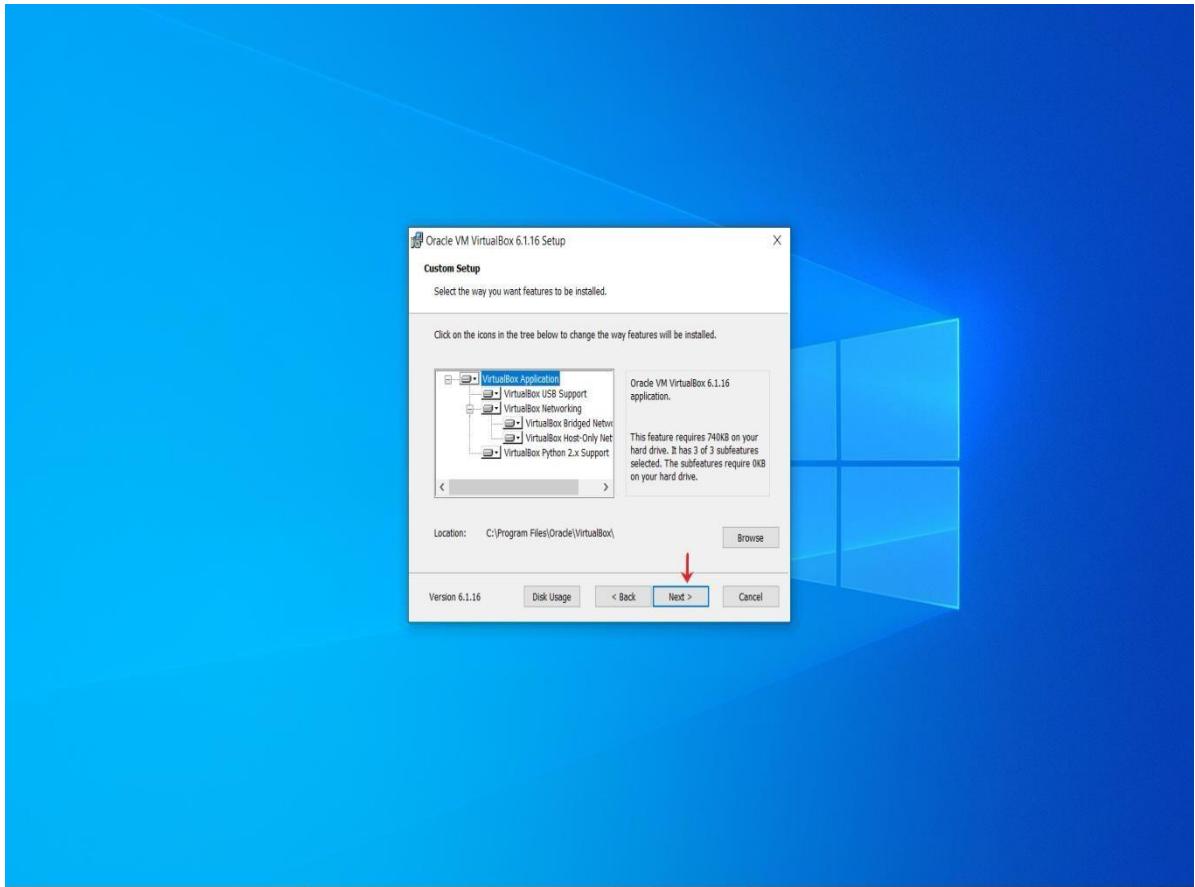
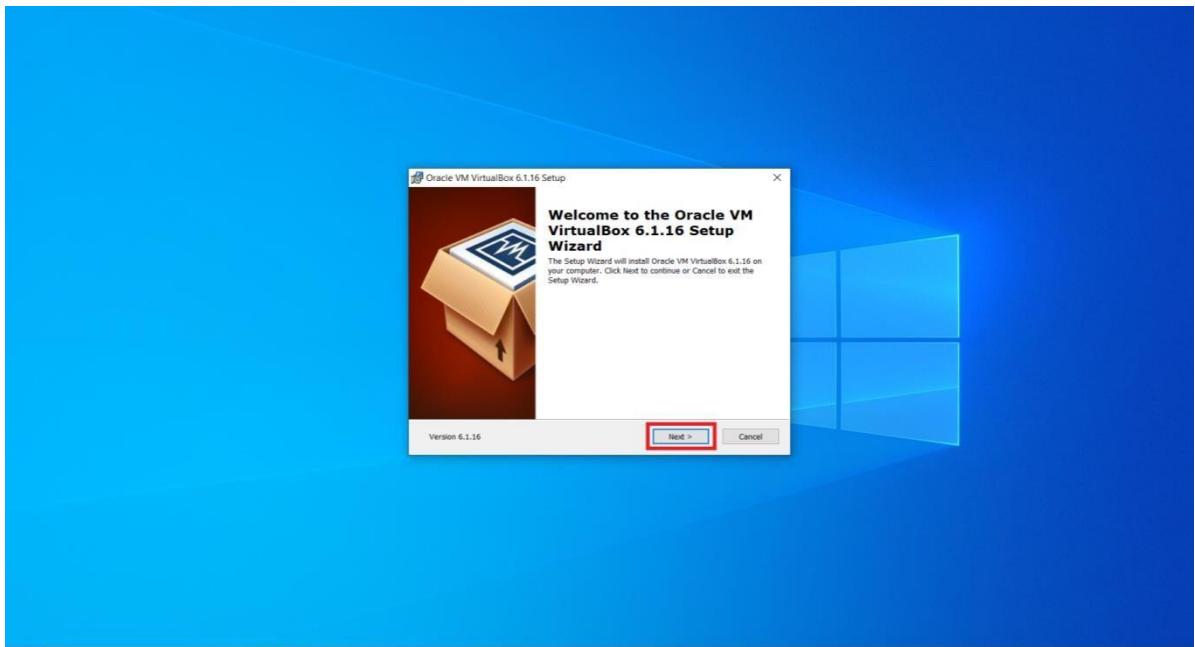
Install Virtual Box:

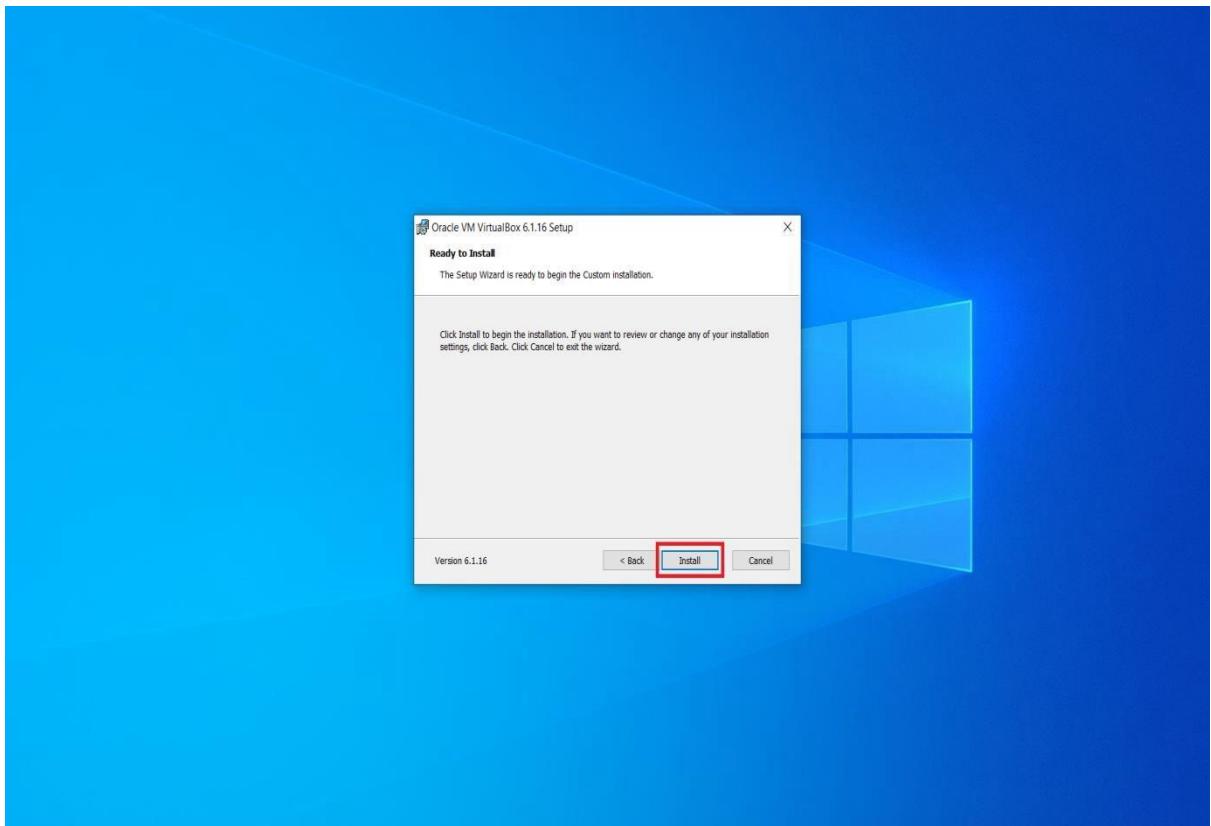
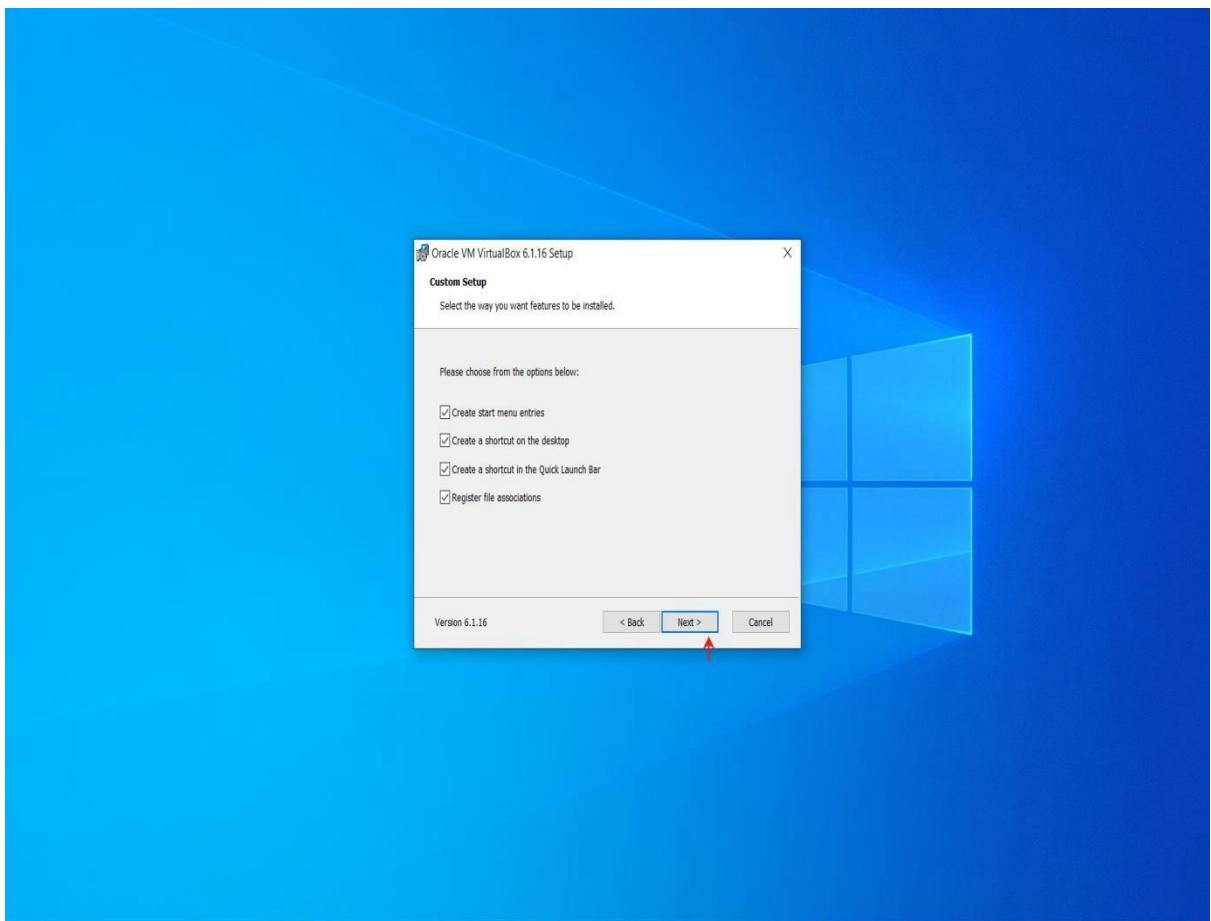
Step1: Visit <https://www.virtualbox.org/wiki/Downloads>

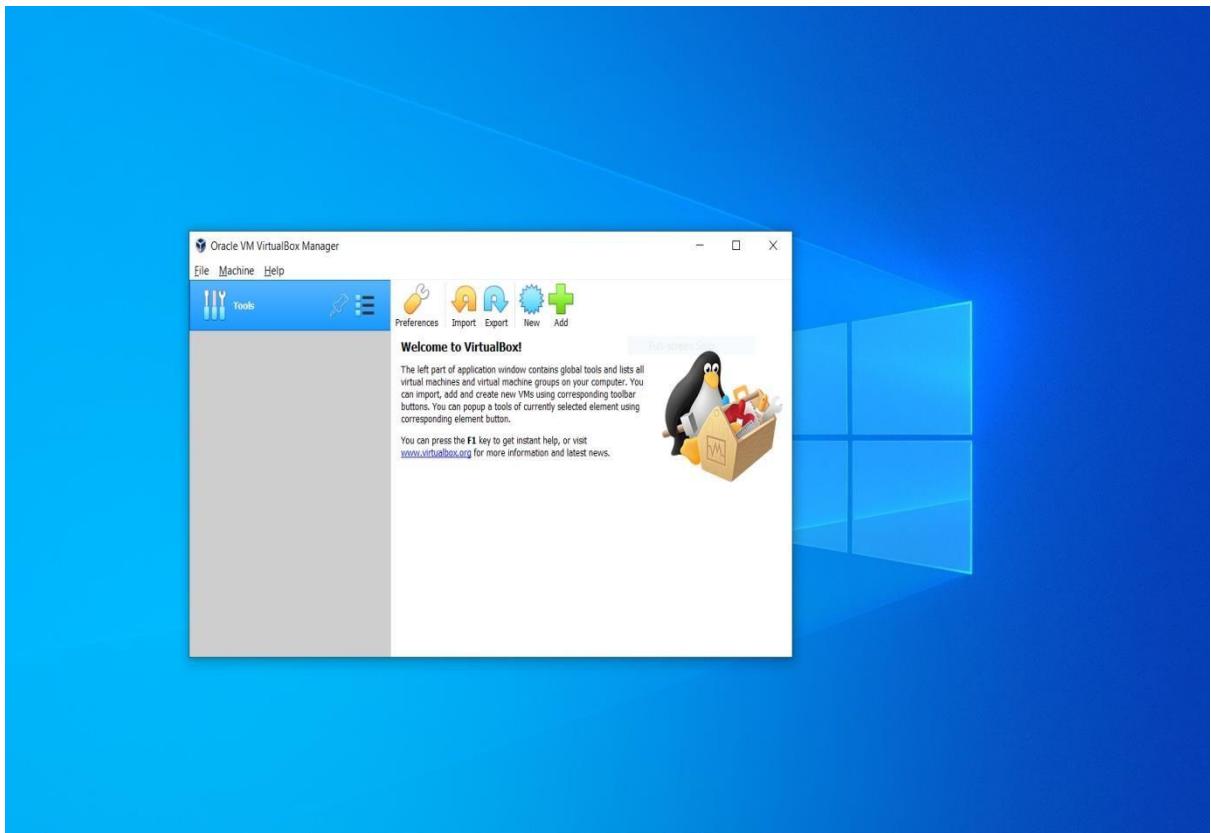
Step2: Download VirtualBox platform packages for your OS

The screenshot shows the official VirtualBox download page. At the top, there's a navigation bar with links for 'About', 'Screenshots', 'Downloads', 'Documentation', 'End-user docs', 'Technical docs', 'Contribute', and 'Community'. Below the navigation, there's a search bar and login/preferences links. The main content area features a large 'VirtualBox' logo and a 'Download VirtualBox' button. A sub-section titled 'VirtualBox binaries' is highlighted with a red box around its list of platforms: Windows hosts, OS X hosts, Linux distributions, and Solaris hosts. Below this, there's a note about GPL version 2, a changelog link, and a note about SHA256 checksums. Another section, 'VirtualBox 6.1.16 Oracle VM VirtualBox Extension Pack', is also shown with a list of supported platforms. At the bottom, there's a 'VirtualBox 6.1.16 Software Developer Kit (SDK)' section and a 'User Manual' section.

Step 3: Open the Installation Package by double clicking and follow procedure.

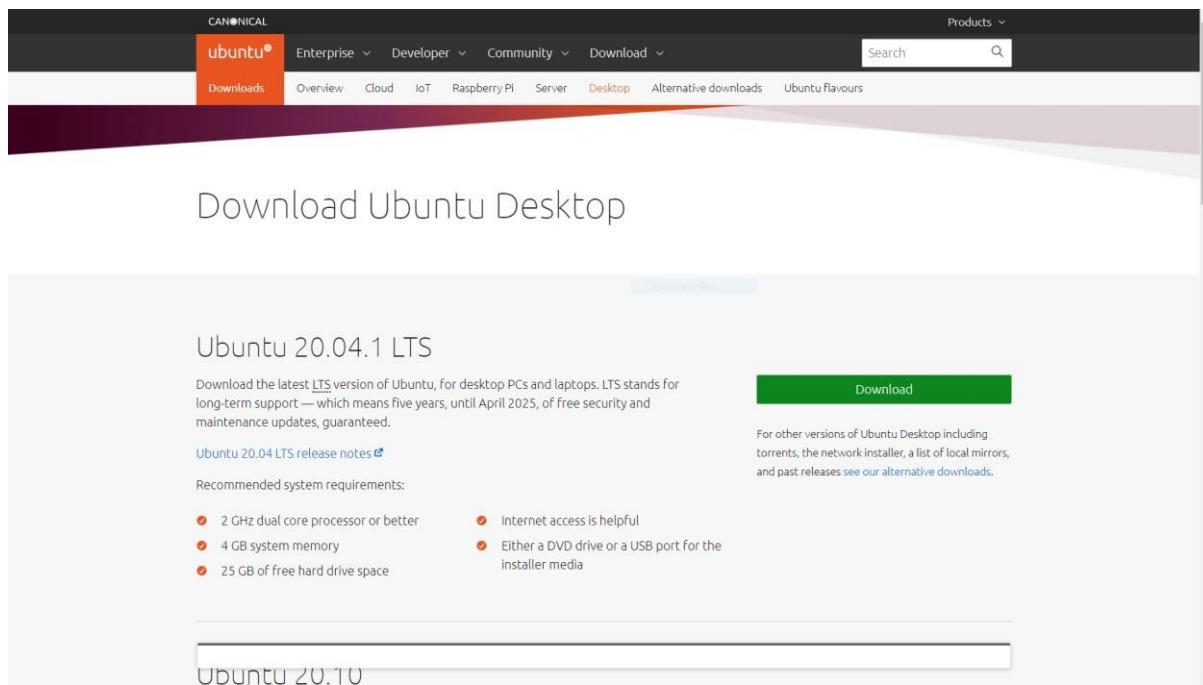






Install Linux using Virtual Box:

Step1: Visit the page <http://www.ubuntu.com/download/ubuntu/download>

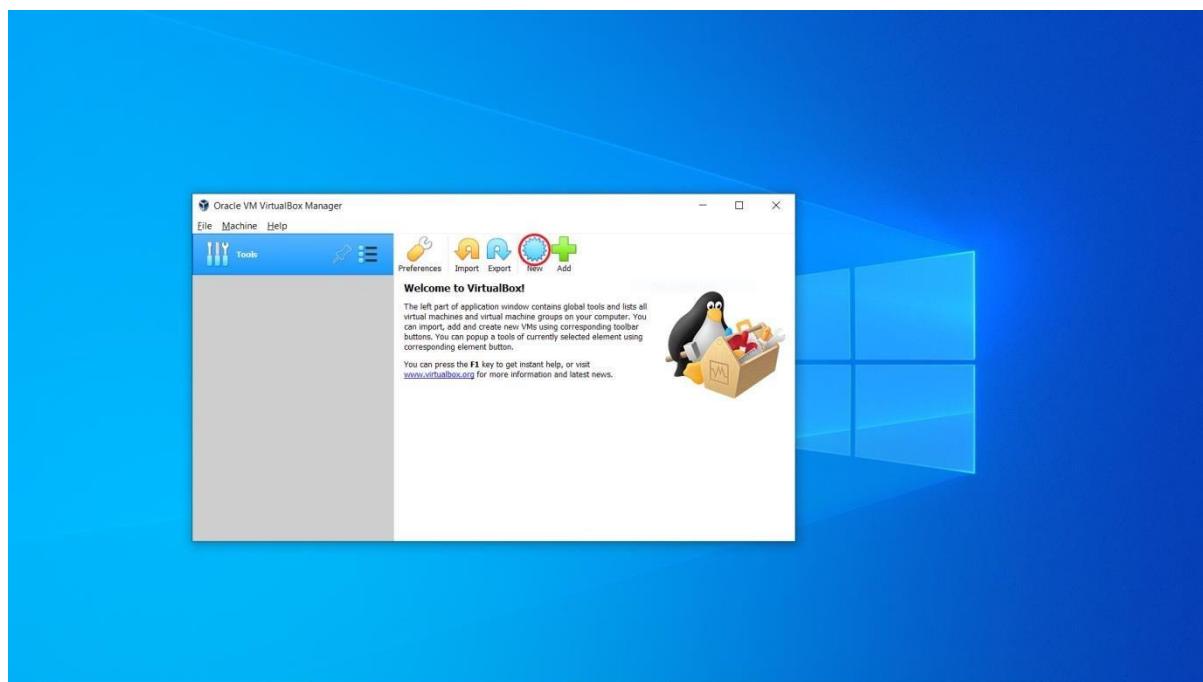


The screenshot shows the Canonical Ubuntu website. The navigation bar includes links for Enterprise, Developer, Community, Download, Overview, Cloud, IoT, Raspberry Pi, Server, Desktop, Alternative downloads, and Ubuntu Flavours. A search bar is at the top right. The main content area is titled "Download Ubuntu Desktop". It features a large image of a laptop screen displaying the Ubuntu desktop environment. Below the image, the text "Ubuntu 20.04.1 LTS" is displayed, along with a brief description of what LTS means. A prominent green "Download" button is visible. To the right, there's a link to "Alternative downloads" for other versions of Ubuntu.

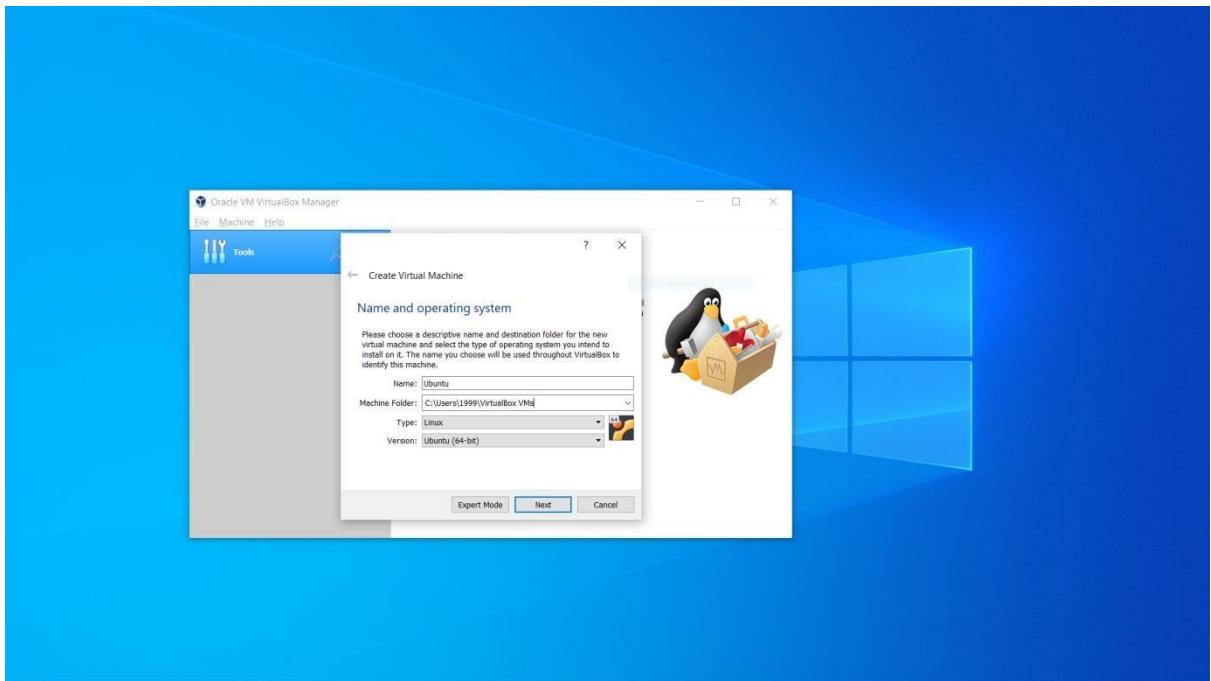
Step 2: Choose the Latest version of Ubuntu and click “Download”.

Step 3: Run VirtualBox by double-clicking the icon.

Step 4: Click the “New” button.

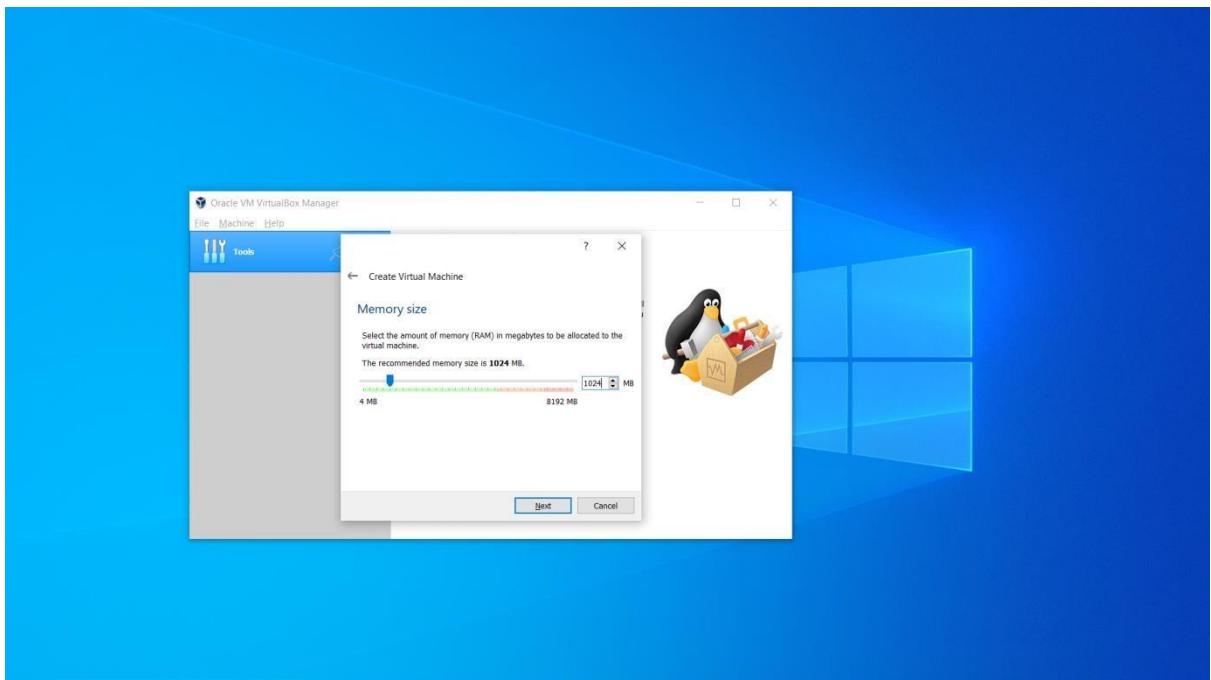


Step 5: Type VM name, select “Linux” for the OS and choose “Ubuntu (32 bit)” or “Ubuntu (64 bit)” version according to your system configuration.



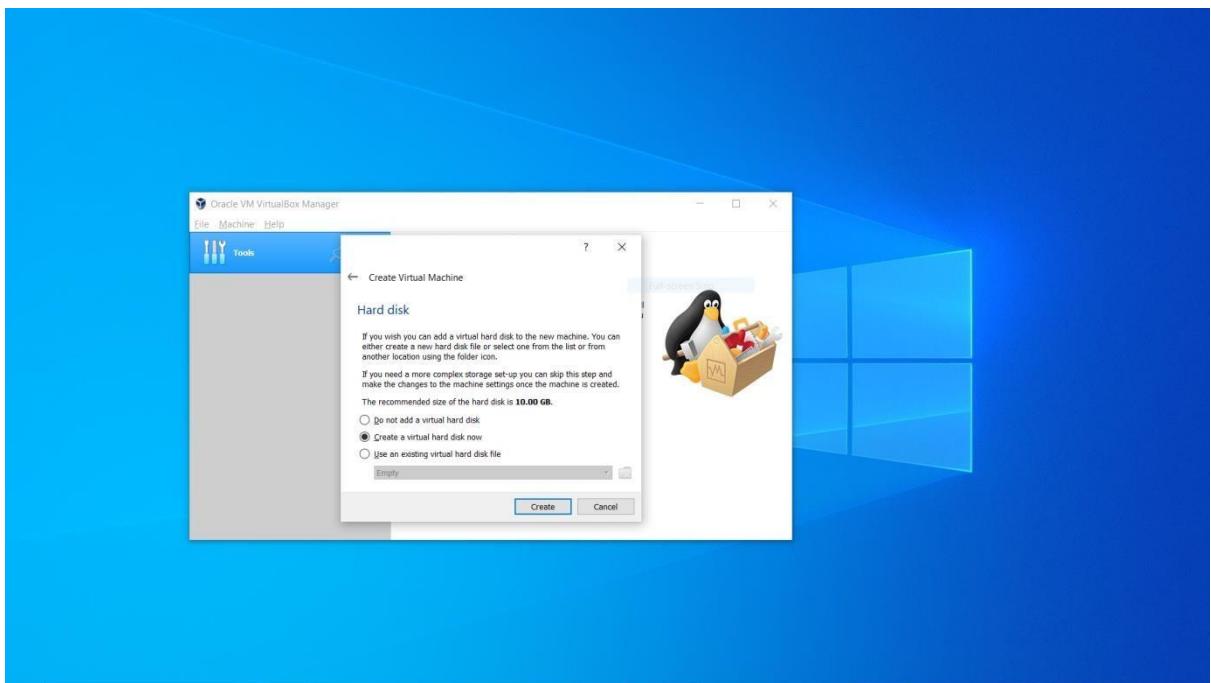
Step 6: Choose the amount of memory to allocate (I suggest choosing between 512 MB to 1024 MB).

Step 7: Click Continue or Next.



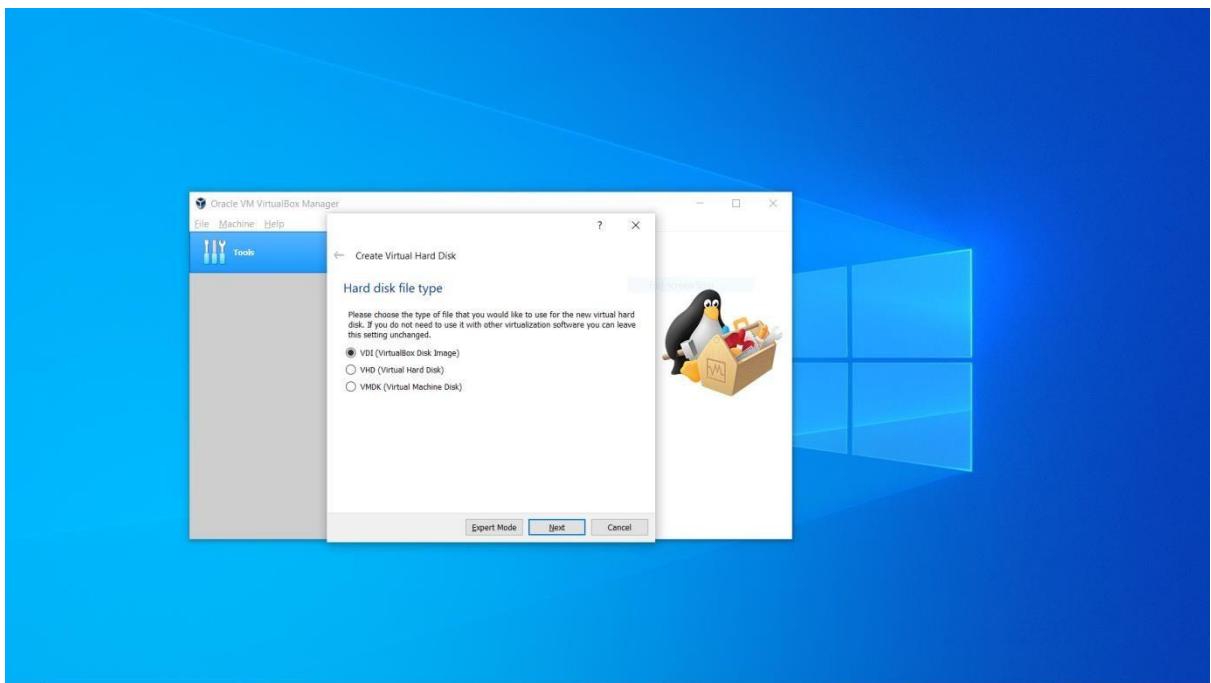
Step 8: Choose to create a new virtual hard disk.

Step 9: Click Next.

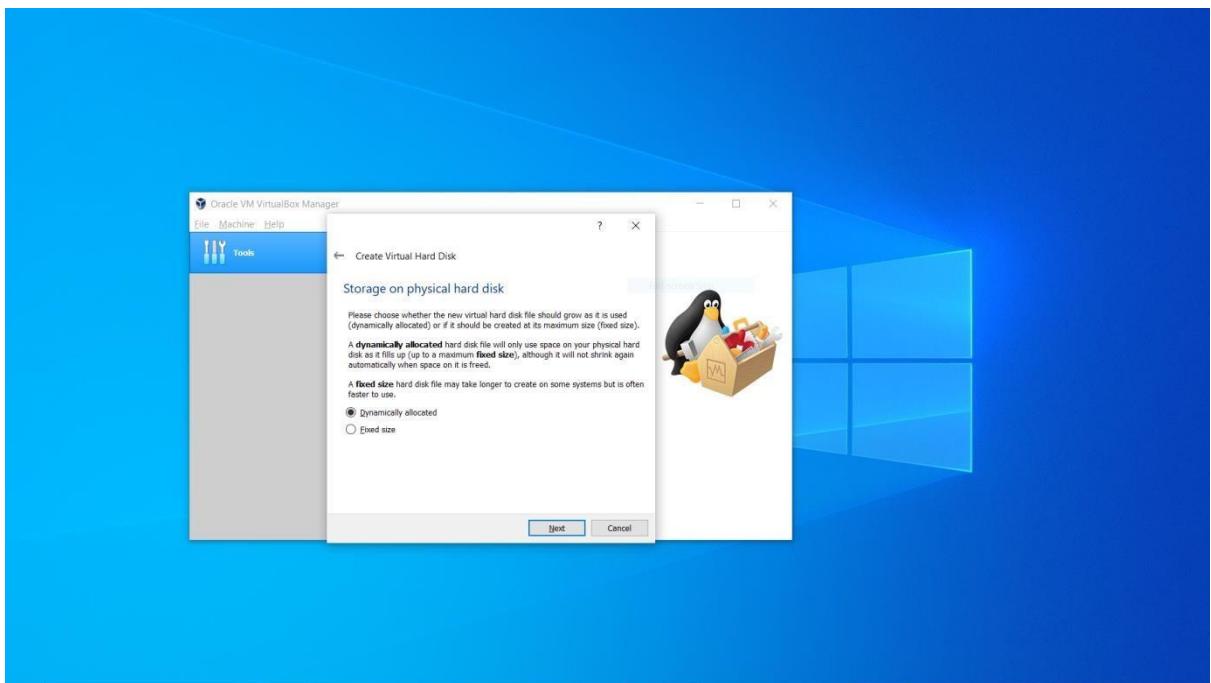


Step 10: Choose VDI (VirtualBox Disk Image)

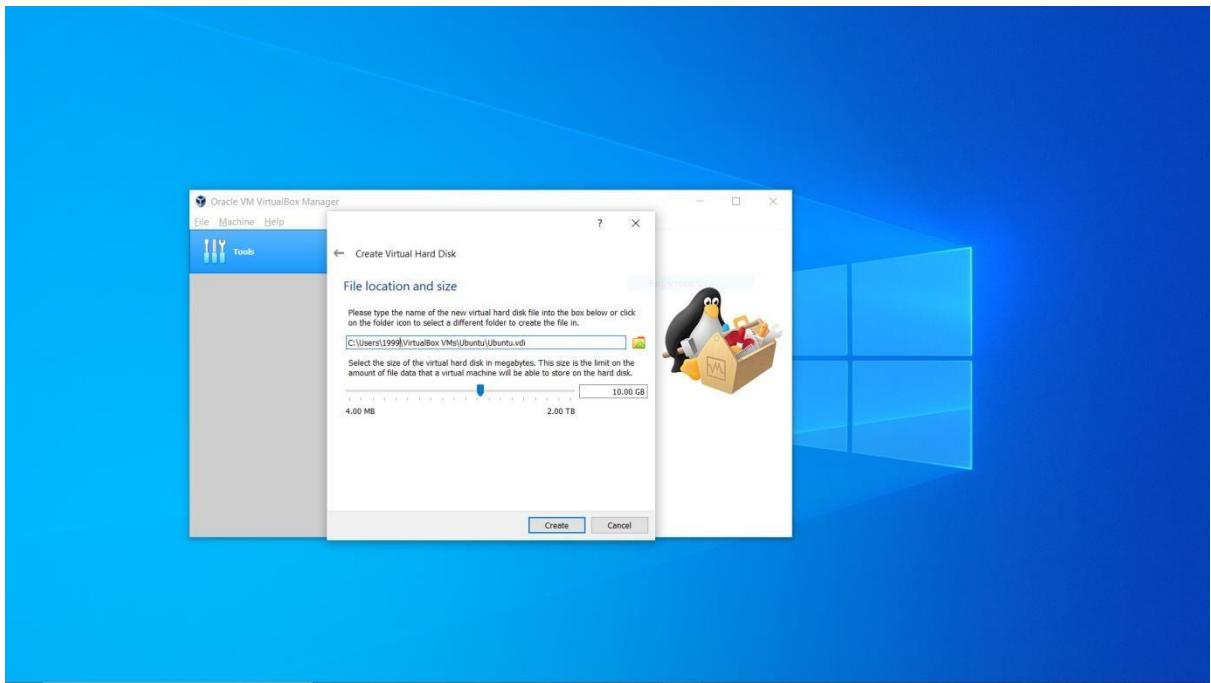
Step 11: Click Next.



Step 12: Choose “Dynamically Allocated” click continue. This way, the size of your Virtual Hard Disk will grow as you use.

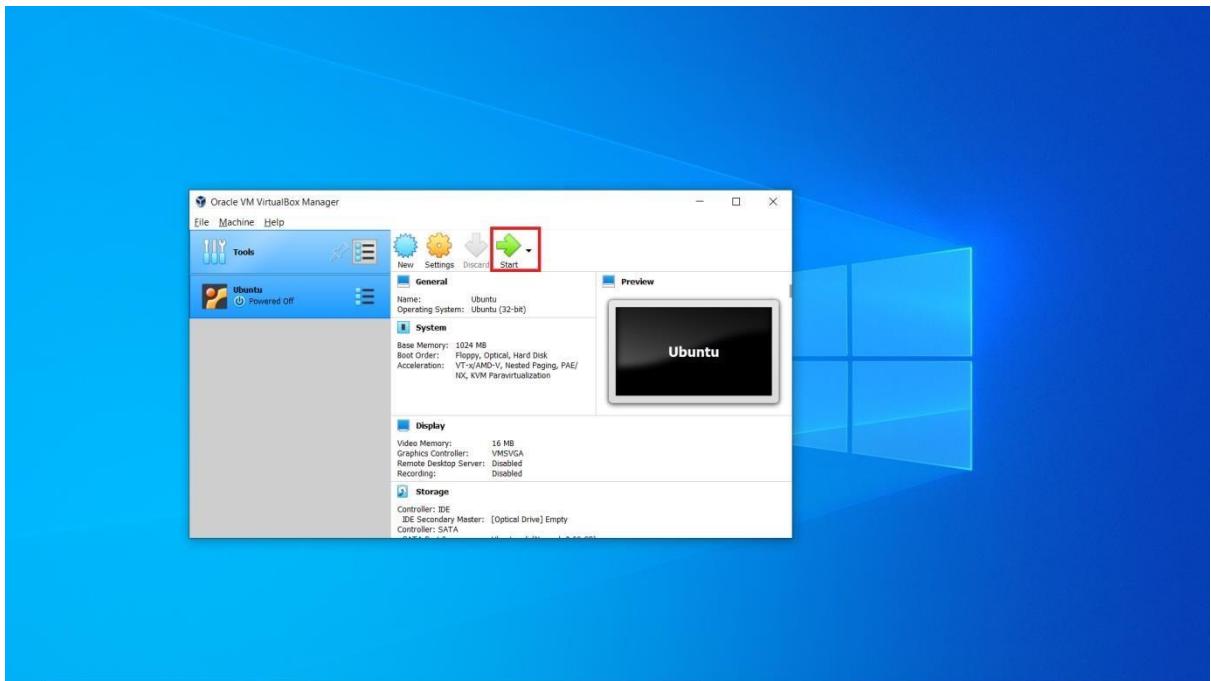


Step 13: Select the size of the Virtual Disk (I recommend choosing 8 GB) and click continue.

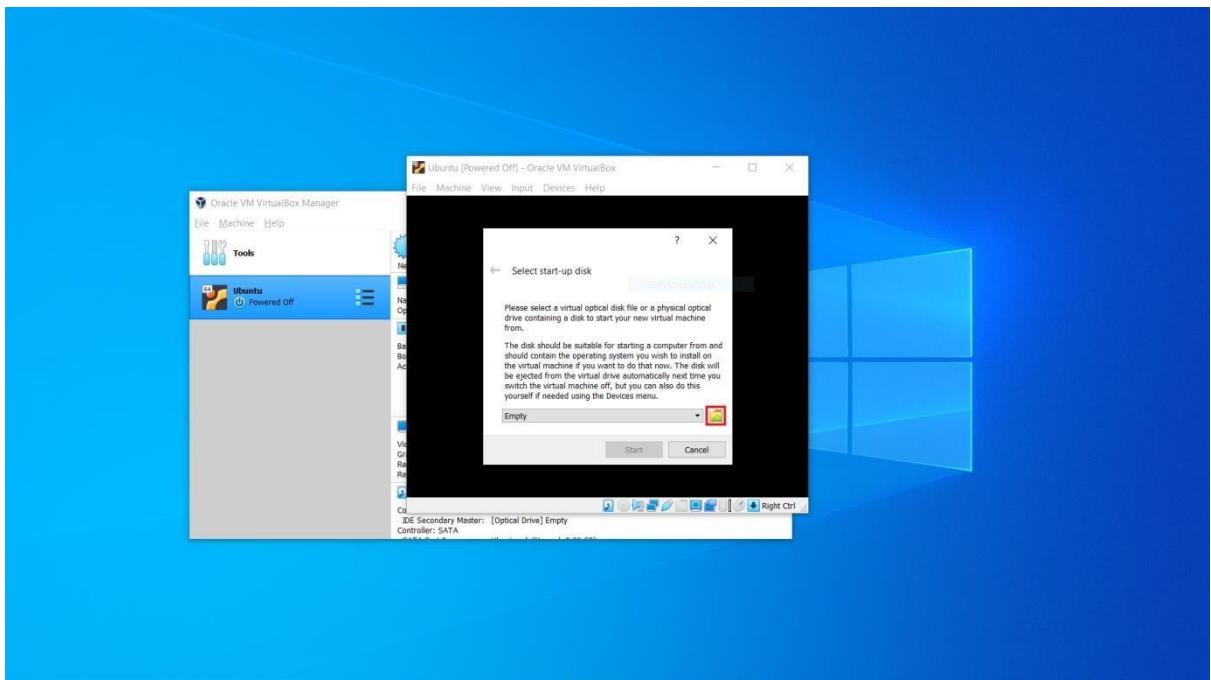


Step 14: Click Create.

Step 15: Choose Ubuntu from the left column and click Start.

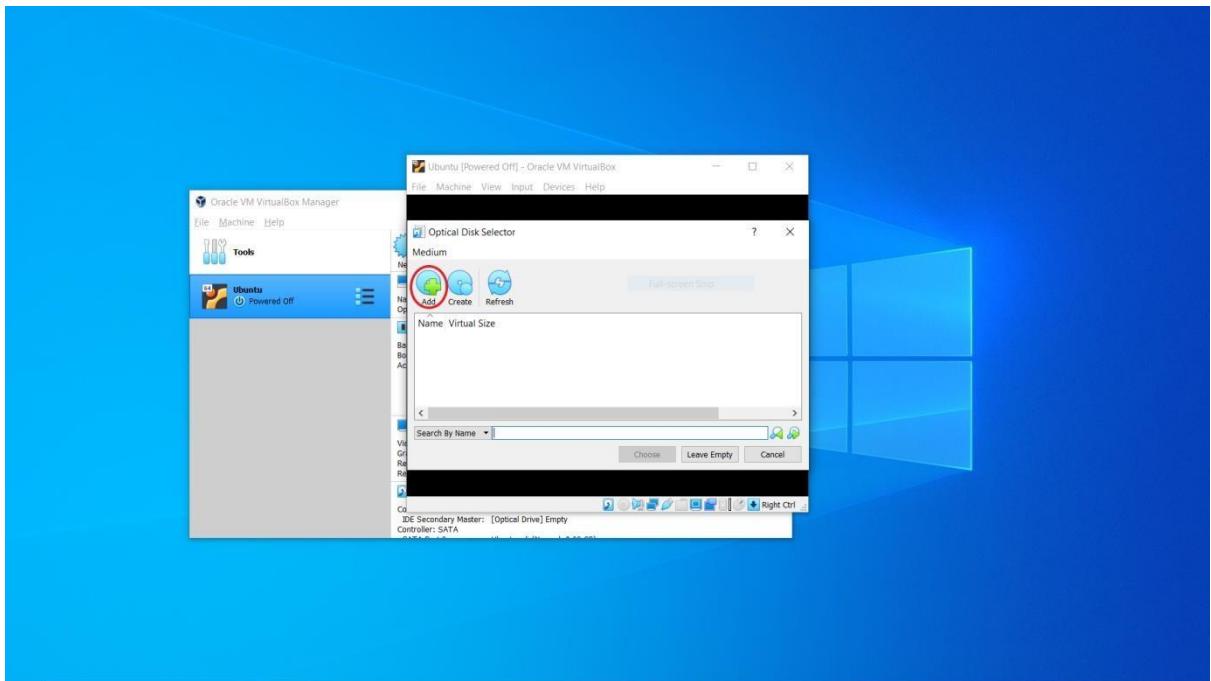


Step 16: Click folder icon.

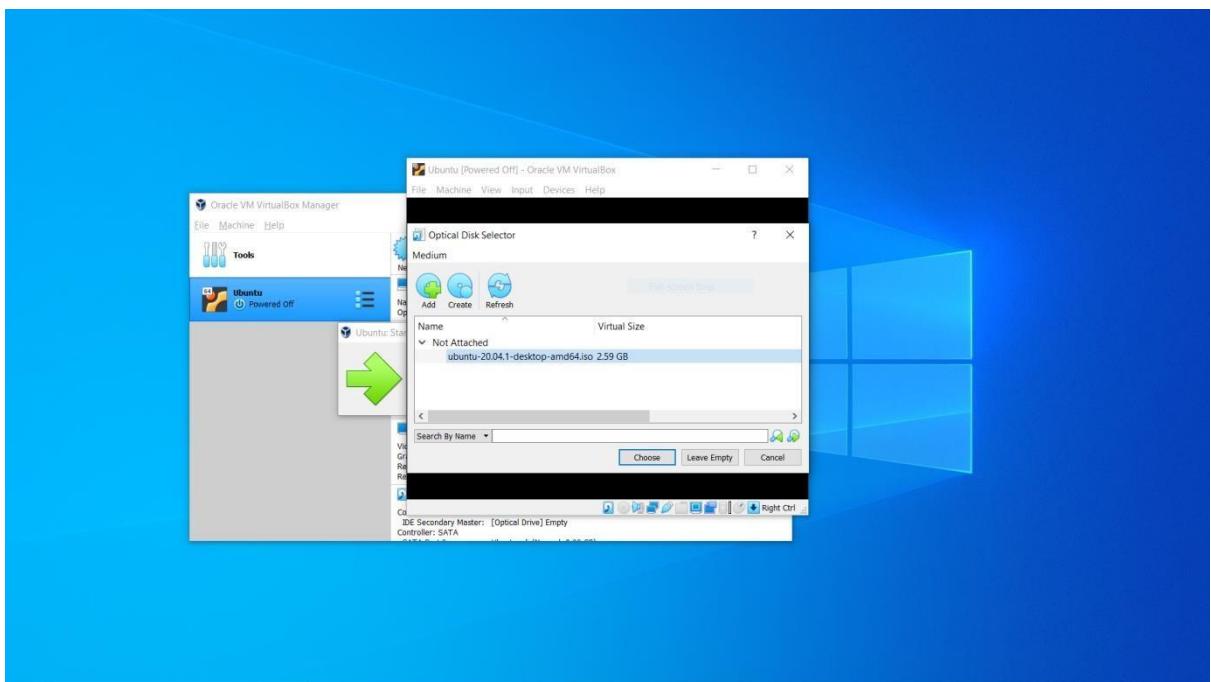


Step 17: Click add icon.

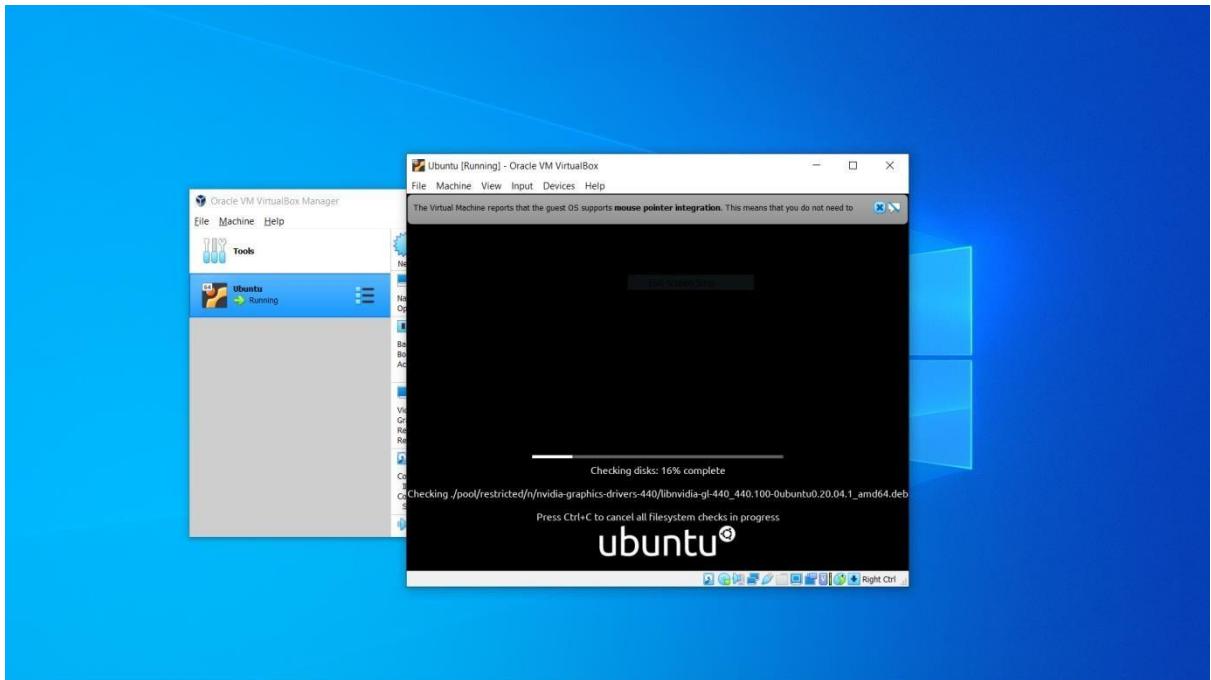
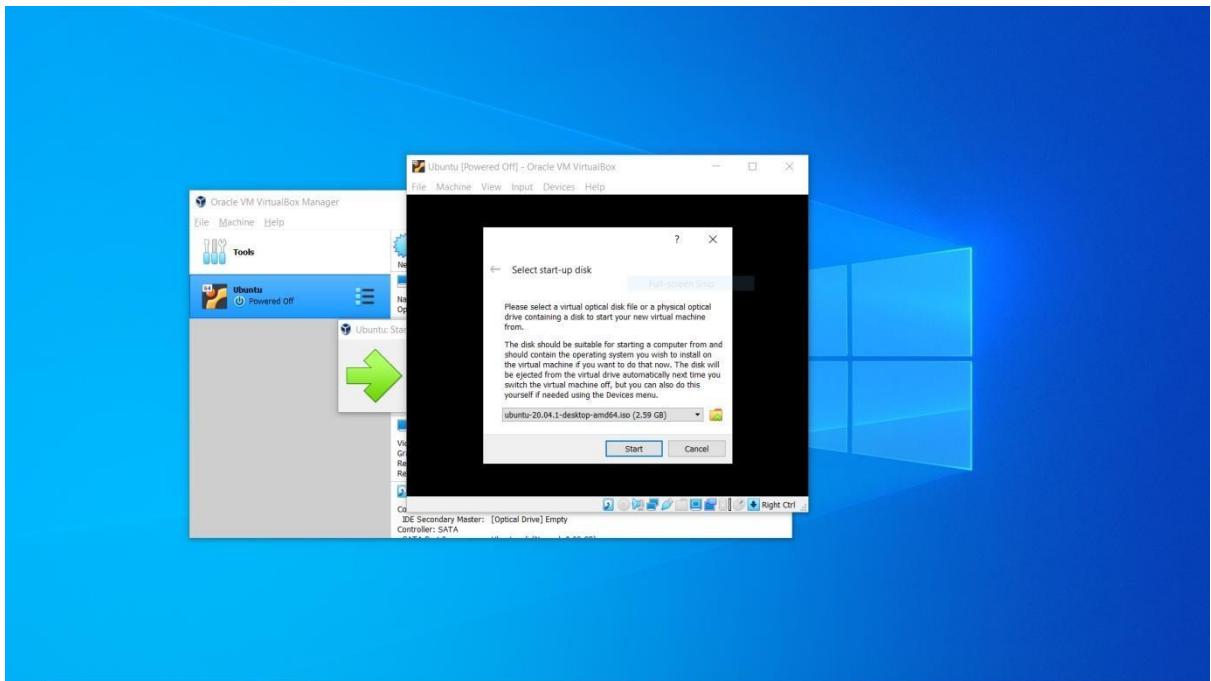
Step 18: Navigate to the folder where the ubuntu file was downloaded and open it.



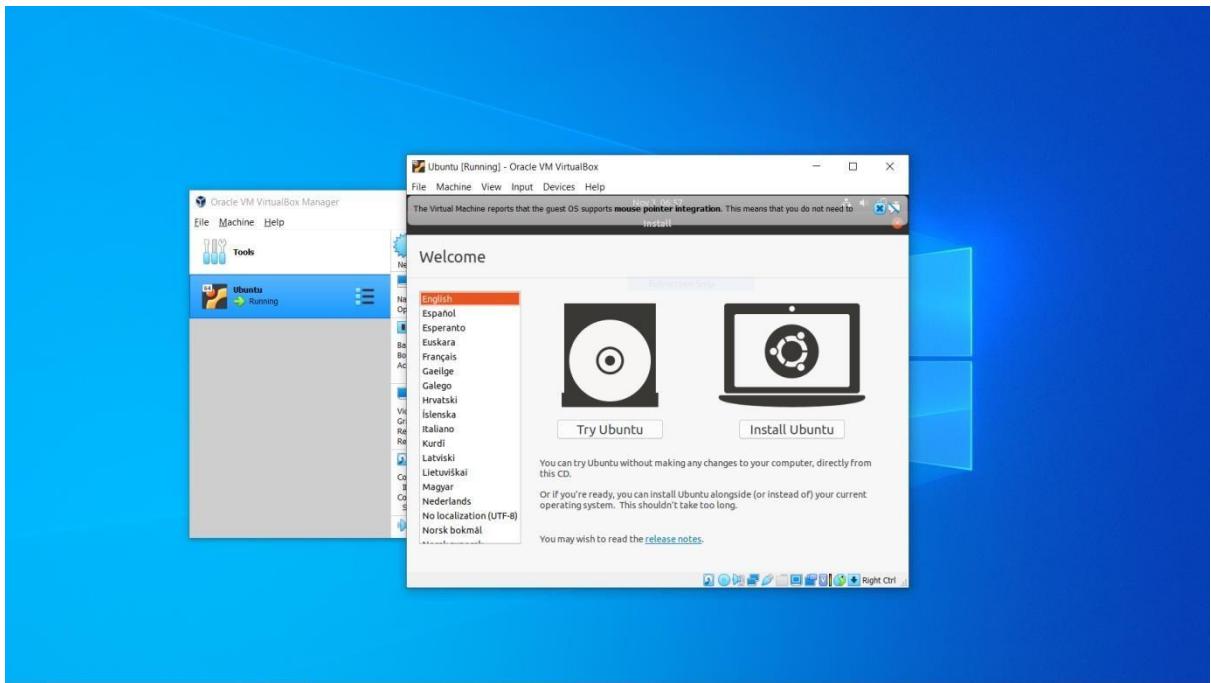
Step 19: Select the ubuntu os and click choose button.



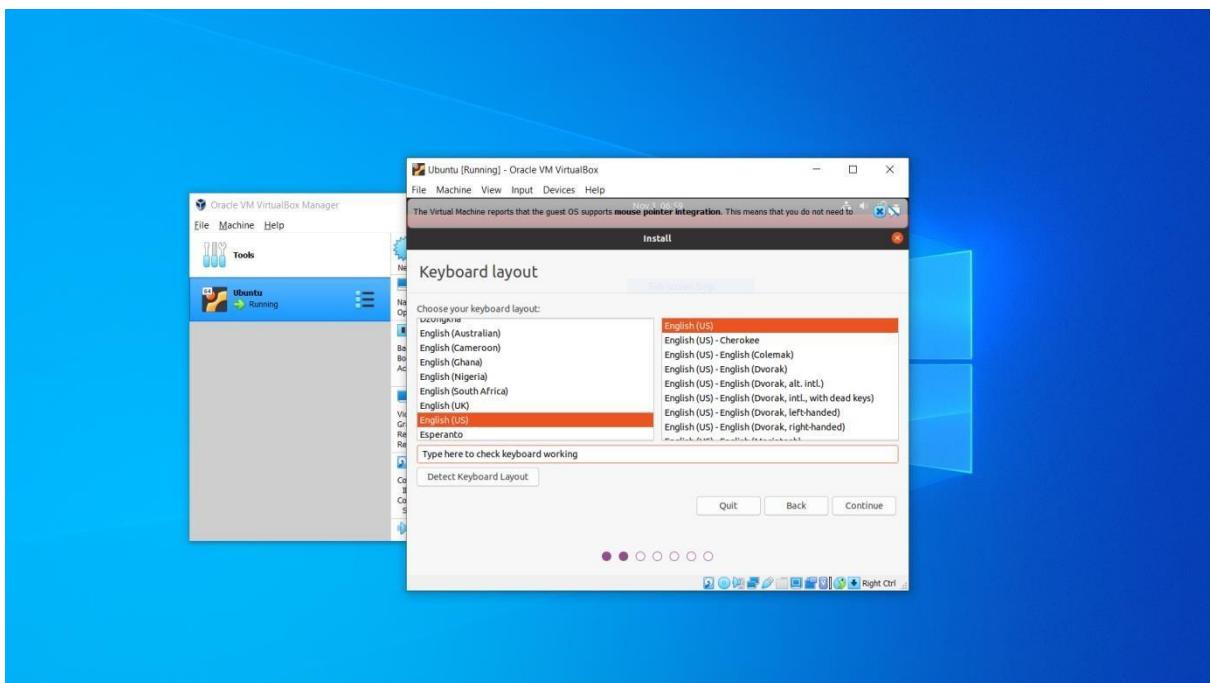
Step 20: Now click the start button to begin the installation process.



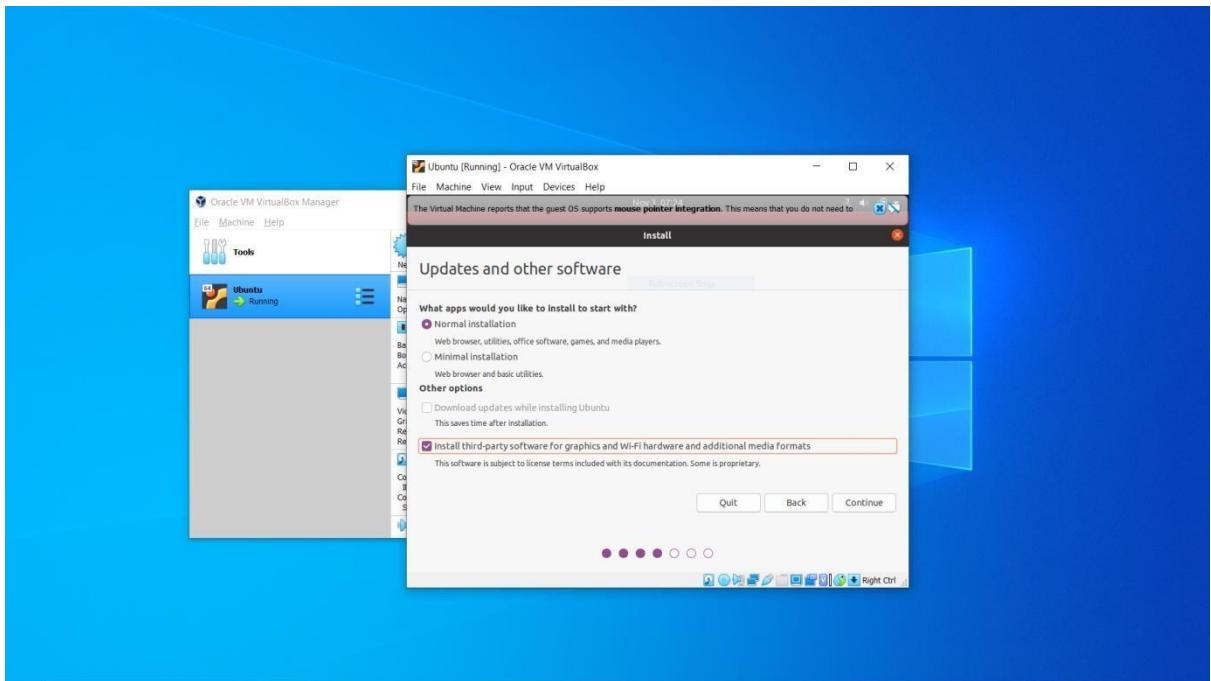
Step 21: Choose language and select Install Ubuntu.



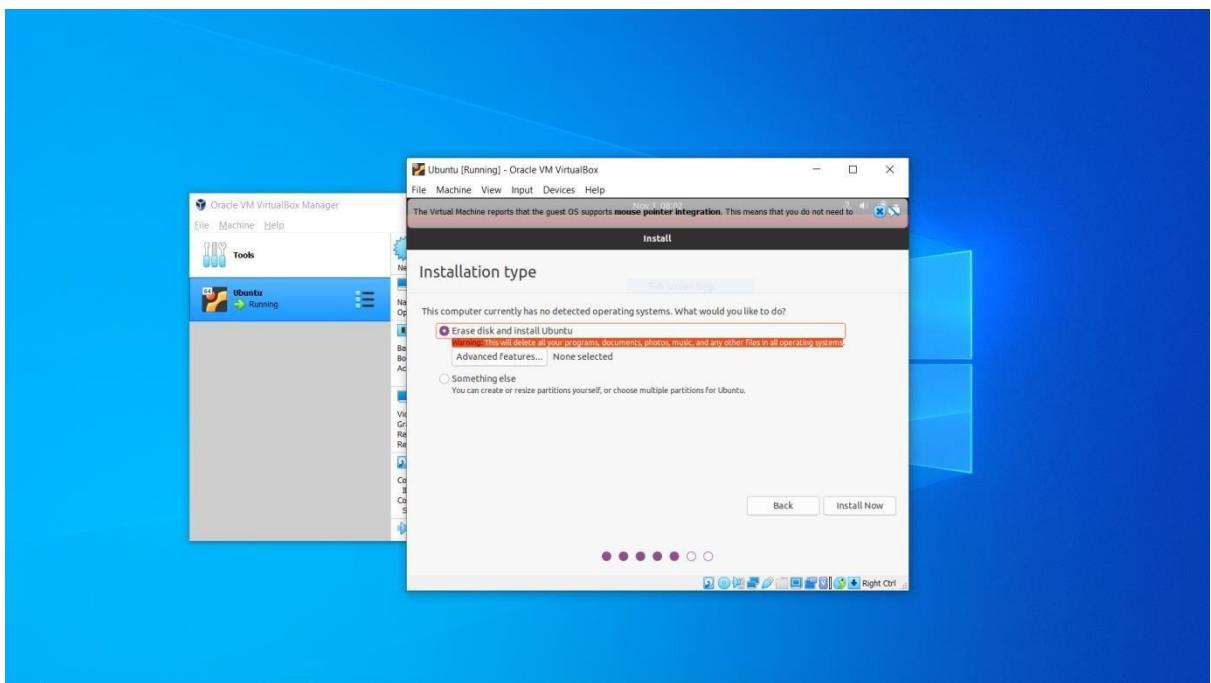
Step 22: Select keyboard layout and language then verify whether it's working or not and click continue.



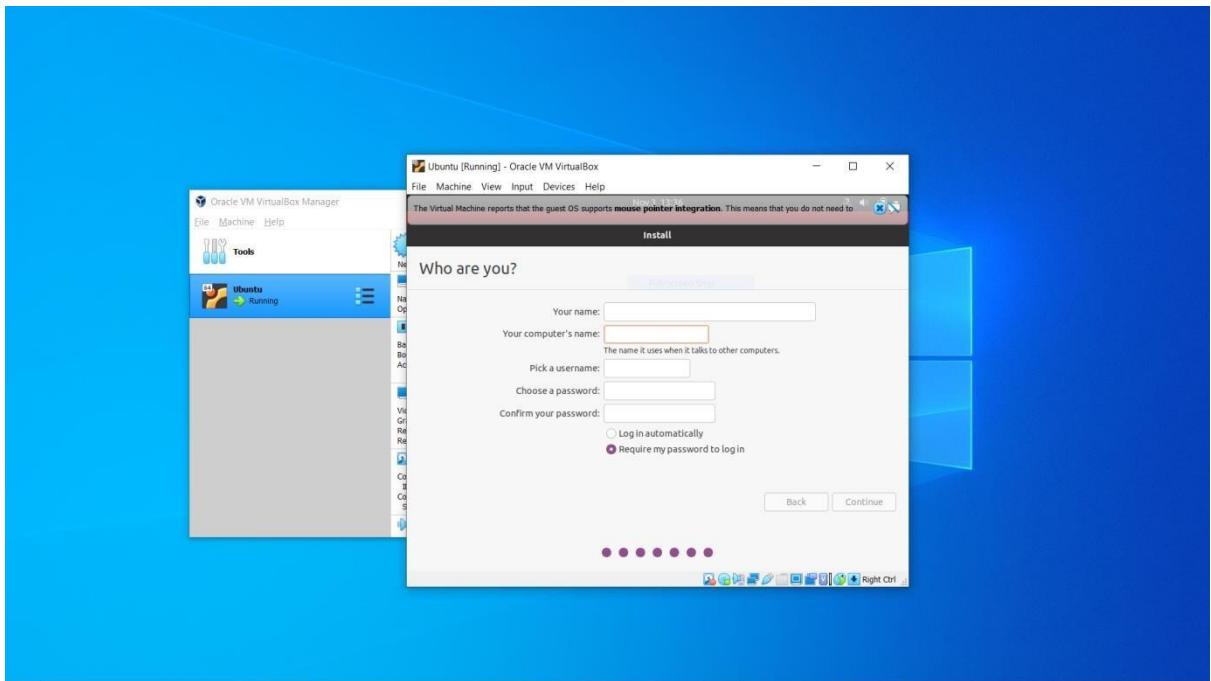
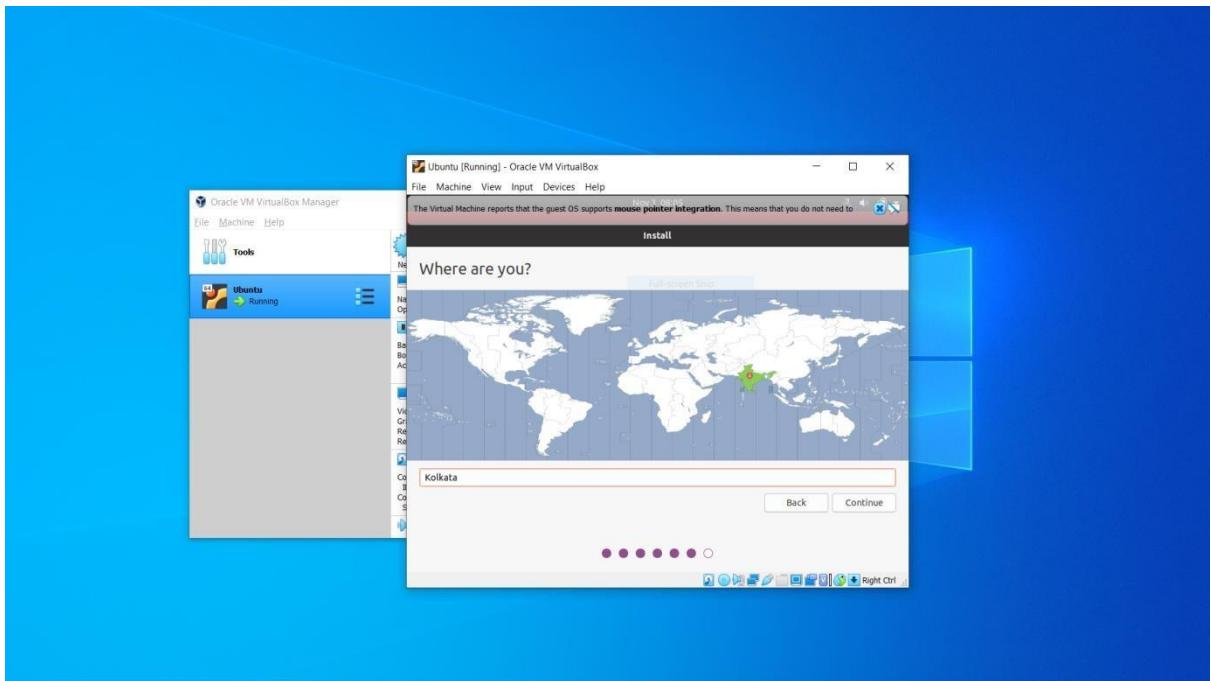
Step 23: Click normal installation and continue.

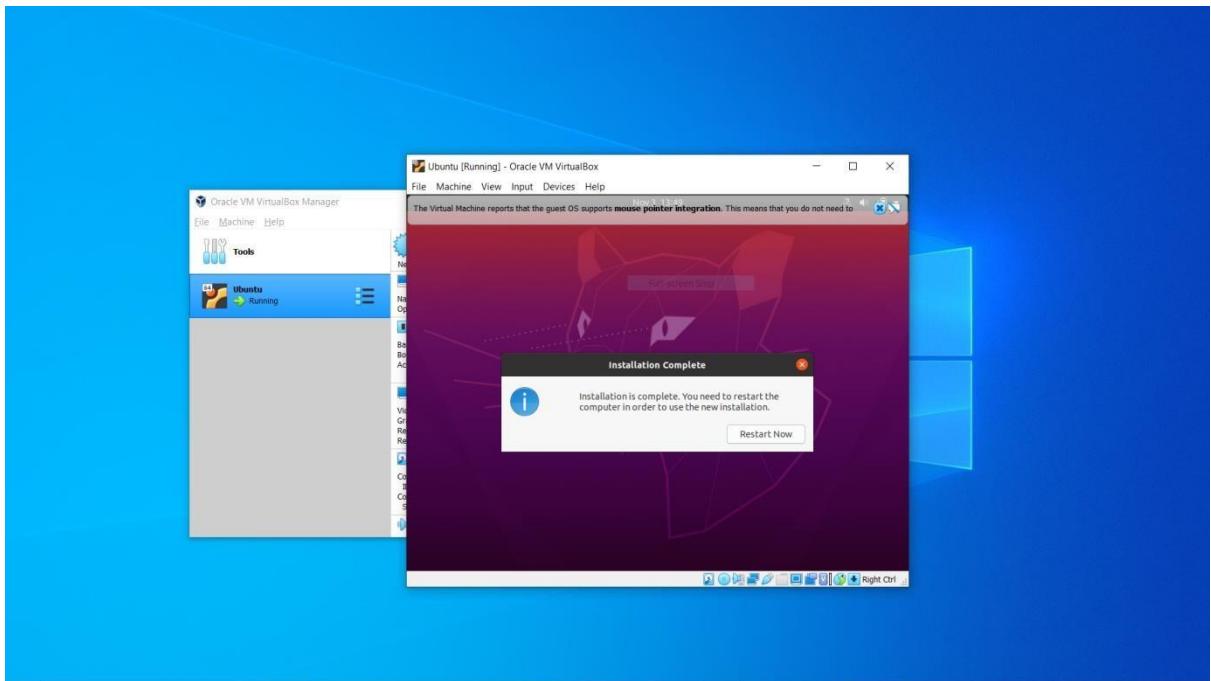
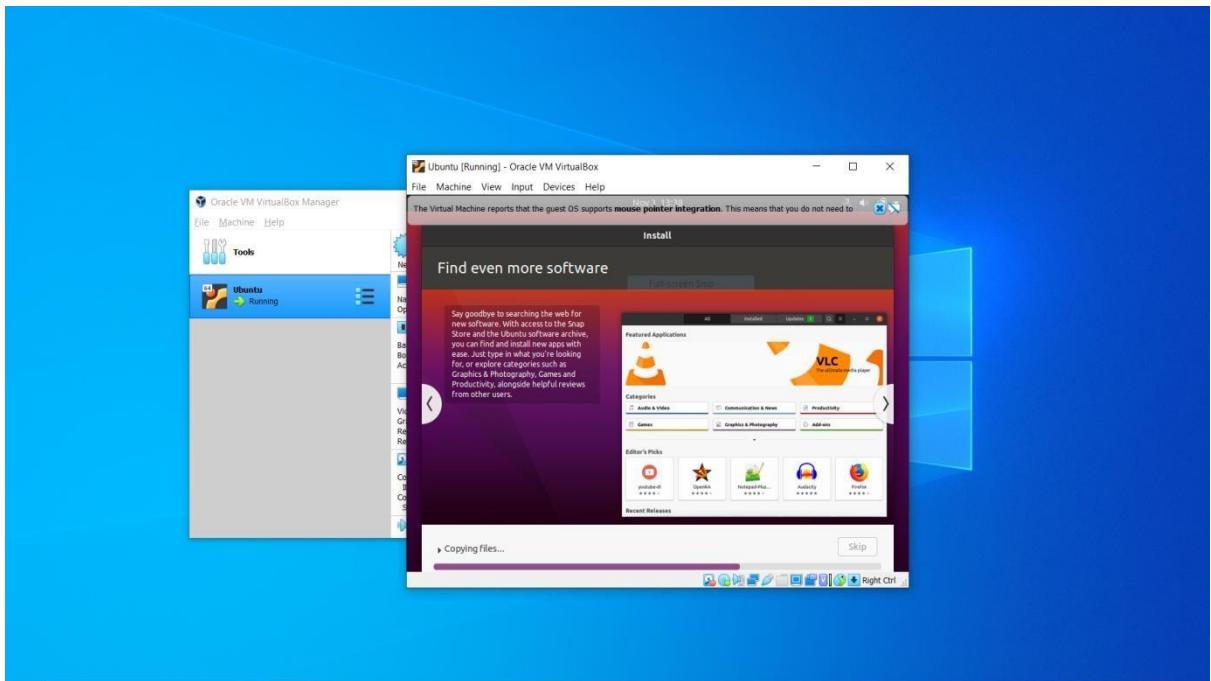


Step 24: Choose “Erase disk and install Ubuntu” and click continue (Don’t worry, it won’t wipe your computer) .



Step 25: Select your region and fill personal details and then continue.





| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Successfully installed the virtual box with different flavours of Linux.

EX:NO: 02

**INSTALL A C COMPILER IN THE VIRTUAL MACHINE
CREATED USING VIRTUAL BOX AND EXECUTE
SIMPLE PROGRAM**

AIM:

Install a C compiler in the virtual machine created using the virtual box and execute a simple program.

PROCEDURE:

Step 1: Open the virtual box and start ubuntu os.

Step 2: Open the terminal.



Step 3: Open any text editor and type any simple code.

```
#include
int binarySearch(int arr[], int l, int r, int x)
{
    while (l <= r) {
        int m = l + (r - l) / 2;
        if (arr[m] == x)
            return m;
        if (arr[m] < x)
            l = m + 1;
        else
            r = m - 1;
    }
    return -1; }

int main()
{
    int arr[] = { 2, 3, 4, 10, 40 };
    int n = sizeof(arr) / sizeof(arr[0]);
    int x = 10;
    int result = binarySearch(arr, 0, n - 1, x);
    (result == -1) ? printf("Element is not present"
                           " in array")
```

```

        : printf("Element is present at "
            "index %d",
            result);

    return 0;
}

```

```

1 #include<stdio.h>
2
3 int binarySearch(int arr[], int l , int r, int x){
4
5     while(l <= r){
6
7         int m = l + (r-l)/2;
8
9         if(arr[m] == x)
10             return m;
11         if(arr[m] < x)
12             l = m + 1;
13         else
14             r = m - 1;
15     }
16
17     return -1;
18 }
19
20 int main (){
21
22     int arr[] = { 2,3,4,10,40};
23     int n = sizeof(arr)/sizeof(arr[0]);
24     int result = binarySearch(arr,0,n-1,x);
25     (result == -1) ? printf("Element is not present in array")
26                      : printf("Element present at index %d",result);
27 }

```

Step 4: Save this anywhere file as “binarySearch.c”.

Step 5: In the terminal confirm that “binarySearch.c” is in the current directory by typing “ls” . If not, type cd DIRECTORY_PATH to go to the directory that has “binarySearch.c”.

Step 6: If you have not installed the C compiler , “type sudo apt install gcc” and execute.

Step 7: After completing installation, type “gcc binarySearch.c” to compile, and type “ls” to confirm that a new executable file “a.out” is created.

Step 8: Type “./a.out” on Terminal to run the program and get the output.

```

balaji@balaji-VirtualBox:~$ ls
Desktop  Downloads  Pictures  Snap  Videos
Documents  Templates
balaji@balaji-VirtualBox:~$ cd Documents
balaji@balaji-VirtualBox:~/Documents$ ls
binarySearch.c
balaji@balaji-VirtualBox:~/Documents$ sudo apt install gcc
[sudo] password for balaji:
Reading package lists... Done
Building dependency tree
Reading state information... Done
gcc is already the newest version (4:9.3.0-1ubuntu2).
The following package was automatically installed and is no longer required:
libfrprint-2-tod1
Use 'sudo apt autoremove' to remove it.
0 upgraded, 0 newly installed, 0 to remove and 3 not upgraded.
balaji@balaji-VirtualBox:~/Documents$ gcc binarySearch.c
binarySearch.c: In function 'binarySearch':
binarySearch.c:13:3: error: 'else' without a previous 'if'
    13 |     |
balaji@balaji-VirtualBox:~/Documents$ gcc binarySearch.c
balaji@balaji-VirtualBox:~/Documents$ ls
binarySearch.c
balaji@balaji-VirtualBox:~/Documents$ ./a.out
Element present at index 3
balaji@balaji-VirtualBox:~/Documents$ 

```

| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Successfully installed a C compiler in the virtual machine created using virtual box.

EX: NO: 03
DATE:

INSTALL GOOGLE APP ENGINE. CREATE A HELLO WORLD APP AND OTHER SIMPLE WEB APPLICATIONS USING PYTHON/JAVA.

AIM:

Install Google App Engine. Create a hello world app and other simple web applications using python/java.

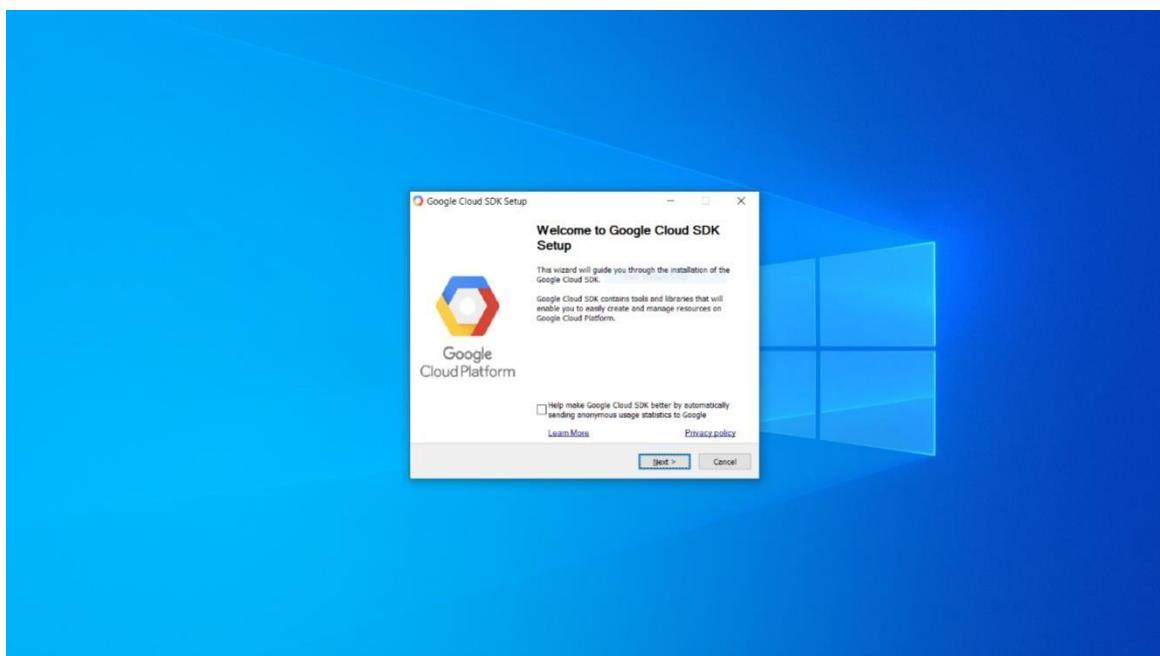
PROCEDURE:

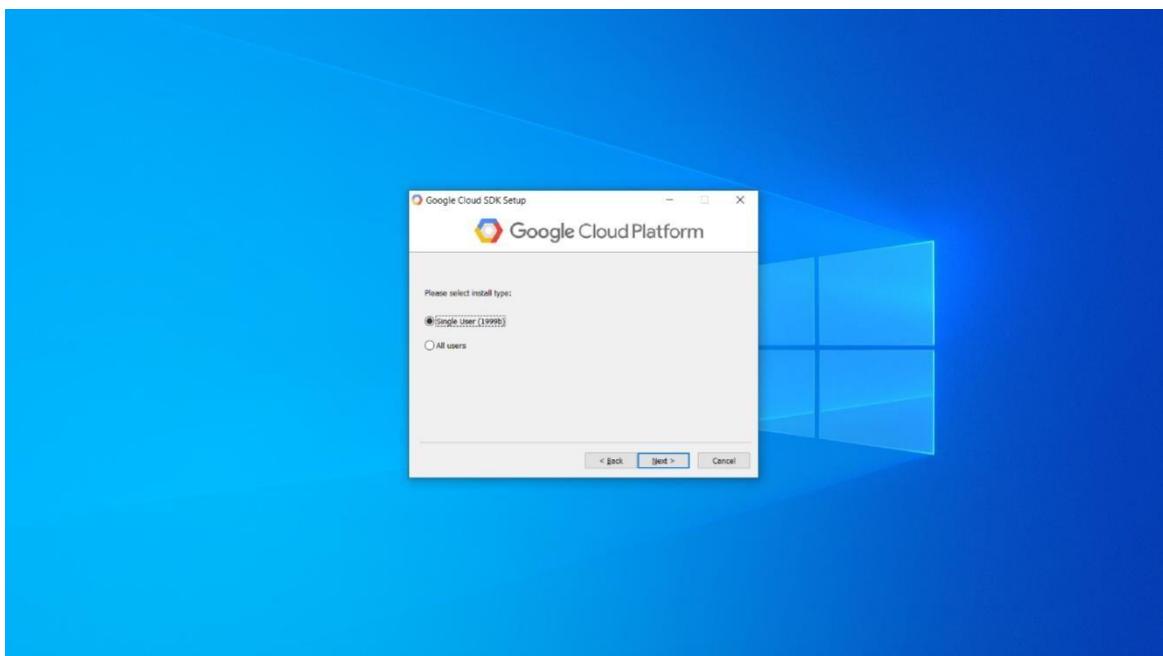
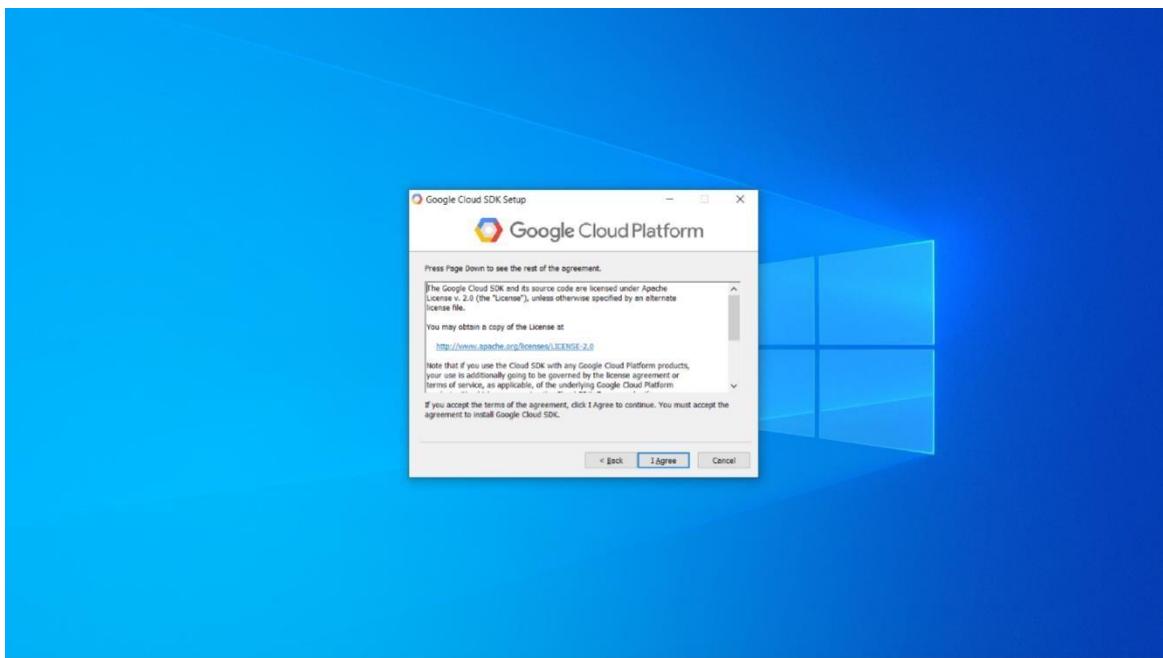
Step 1: Install python <https://www.python.org/downloads/>

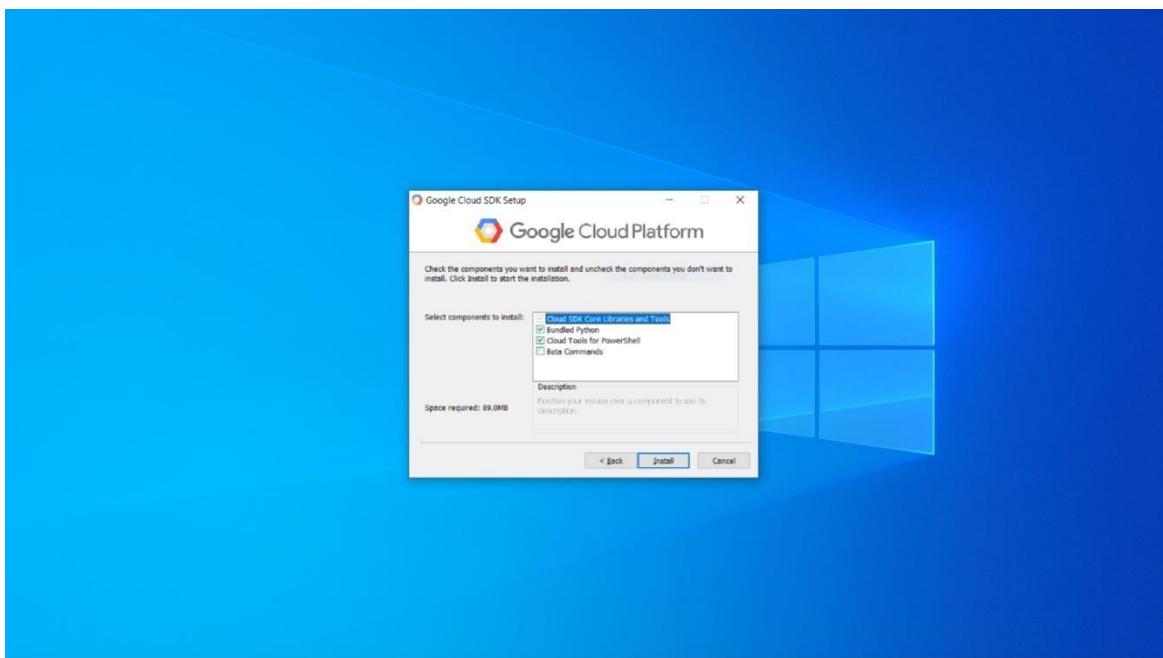
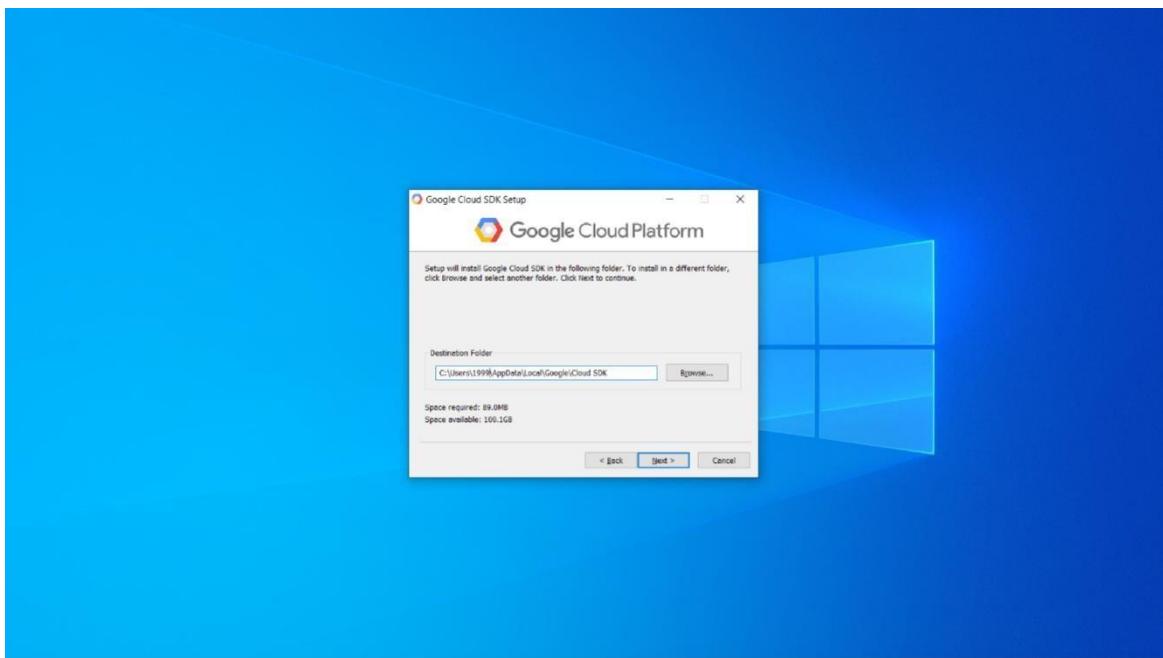
Step 2: download the Google App Engine SDK by going to :

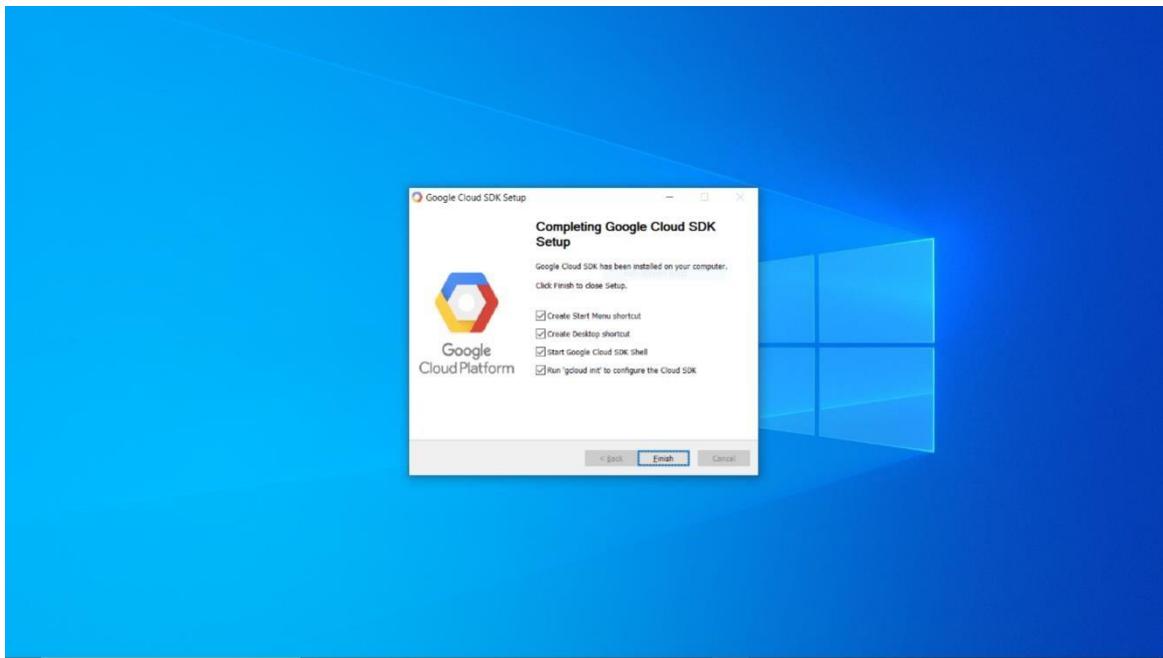
<https://cloud.google.com/appengine/downloads?csw=1> and download the appropriate install package.

Step 3: Complete the google cloud SDK setup.









Step 4: Complete the installation procedure by logging into google account.

Step 5: Open python IDE and create test.py file then type below code.

```
import webapp2

class MainPage(webapp2.RequestHandler):
    def get(self):
        self.response.write("Hello World")

app = webapp2.WSGIApplication([
    ('/', MainPage),
], debug=True)
```

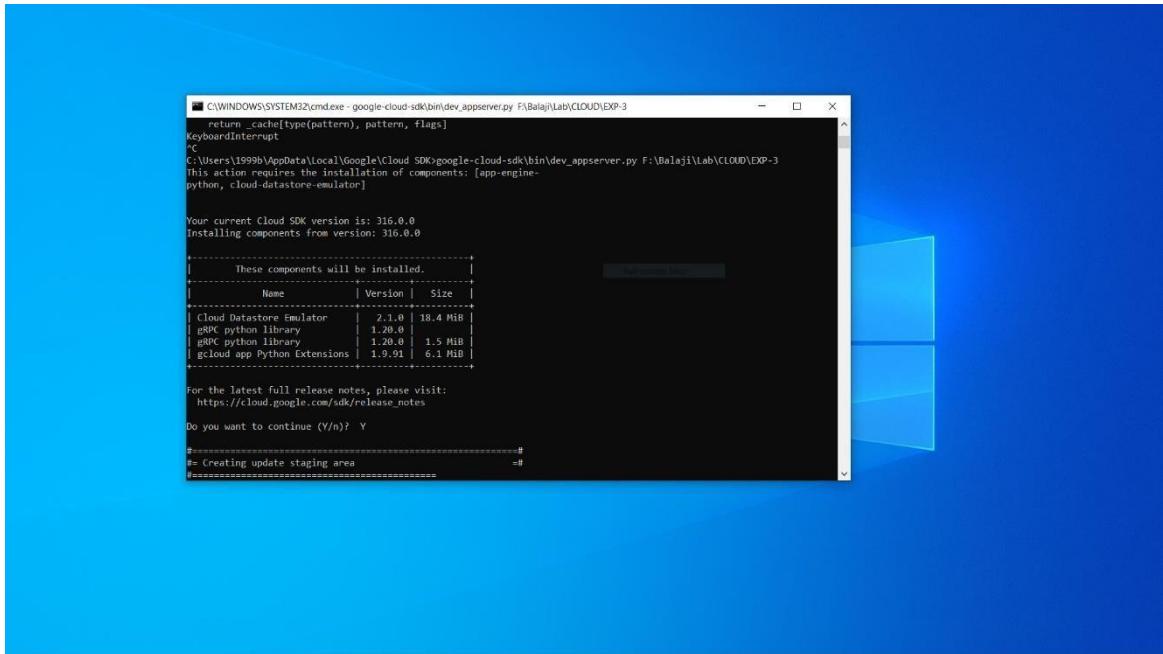
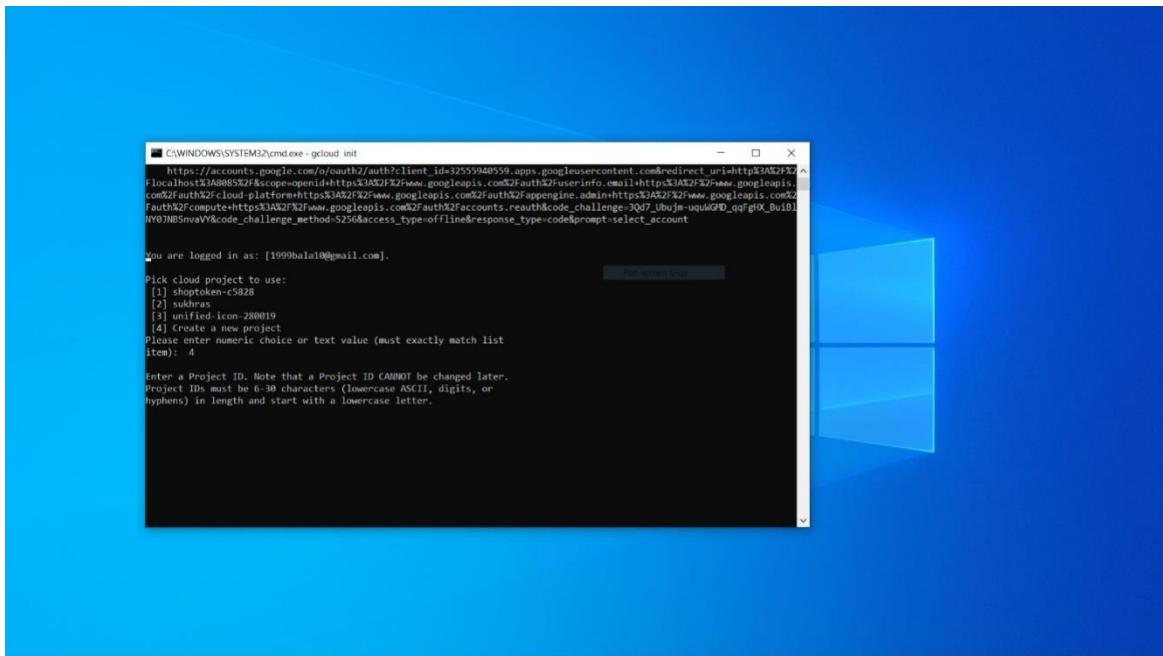
Step 6: Create test.yaml type file using notepad++ , save it near the python file and enter below code.

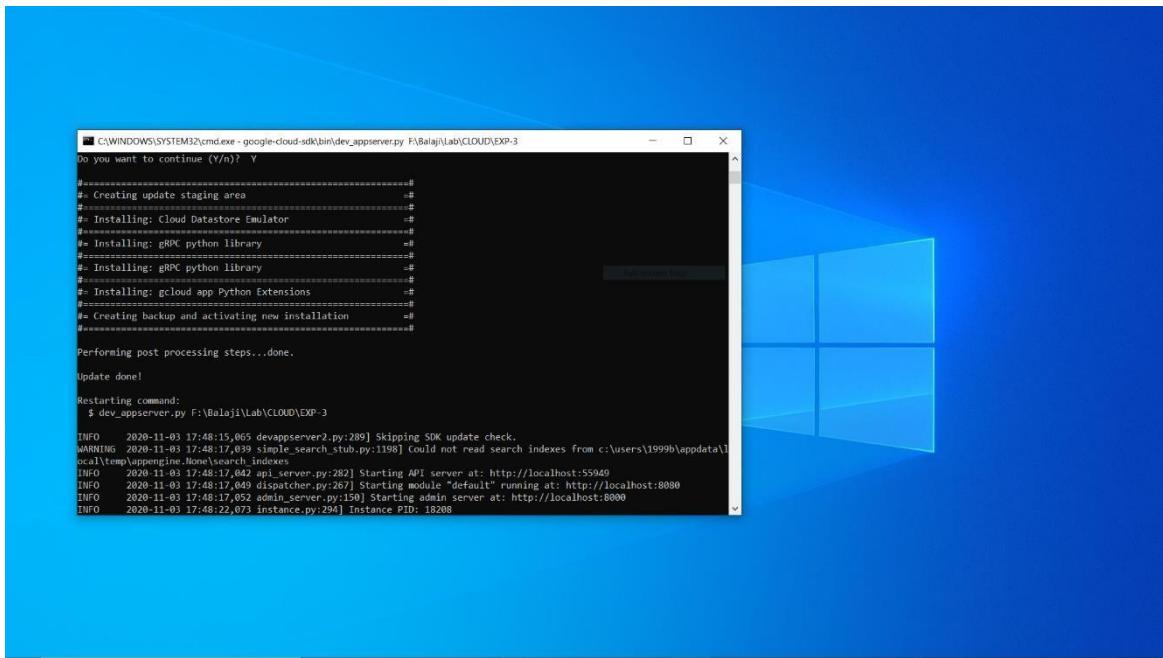
```
runtime: python27
api_version: 1
threadsafe: true
```

```
handlers:
  - url: /
    script: test.app
```

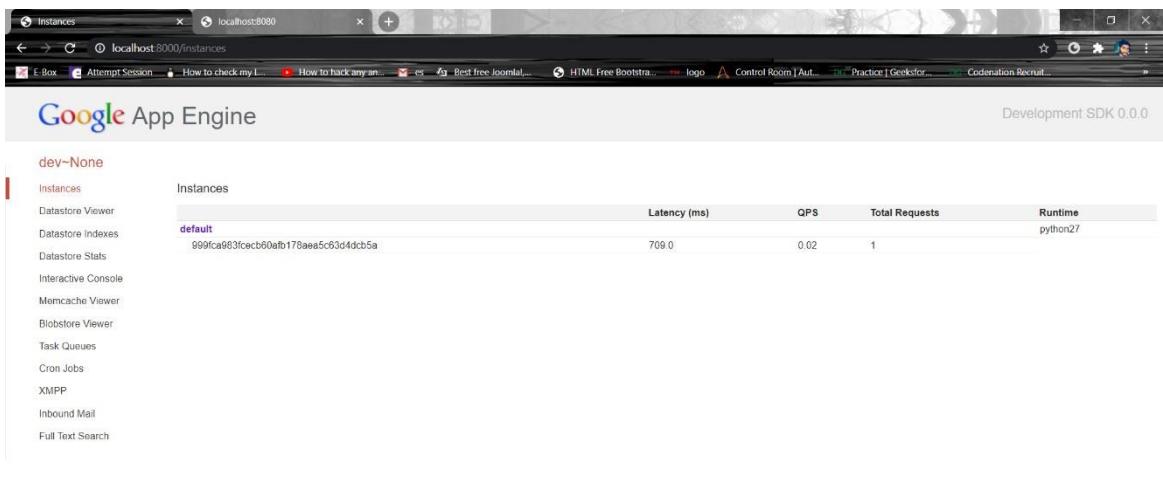
Step 7: Copy the folder directory path and paste it into the command

"google-cloud-sdk\bin\dev_appserver.py FOLDER_DIRECTORY_PATH"
prompt which is in Google Cloud SDK, then press Enter.





Step 8: After installing all files type “localhost:8080” and click default to see the result.





Hello World

| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Successfully installed the google app engine and it is verified.

EX: NO: 04
DATE:

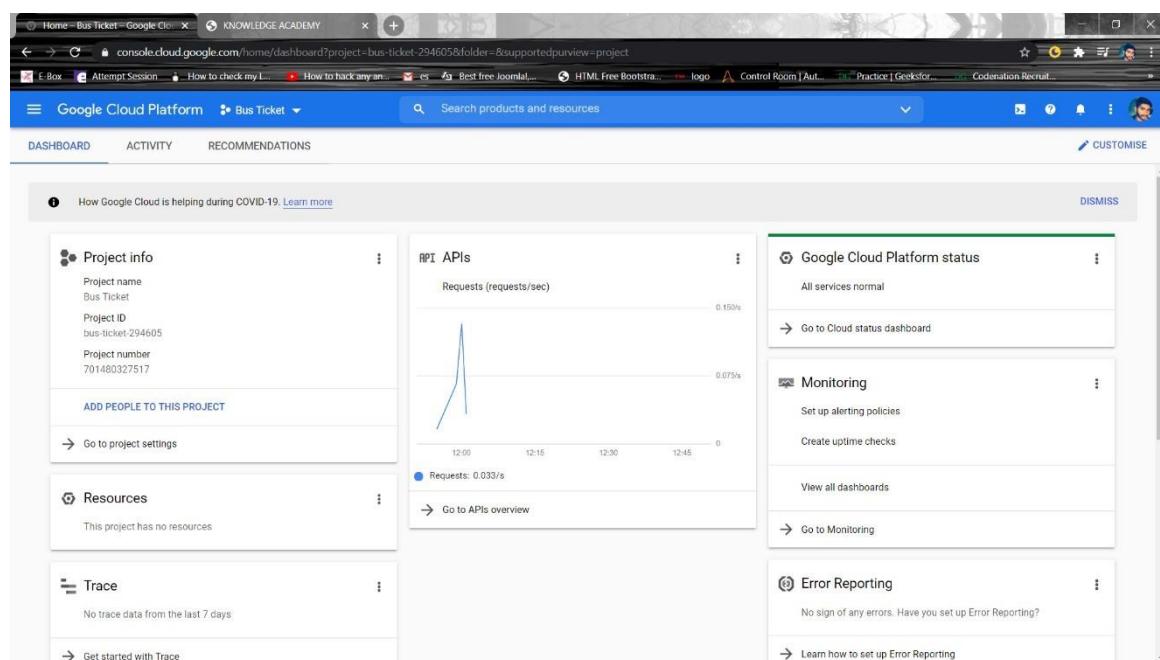
USE GOOGLE APP ENGINE LAUNCHER TO LAUNCH THE WEB APPLICATIONS

AIM:

Use GAE launcher to launch the web applications.

PROCEDURE:

Step 1: Create Google Cloud Platform account <https://console.cloud.google.com/> and create a project.



Step 2: Install python <https://www.python.org/downloads/>.

Step 3: download the Google App Engine SDK by going to :

<https://cloud.google.com/appengine/downloads?cs=1> and download the appropriate install package.

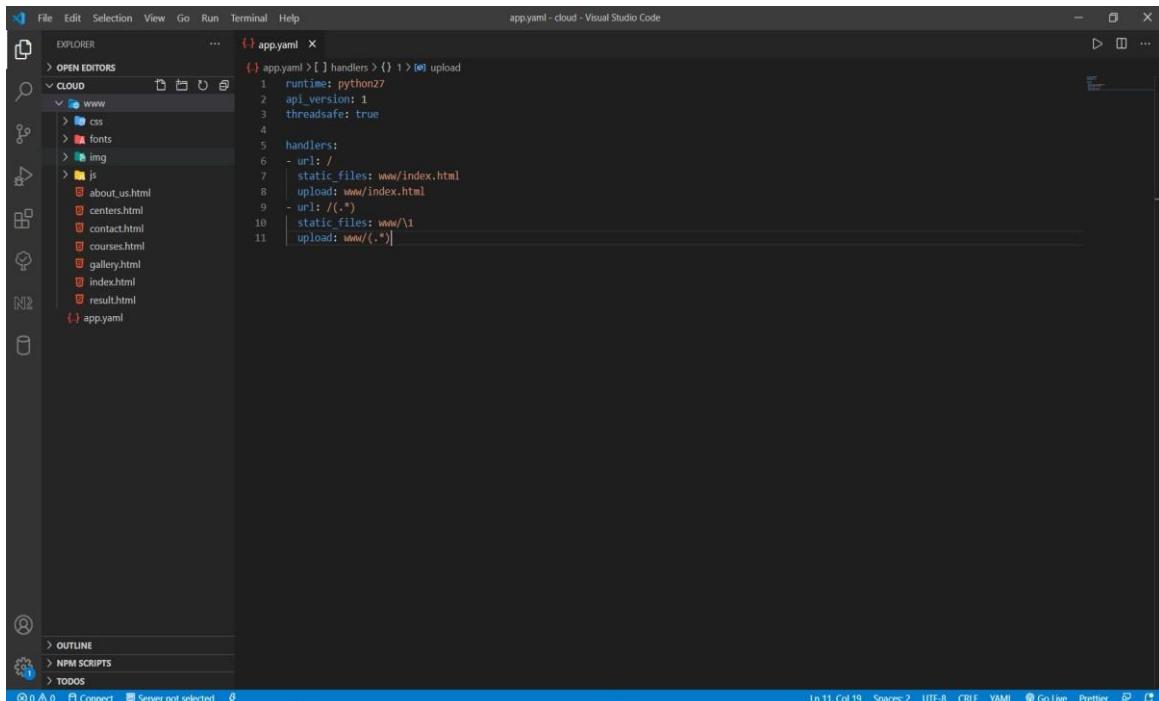
Step 4: Complete the google cloud SDK setup.

Step 5: Create a “app.yaml” configuration file, then create static website within “www” folder.

app.yaml :

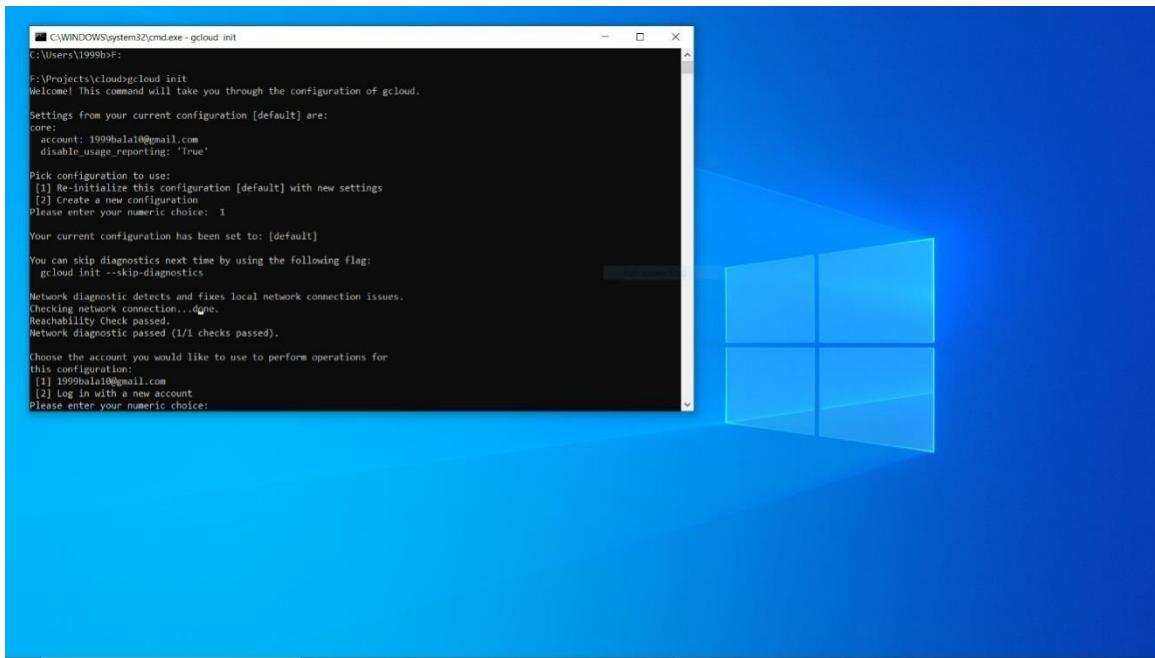
```
runtime: python27
api_version: 1
threadsafe: true

handlers:
- url: /
  static_files: www/index.html
  upload: www/index.html
- url: /(.*)
  static_files: www\1
  upload: www/(.*)
```

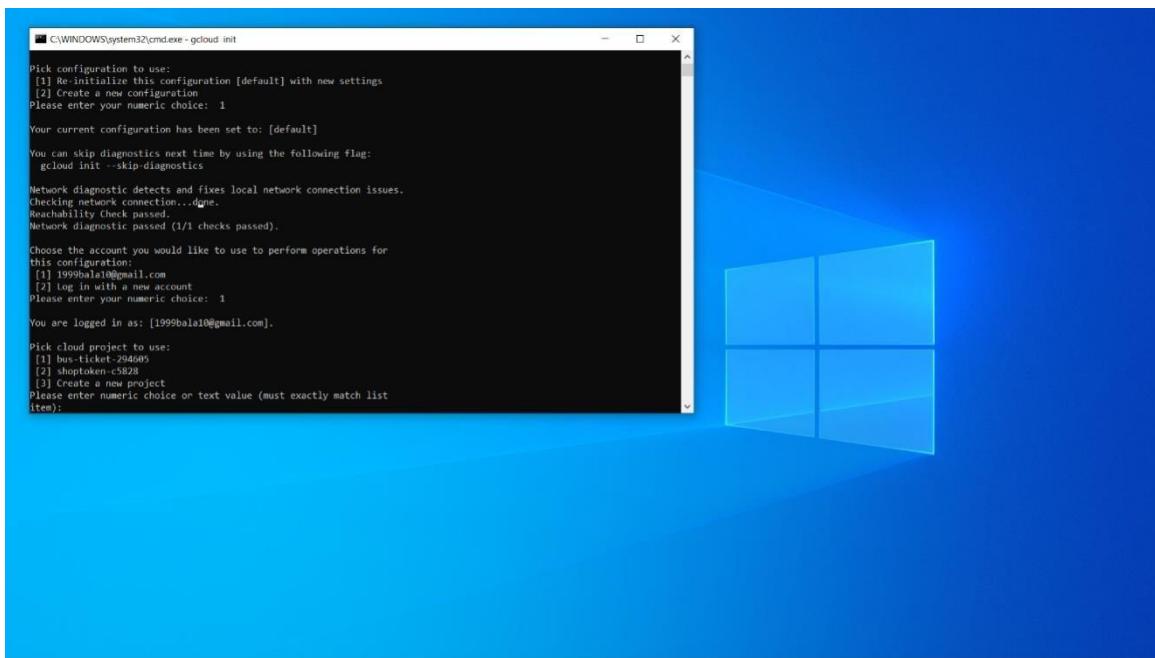


Step 6: Open command prompt and direct the path to the project folder.

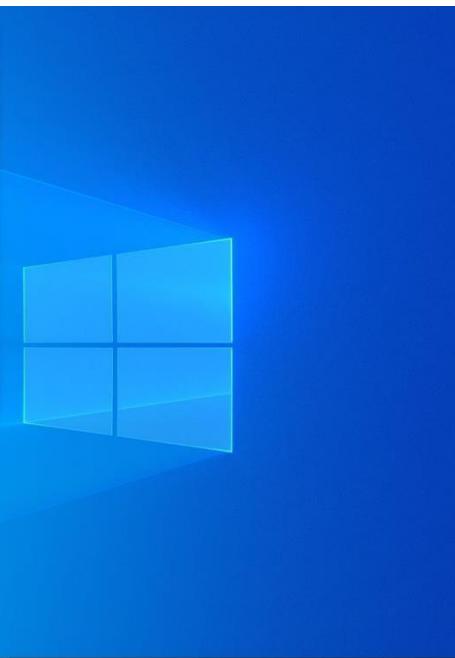
Step 7: Type “gcloud init” and type “1” when it asks for configuration.



Step 8: Type numerical value to choose the account.



Step 9: Type numerical value to choose the cloud project.

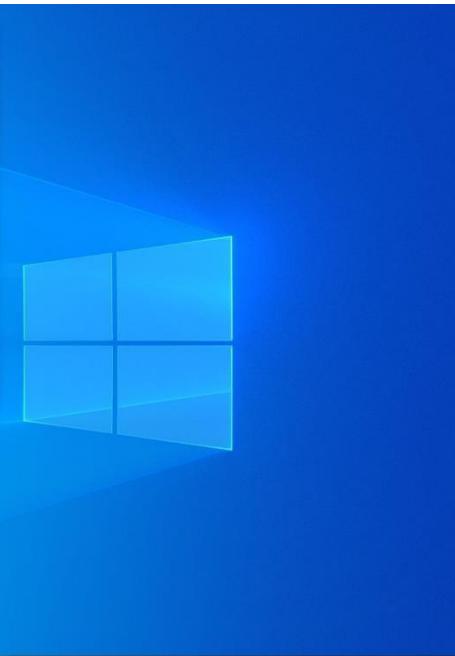


```
C:\WINDOWS\system32\cmd.exe
Pick cloud project to use:
[1] bus-ticket-294605
[2] kryptone-158208
[3] Create a new project
Please enter numeric choice or text value (must exactly match list item): 1
Your current project has been set to: [bus-ticket-294605].
Not setting default zone/region (this feature makes it easier to use [gcloud compute] by setting an appropriate default value for the --zone and --region flag).
See https://cloud.google.com/compute/docs/gcloud-compute section on how to set default compute region and zone manually. If you would like [gcloud init] to be able to do this for you the next time you run it, make sure the Compute Engine API is enabled for your project on the https://console.developers.google.com/apis page.

Created a default boto configuration file at [C:\Users\bala10@gmail.com by default
* Commands that require authentication will use 1999balal0@gmail.com by default
* Commands will reference project 'bus-ticket-294605' by default
Run 'gcloud help config' to learn how to change individual settings

This gcloud configuration is called [default]. You can create additional configurations if you work with multiple accounts and/or projects.
```

Step 10: gcloud app deploy



```
C:\WINDOWS\system32\cmd.exe - gcloud app deploy
--zone and --region flag).
See https://cloud.google.com/compute/docs/gcloud-compute section on how to set default compute region and zone manually. If you would like [gcloud init] to be able to do this for you the next time you run it, make sure the Compute Engine API is enabled for your project on the https://console.developers.google.com/apis page.

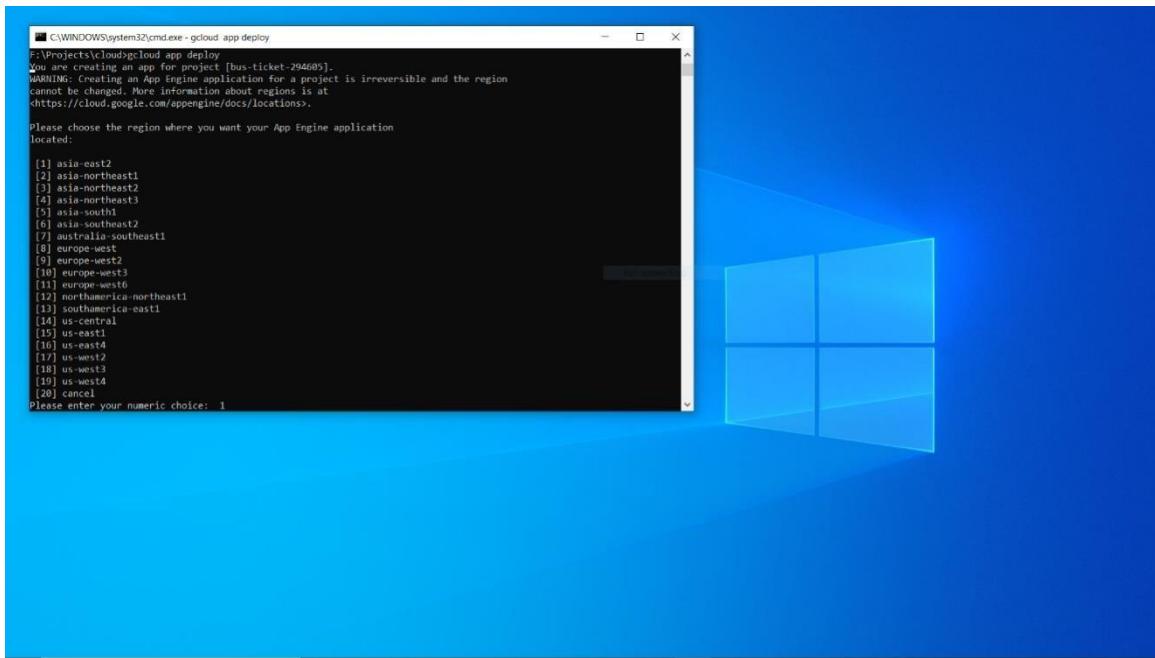
Created a default boto configuration file at [C:\Users\bala10@gmail.com by default
* Commands that require authentication will use 1999balal0@gmail.com by default
* Commands will reference project 'bus-ticket-294605' by default
Run 'gcloud help config' to learn how to change individual settings

This gcloud configuration is called [default]. You can create additional configurations if you work with multiple accounts and/or projects.
Run 'gcloud topic configurations' to learn more.

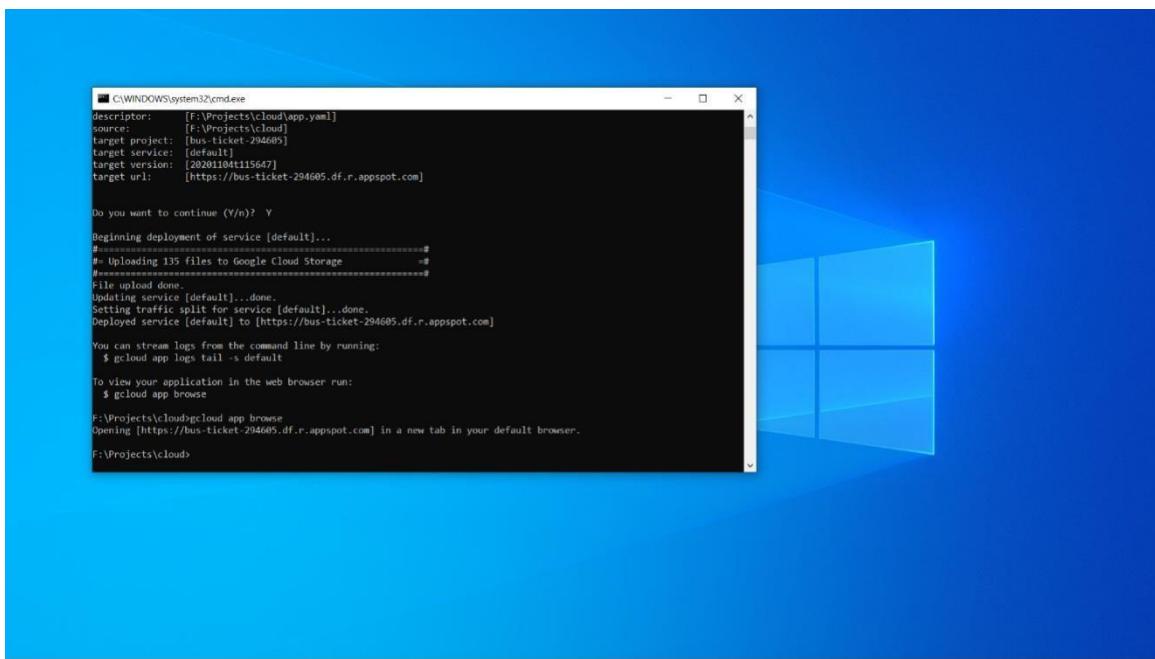
Some things to try next:
* Run 'gcloud --help' to see the Cloud Platform services you can interact with. And run 'gcloud help COMMAND' to get help on any gcloud command.
* Run 'gcloud topic --help' to learn about advanced features of the SDK like arg files and output formatting

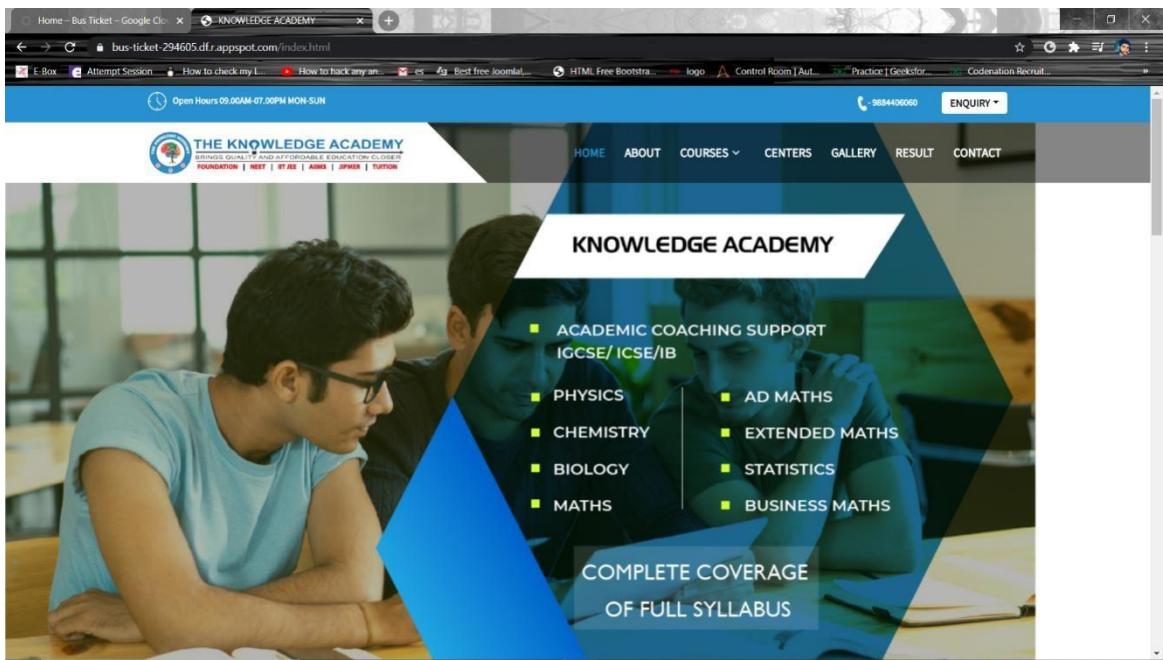
F:\Projects\cloud>gcloud app deploy
```

Step 11: Choose the appropriate region by entering numerical value and type “Y” when it asks for deployment.



Step 12 : After completion of deployment type “gcloud app browse” to open the website.





| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Successfully launched the web applications using google app engine launcher.

EX:NO:05

**SIMULATE A CLOUD SCENARIO USING CLOUDSIM AND
RUN A SCHEDULING ALGORITHM THAT IS NOT PRESENT
IN CLOUDSIM**

AIM:

Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.

PROCEDURE:

Step 1: Download CloudSim zip file

<https://github.com/Cloudslab/cloudsim/releases/tag/cloudsim-3.0.3>

Step 2: Download [commons-math3-3.6.1-bin.zip](http://commons.apache.org/proper/commons-math/download_math.cgi) from

http://commons.apache.org/proper/commons-math/download_math.cgi

Step 3: Extract both zip files.

Step 4: Create java project in Eclipse IDE for Enterprise Java Developer
by navigating “**File -> New project -> Java Project**”.

Step 5: Type project name and uncheck the default location.

Step 6: Locate the path where cloudsim unzipped the folder available and click next.

Step 7: In libraries tab click “**Add External JARs**” and add

“**Commons-math3-3.6.1.jar**” file present inside the commons-math3-3.6.1
unzipped folder then click the finish button.

Step 8: Open “**examples -> org.cloudbus.cloudsim.examples ->
CloudSimExample1.java**”.

Step 9: Right click the file and click “**Run as -> 1 Java Application**”.

Step 10: It starts to execute the program.

OUTPUT:

The screenshot shows the Eclipse IDE interface with the following details:

- Project Explorer:** Displays the CloudSimProject structure, including IRE System Library (jre1.8.0_271), examples (CloudSimExample1.java, CloudSimExample2.java, CloudSimExample3.java, CloudSimExample4.java, CloudSimExample5.java, CloudSimExample6.java, CloudSimExample7.java, CloudSimExample8.java), org.cloudbus.cloudsim.examples.network, org.cloudbus.cloudsim.examples.power, org.cloudbus.cloudsim.examples.power.planetlab, org.cloudbus.cloudsim.examples.power.random, workload.planetlab, sources, Referenced Libraries, docs, jars, build.xml, changeLog.txt, examples.txt, license.txt, pom.xml, README.txt, and release_notes.txt.
- Code Editor:** Shows CloudSimExample1.java with code related to CloudSim initialization and Datacenter creation.
- Console:** Displays the execution log of CloudSimExample1, including initialization messages, broker activity, and simulation completion.
- Output:** Shows the final simulation results, including a table of Cloudlet statistics and a message indicating the simulation is finished.

```
boolean trace_flag = false; // mean trace events
// Initialize the CloudSim library
CloudSim.init(num_user, calendar, trace_flag);
// Second step: Create Datacenters
// Datacenters are the resource providers in CloudSim. We need at
// least one of them to run a CloudSim simulation
Datacenter datacenter0 = createDatacenter("Datacenter_0");

```

```
Starting CloudSim version 3.0
Initialising...
Datacenter_0 is starting...
Broker is starting...
Entities started.
0.0: Broker: Cloud Resource List received with 1 resource(s)
0.0: Broker: Trying to Create VM #0 in Datacenter_0
0.1: Broker: VM #0 has been created in Datacenter #2, Host #0
0.1: Broker: Sending cloudlet 0 to VM #0
400.1: Broker: Cloudlet 0 received
400.1: Broker: All tasks executed. Finishing...
400.1: Broker: Destroying VM #0
Broker is shutting down...
Simulation: No more future events
CloudInformationService: Notify all CloudSim entities for shutting down.
Datacenter_0 is shutting down...
Broker is shutting down...
Simulation completed.
Simulation completed.

***** OUTPUT *****
Cloudlet ID STATUS Data center ID VM ID Time Start Time Finish Time
0 SUCCESS 2 0 400 0.1 400.1
CloudSimExample1 finished!
```

| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Successfully stimulated a cloud scenario using cloudsim and verified the scheduling algorithm that not present in cloudsim.

EX:NO: 06
DATE:

**FIND A PROCEDURE TO TRANSFER THE FILES FROM ONE
VIRTUAL MACHINE TO ANOTHER VIRTUAL MACHINE**

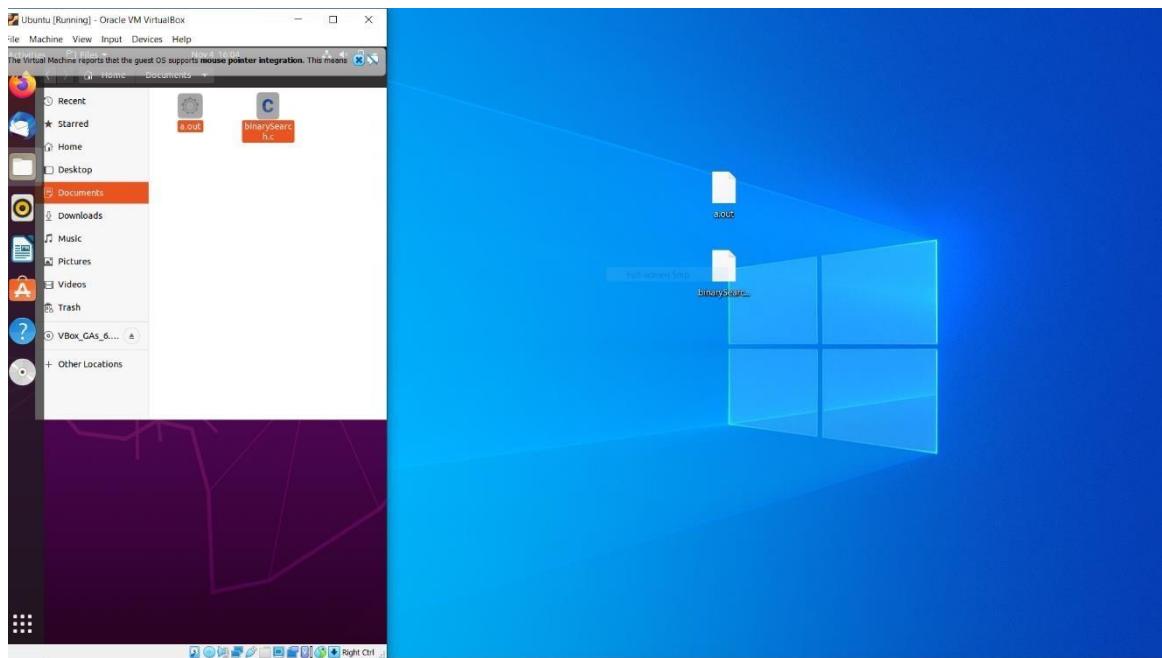
AIM:

Find a procedure to transfer the files from one virtual machine to another virtual machine.

PROCEDURE:

- Step 1: Open Virtualbox and start the virtual machine.
- Step 2: Click “**Device**” in the menu bar.
- Step 3: Click “**Drag and Drop**” inside the dropdown.
- Step 4: Choose “**Bidirectional**” in the sub menu.
- Step 5: Click “**Device -> Insert Guest Additional CD image**” in the menu bar.
- Step 6: Install the required file shows.
- Step 7: Now Drag and drop any file from one virtual machine to another.

Output:



| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Designed a procedure to transfer files from one virtual machine to another and it is verified.

EX NO:07
DATE:

**FIND A PROCEDURE TO LAUNCH VIRTUAL MACHINE USING
TRYSTACK (ONLINE OPENSTACK DEMO VERSION)**

AIM:

Find a procedure to launch virtual machine using try stack (Online Open stack Demo Version)

PROCEDURE:

Step 1: Create Network

1. Go to **Network > Networks** and then click **Create Network**.
2. In **Network** tab, fill **Network Name** for example **internal** and then click **Next**.
3. In **Subnet** tab,
 1. Fill **Network Address** with appropriate CIDR, for example **192.168.1.0/24**. Use a private **network CIDR block** as the best practice.
 2. Select **IP Version** with appropriate IP version, in this case **IPv4**.
 3. Click **Next**.
4. In **Subnet Details** tab, fill **DNS Name Servers** with **8.8.8.8 (Google DNS)** and then click **Create**.

Step 2: Create Instance

1. Go to **Compute > Instances** and then click **Launch Instance**.
2. In **Details** tab,
 1. Fill **Instance Name**, for example **Ubuntu 1**.
 2. Select **Flavor**, for example **m1.medium**.
 3. Fill **Instance Count** with **1**.
 4. Select **Instance Boot Source** with **Boot from Image**.
 5. Select **Image Name** with **Ubuntu 14.04 amd64 (243.7 MB)** if you want to install Ubuntu 14.04 in your virtual machine.
3. In **Access & Security** tab,
 1. Click **[+]** button of the **Key Pair** to import the key pair. This key pair is a public and private key that we will use it to connect to the instance from our machine.
 2. In **Import Key Pair** dialog,
 1. Fill **Key Pair Name** with your machine name (for example **Edward-Key**).
 2. Fill **Public Key** with your **SSH public key** (usually is in **~/.ssh/id_rsa.pub**). See description in Import Key Pair dialog box for more information. If

you are using Windows, you can use **Puttygen** to generate key pairs.

3. Click the **Import key pair**.
3. In **Security Groups**, mark/check **default**.
4. In **Networking** tab,
 1. In **Selected Networks**, select networks that have been created in Step 1, for example **internal**.
5. Click **Launch**.
6. If you want to create multiple instances, you can repeat step 1-5. I created one more instance with instance name **Ubuntu 2**.

Step 3: Create Router

1. Go to **Network > Routers** and then click **Create Router**.
2. Fill **Router Name** for example **router1** and then click **Create router**.
3. Click on your **router name link**, for example **router1**, **Router Details** page.
4. Click **Set Gateway** button in upper right:
 1. Select **External networks** with **external**.
 2. Then **OK**.
5. Click the **Add Interface** button.
 1. Select **Subnet** with the network that you have been created in Step 1.
 2. Click **Add interface**.
6. Go to **Network > Network Topology**. You will see the network topology. In the example, there are two networks, i.e. external and internal, that are bridged by a router. There are instances that are joined to the internal network.

Step 4: Configure Floating IP Address

1. Go to **Compute > Instance**.
2. In one of your instances, click **More > Associate Floating IP**.
3. In **IP Address**, click Plus [+].
4. Select **Pool to external** and then click **Allocate IP**.
5. Click **Associate**.
6. Now you will get a public IP, e.g. 8.21.28.120, for your instance.

Step 5: Configure Access & Security

1. Go to **Compute > Access & Security** and then open the **Security Groups** tab.
2. In the **default** row, click **Manage Rules**.
3. Click **Add Rule**, choose **ALL ICMP** rules to enable ping into your instance, and then click **Add**.
4. Click **Add Rule**, choose **HTTP** rule to open HTTP port (port 80), and then

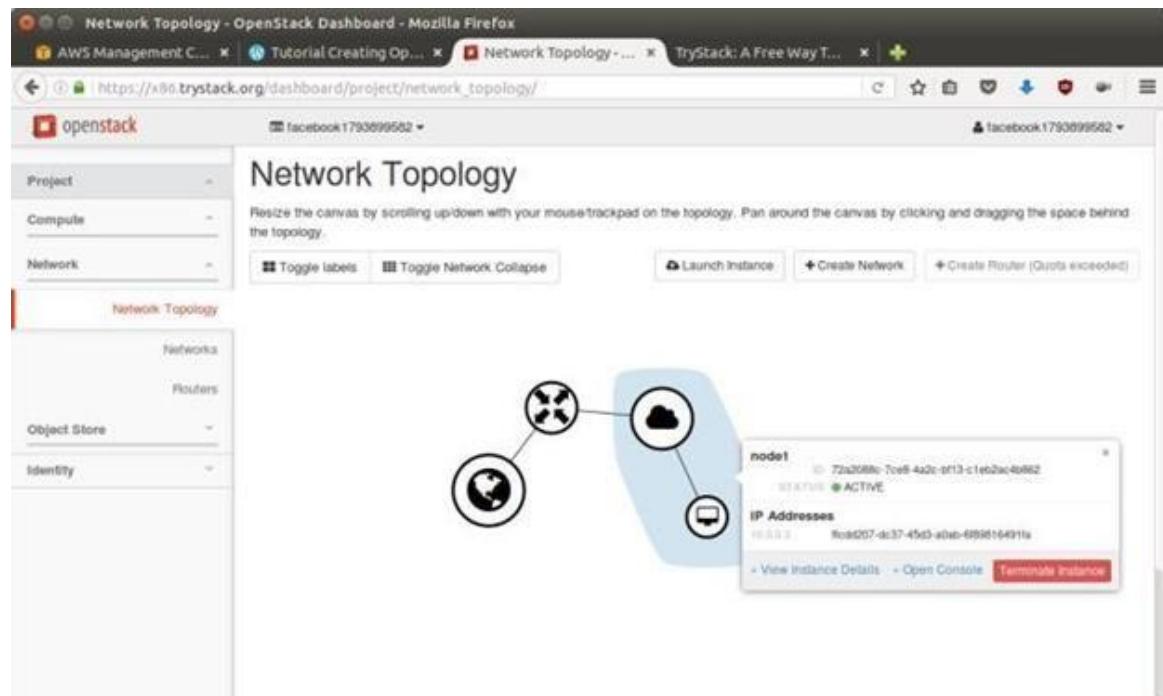
click **Add**.

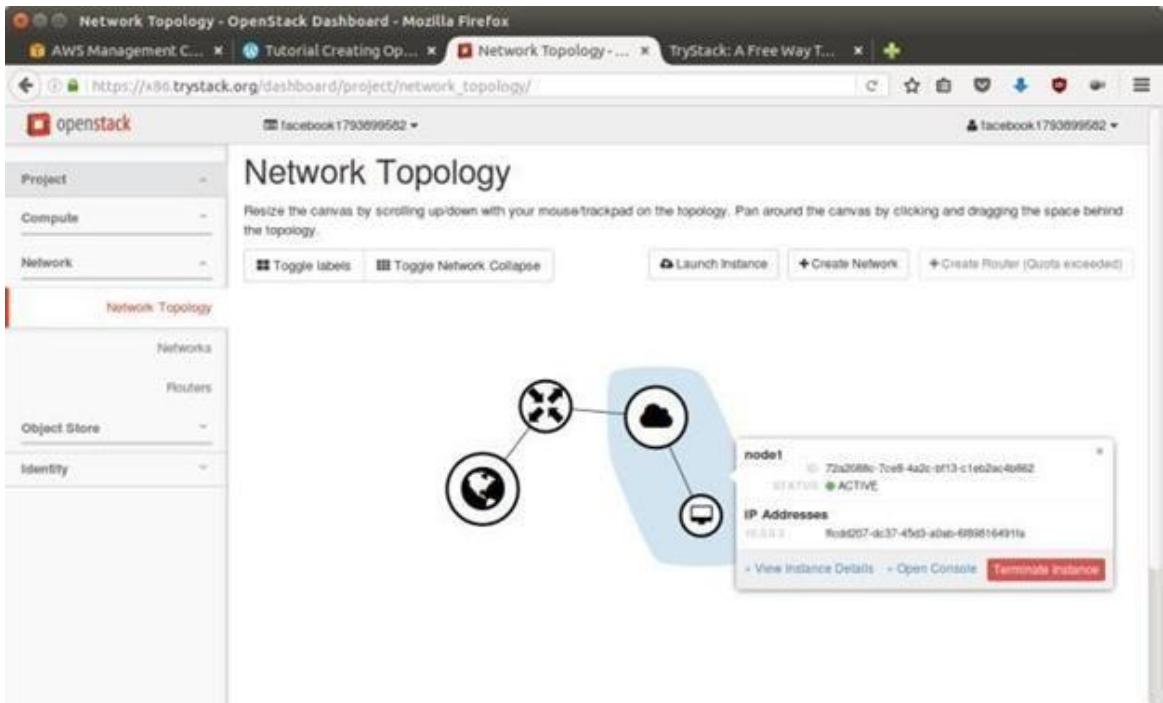
5. Click **Add Rule**, choose **SSH** rule to open SSH port (port 22), and then click **Add**.
6. You can open other ports by creating new rules.

Step 6: SSH to Your Instance

1. Now, you can SSH your instances to the floating IP address that you got in the step 4. If you are using Ubuntu image, the SSH user will be **ubuntu**.

OUTPUT:





| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Successfully launched the virtual machine using try stack and it is verified.

EX NO:8 STUDY AND IMPLEMENTATION OF INFRASTRUCTURE AS A SERVICE

AIM:

To write a case study and implementation about infrastructure as a Service.

THEORY:

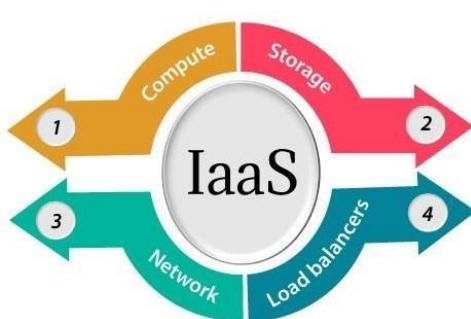
IaaS is also known as Hardware as a Service (HaaS). It is one of the layers of the cloud computing platform. It allows customers to outsource their IT infrastructures such as servers, networking, processing, storage, virtual machines, and other resources. Customers access these resources on the Internet using a pay-as-per-use model.

In traditional hosting services, IT infrastructure was rented out for a specific period of time, with pre-determined hardware configuration. The client paid for the configuration and time, regardless of the actual use. With the help of the IaaS cloud computing platform layer, clients can dynamically scale the configuration to meet changing requirements and are billed only for the services actually used.

IaaS cloud computing platform layer eliminates the need for every organization to maintain the IT infrastructure.

IaaS provider provides the following services -

1. **Compute:** Computing as a Service includes virtual central processing units and virtual main memory for the Vms that is provisioned to the end- users.
 2. **Storage:** IaaS provider provides back-end storage for storing files.
 3. **Network:** Network as a Service (NaaS) provides networking components such as routers, switches, and bridges for the Vms.
 4. **Load balancers:** It provides load balancing capability at the infrastructure layer.



Advantages of IaaS cloud computing layer

There are the following advantages of IaaS computing layer -

1. Shared infrastructure

IaaS allows multiple users to share the same physical infrastructure.

2. Web access to the resources

IaaS allows IT users to access resources over the internet.

3. Pay-as-per-use model

IaaS providers provide services based on the pay-as-per-use basis. The users are required to pay for what they have used.

4. Focus on the core business

IaaS providers focus on the organization's core business rather than on IT infrastructure.

5. On-demand scalability

On-demand scalability is one of the biggest advantages of IaaS. Using IaaS, users do not worry about to upgrade software and troubleshoot the issues related to hardware components.

Disadvantages of IaaS cloud computing layer

1. Security

Security is one of the biggest issues in IaaS. Most of the IaaS providers are not able to provide 100% security.

2. Maintenance & Upgrade

Although IaaS service providers maintain the software, but they do not upgrade the software for some organizations.

3. Interoperability issues

It is difficult to migrate VM from one IaaS provider to the other, so the customers might face problem related to vendor lock-in.

Some important point about IaaS cloud computing layer

IaaS cloud computing platform cannot replace the traditional hosting method, but it provides more than that, and each resource which are used are predictable as per the usage.

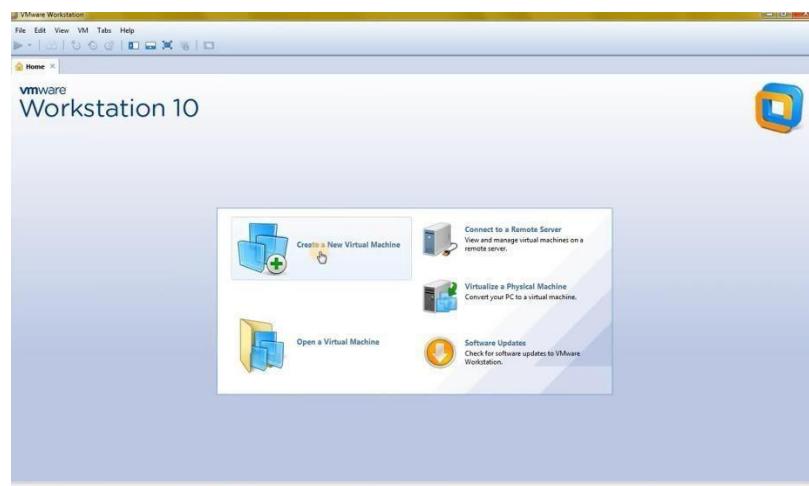
IaaS cloud computing platform may not eliminate the need for an in-house IT department. It will be needed to monitor or control the IaaS setup. IT salary expenditure might not reduce significantly, but other IT expenses can be reduced.

Breakdowns at the IaaS cloud computing platform vendor's can bring your business to the halt stage. Assess the IaaS cloud computing platform vendor's stability and finances. Make sure that SLAs (i.e., Service Level Agreement) provide backups for data, hardware, network, and application failures. Image portability and third-party support is a plus point.

The IaaS cloud computing platform vendor can get access to your sensitive data. So, engage with credible companies or organizations. Study their security policies and precautions.

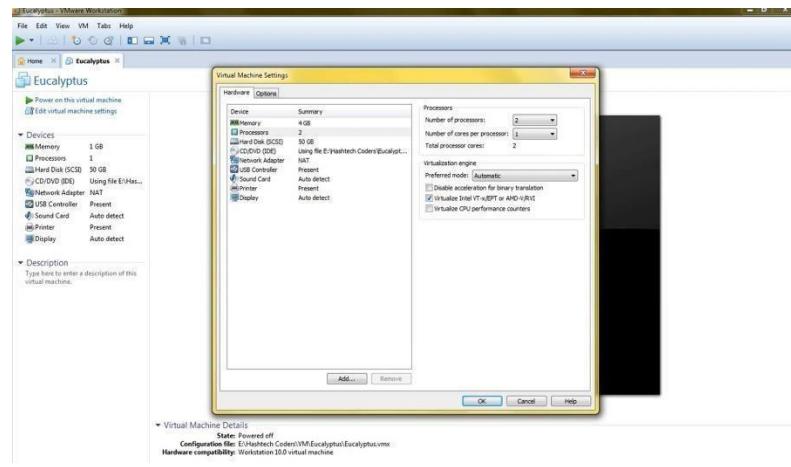
IMPLEMENTATION :

Step 1: Open a vmware workstation.



Step 2: Install Eucalyptus in the vmware workstation

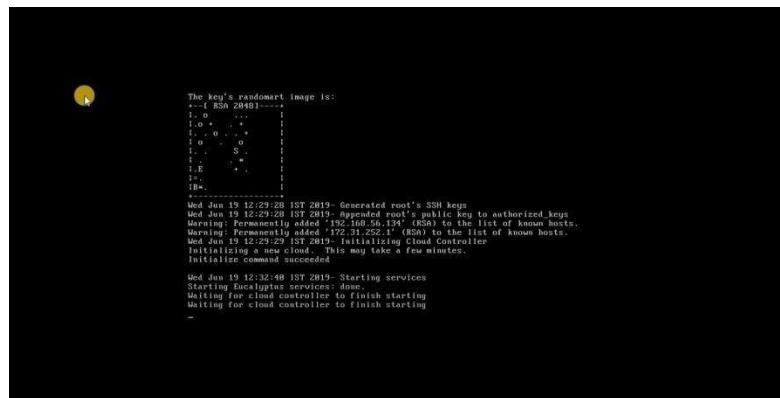




Step 3: Power on virtual machine in the vmware and click the Install centOs 6 with Eucalyptus cloud in a box.

Step 4 : Select the Cloud in box before the timer expire and create a password.

Step 5: After installation of package, the vm will reboot.



Step 6: Creating user to login into os.

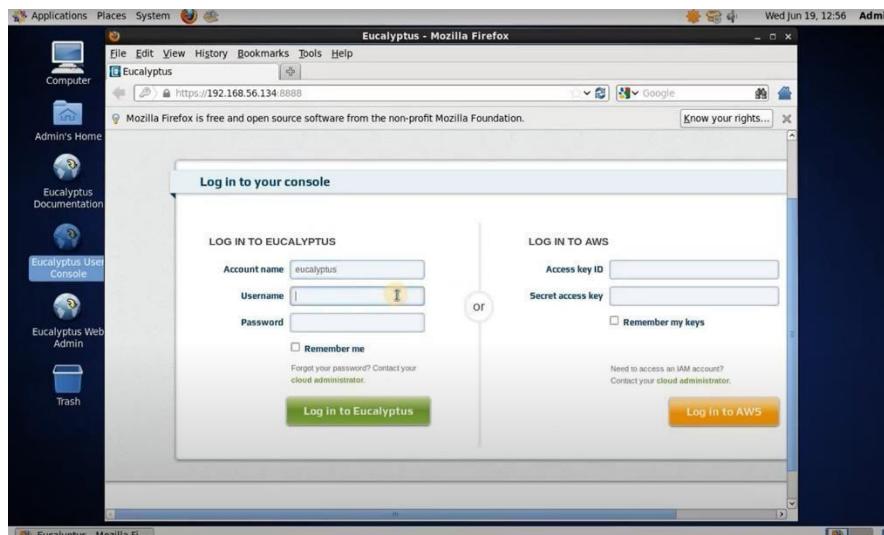


Step 7: Make a note of Url.

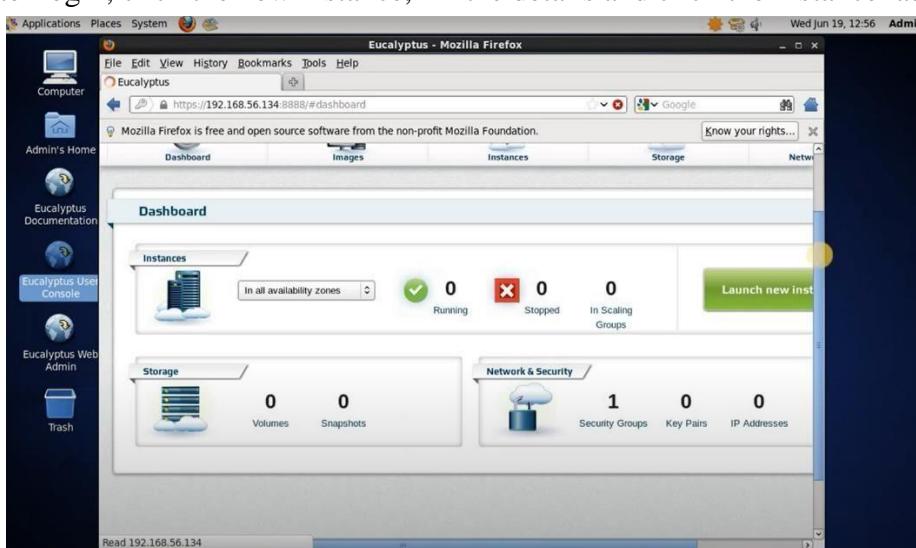


Step 8: Click on finish and now your conguration is completed.

Step 9: Click the user Cansole and fill the details.



Step 10: After login, click the new instance, fill the details and click the instance launch



Step 11: Now the instance is launched.

| INSTANCE | STATUS | IMAGE ID | AVAILABILITY ZONE | PUBLIC ADDRESS | PRIVATE ADDRESS | KEY NAME | SECURITY GROUP | LAUNCH TIME |
|------------|---------|--------------|-------------------|----------------|-----------------|----------|----------------|---------------------------|
| i-5DC9456C | Running | ami-0D493A2C | CLUSTER01 | 192.168.56.1 | 172.31.255.28 | default | default | 01:00:07 PM Jun 19th 2019 |

| | |
|-------------------|--|
| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

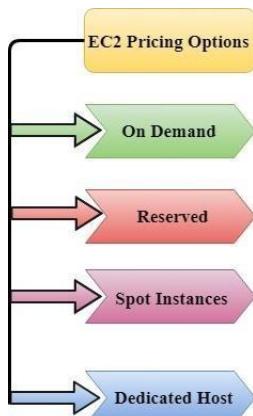
Thus, the study and implementation on Infrastructure as a service is done successfully.

AIM:

To write a case study about AMAZON EC2/ MICROSOFT AZURE/ GOOGLE CLOUD PLATFORM .

THEORY:

EC2 stands for Amazon Elastic Compute Cloud. Amazon EC2 is a web service that provides resizable compute capacity in the cloud. Amazon EC2 reduces the time required to obtain and boot new user instances to minutes rather than in older days, if you need a server then you had to put a purchase order, and cabling is done to get a new server which is a very time-consuming process. Now, Amazon has provided an EC2 which is a virtual machine in the cloud that completely changes the industry. You can scale the compute capacity up and down as per the computing requirement changes. Amazon EC2 changes the economics of computing by allowing you to pay only for the resources that you actually use. Rather than you previously buy physical servers, you would look for a server that has more CPU capacity, RAM capacity and you buy a server over 5 year term, so you have to plan for 5 years in advance. People spend a lot of capital in such investments. EC2 allows you to pay for the capacity that you actually use. Amazon EC2 provides the developers with the tools to build resilient applications that isolate themselves from some common scenarios.

EC2 Pricing Options:**On Demand:**

It allows you to pay a fixed rate by the hour or even by the second with no commitment. Linux instance is by the second and windows instance is by the hour. On Demand is perfect for the users who want low cost and flexibility of Amazon EC2 without any up-front investment or long-term commitment. It is suitable for the applications with short term, spiky or unpredictable workloads that cannot be interrupted. It is useful for the applications that have been developed or tested on Amazon EC2 for the first time. On Demand instance is recommended when you are not sure which instance type is required for your performance needs.

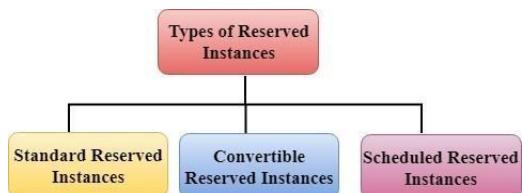
Reserved:

It is a way of making a reservation with Amazon or we can say that we make a contract with Amazon. The contract can be for 1 or 3 years in length. In a Reserved instance, you are making a contract means you are paying some upfront, so it gives

you a significant discount on the hourly charge for an instance. It is useful for applications with steady state or predictable usage. It is used for those applications that require reserved capacity. Users can make up-front payments to reduce their total computing costs. For example, if you pay all your upfronts and you do 3 years contract, then only you can get a maximum discount, and if you do not pay all upfronts and do one year contract then you will not be able to get as much discount as you can get. If you do 3 year contract and pay all the upfronts.

Types of Reserved Instances:

- Standard Reserved Instances
- Convertible Reserved Instances
- Scheduled Reserved Instances



Standard Reserved Instances:

It provides a discount of up to 75% off on demand. For example, you are paying all up-fronts for 3 year contract. It is useful when your Application is at the steady-state.

Convertible Reserved Instances:

It provides a discount of up to 54% off on demand. It provides the feature that has the capability to change the attributes of RI as long as the exchange results in the creation of Reserved Instances of equal or greater value. Like Standard Reserved Instances, it is also useful for the steady state applications.

Scheduled Reserved Instances

Scheduled Reserved Instances are available to launch within the specified time window you reserve. It allows you to match your capacity reservation to a predictable recurring schedule that only requires a fraction of a day, a week, or a month.

Spot Instances:

It allows you to bid for a price whatever price that you want for instance capacity, and providing better savings if your applications have flexible start and end times. Spot Instances are useful for those applications that have flexible start and end times. It is useful for those applications that are feasible at very low compute prices. It is useful for those users who have an urgent need for large amounts of additional computing capacity. EC2 Spot Instances provide less discounts as compared to On Demand

prices. Spot Instances are used to optimize your costs on the AWS cloud and scale your application's throughput up to 10X. EC2 Spot Instances will continue to exist until you terminate these instances.

Dedicated Hosts

A dedicated host is a physical server with EC2 instance capacity which is fully dedicated to your use. The physical EC2 server is the dedicated host that can help you to reduce costs by allowing you to use your existing server-bound software licenses. For example, Vmware, Oracle, SQL Server depending on the licenses that you can bring over to AWS and then they can use the Dedicated host. Dedicated hosts are used to address compliance requirements and reduces host by allowing to use your existing server-bound server licenses. It can be purchased as a Reservation for up to 70% off On-Demand price.

STUDY OF MICROSOFT AZURE:

THEORY:

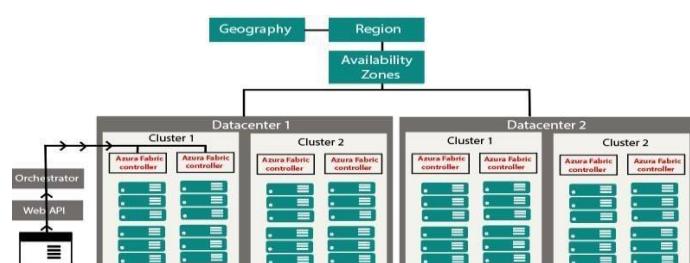
Microsoft Azure is a cloud computing platform that provides a wide variety of services that we can use without purchasing and arranging our hardware. It enables the fast development of solutions and provides the resources to complete tasks that may not be achievable in an on-premises environment. Azure Services like compute, storage, network, and application services allow us to put our effort into building great solutions without worrying about the assembly of physical infrastructure. Microsoft Azure is a growing set of cloud computing services created by Microsoft that hosts your existing applications, streamline the development of a new application, and also enhances our on-premises applications. It helps the organizations in building, testing, deploying, and managing applications and services through Microsoft-managed data centers.

Azure Services:

- **Compute services:** It includes the Microsoft Azure Cloud Services, Azure Virtual Machines, Azure Website, and Azure Mobile Services, which processes the data on the cloud with the help of powerful processors.
- **Data services:** This service is used to store data over the cloud that can be scaled according to the requirements. It includes Microsoft Azure Storage (Blob, Queue Table, and Azure File services), Azure SQL Database, and the Redis Cache.
- **Application services:** It includes services, which help us to build and operate our application, like the Azure Active Directory, Service Bus for connecting distributed systems, HDInsight for processing big data, the Azure Scheduler, and the Azure Media Services.
- **Network services:** It helps you to connect with the cloud and on-premises infrastructure, which includes Virtual Networks, Azure Content Delivery Network, and the Azure Traffic Manager.

Working of Azure:

It is essential to understand the internal workings of Azure so that we can design our applications on Azure effectively with high availability, data residency, resilience, etc.



Microsoft Azure is completely based on the concept of virtualization. So, similar to other virtualized data center, it also contains *racks*. Each rack has a separate power unit and network switch, and also each rack is integrated with a software called *Fabric-Controller*. This *Fabric-controller* is a distributed application, which is responsible for managing and monitoring servers within the rack. In case of any server failure, the Fabric-controller recognizes it and recovers it. And Each of these Fabric-Controller is, in turn, connected to a piece of software called *Orchestrator*. This *Orchestrator* includes web-services, Rest API to create, update, and delete resources. When a request is made by the user either using PowerShell or Azure portal. First, it will go to the Orchestrator, where it will fundamentally do three things:

1. Authenticate the User
2. It will Authorize the user, i.e., it will check whether the user is allowed to do the requested task.
3. It will look into the database for the availability of space based on the resources and pass the request to an appropriate Azure Fabric controller to execute the request.

Combinations of racks form a cluster. We have multiple clusters within a data center, and we can have multiple Data Centers within an Availability zone, multiple Availability zones within a Region, and multiple Regions within a Geography.

- **Geographies:** It is a discrete market, typically contains two or more regions, that preserves data residency and compliance boundaries.
- **Azure regions:** A region is a collection of data centers deployed within a defined perimeter and interconnected through a dedicated regional low-latency network.

Azure covers more global regions than any other cloud provider, which offers the scalability needed to bring applications and users closer around the world. It is globally available in 50 regions around the world. Due to its availability over many regions, it helps in preserving data residency and offers comprehensive compliance and flexible options to the customers.

- **Availability Zones:** These are the physically separated location within an Azure region. Each one of them is made up of one or more data centers, independent configuration.

Azure Pricing:

It is one of the main reasons to learn Microsoft Azure. Because Microsoft is providing free Credits in the Azure account to access Azure services for free for a short duration. This credit is sufficient for people who are new at Microsoft Azure and want to use the services. Microsoft offers the **pay-as-you-go** approach that helps organizations to serve their needs. Typically the cloud services will be charged based on the usage. The flexible pricing option helps in up-scaling and down-scaling the architecture as per our requirements.

Azure Certification:

Microsoft Azure helps to fill the gap between the industry requirement and the resource available. Microsoft provides Azure Certification into three major categories, which are:

- **Azure Administrator:** Those who implement, monitor, and maintain Microsoft Azure solutions, including major services.
- **Azure Developer:** Those who design, build, test, and maintain cloud solutions, such as applications and services, partnering with cloud solution architects, cloud DBAs, cloud administrators, and clients to implement these solutions.
- **Azure Solution Architect:** Those who have expertise in compute, network, storage, and security so that they can design the solutions that run on Azure.

All these certifications are divided into different levels. If anyone is planning to get certified, then he/she first has to get an associate-level certification and then go for the advanced level.

STUDY OF GOOGLE CLOUD PLATFORM:

THEORY:

Cloud computing is defined as the services offered through remote servers on the internet. These services might include database storage, applications, compute power and other IT resources over the pay-as-you-go pricing approach. The remote server allows users to save, modify, or process data on the internet or cloud-based platform instead of storing it on a local server or their devices. Cloud computing is evolving due to fast performance, better manageability, and less maintenance. It helps organizations to minimize the number of resources and overall infrastructure costs. Additionally, it helps IT teams better focus on the important applications, services, and processes and achieve the company's goals.

Typically, the cloud-computing providers offer their services according to the following three standard models:

- Platform as a Service (PaaS) ○ Software as a Service (SaaS)
- Infrastructure as a Service (IaaS)

Google Cloud Platform:

Google Cloud Platform (GCP) is a suite of cloud computing services provided by Google. It is a public cloud computing platform consisting of a variety of services like compute, storage, networking, application development, Big Data, and more, which run on the same cloud infrastructure that Google uses internally for its end-user products, such as Google Search, Photos, Gmail and YouTube, etc. The services of GCP can be accessed by software developers, cloud administrators and IT professionals over the Internet or through a dedicated network connection.

Google Cloud Platform is known as one of the leading cloud providers in the IT field. The services and features can be easily accessed and used by the software developers and users with little technical knowledge. Google has been on top amongst its competitors, offering the highly scalable and most reliable platform for building, testing and deploying the applications in the real-time environment.

Apart from this, GCP was announced as the leading cloud platform in the Gartner's IaaS Magic Quadrant in 2018. Gartner is one of the leading research and advisory company. Gartner organized a campaign where Google Cloud Platform was compared with other cloud providers, and GCP was selected as one of the top three providers in the market.

Most companies use data centers because of the availability of cost forecasting, hardware certainty, and advanced control. However, they lack the necessary features to run and maintain resources in the data center. GCP, on the other side, is a fully-featured cloud platform that includes:

- Capacity:** Sufficient resources for easy scaling whenever required. Also, effective management of those resources for optimum performance.
- **Security:** Multi-level security options to protect resources, such as assets, network and OS components.
 - **Network Infrastructure:** Number of physical, logistical, and human-resource-related components, such as wiring, routers, switches, firewalls, load balancers, etc.
 - **Support:** Skilled professionals for installation, maintenance, and support. ○ **Bandwidth:** Suitable amount of bandwidth for peak load. ○ **Facilities:** Other infrastructure components, including physical equipment and power resources.

Therefore, Google Cloud Platform is a viable option for businesses, especially when the businesses require an extensive catalog of services with global recognition.

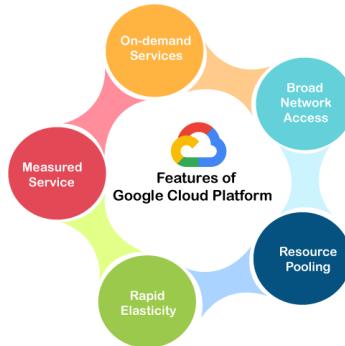
Benefits of Google Cloud Platform:

- **Best Pricing:** Google enables users to get Google Cloud hosting at the cheapest rates. The hosting plans are not only cheaper than other hosting platforms but also offer better features than others. GCP provides a pay-as-you-go option to the users where users can pay separately only for the services and resources they want to use.
- **Work from Anywhere:** Once the account is configured on GCP, it can be accessed from anywhere. That means that the user can use GCP across different devices from different places. It is possible because Google provides web-based applications that allow users to have complete access to GCP.
- **Private Network:** Google has its own network that enables users to have more control over GCP functions. Due to this, users achieve smooth performance and increased efficiency over the network.
- **Scalable:** Users are getting a more scalable platform over the private network. Because Google uses fiber-optic cables to extend its network range, it is likely to have more scalability. Google is always working to scale its network because there can be any amount of traffic at any time.
- **Security:** There is a high number of security professionals working at Google. They always keep trying to secure the network and protect the data stored on servers. Additionally, Google uses an algorithm that encrypts all the data on the Cloud platform. This gives assurance to the users that their data is completely safe and secure from unauthorized sources.
- **Redundant Backup:** Google always keeps backup of user's data with built-in redundant backup integration. In case a user has lost the stored data, it's not a big problem. Google always has a copy of the users' data unless the data is deleted forcefully. This adds data integrity, reliability and durability with GCP.

Key Features of Google Cloud Platform:

- **On-demand services:** Automated environment with web-based tools. Therefore, no human intervention is required to access the resources.
- **Broad network access:** The resources and the information can be accessed from anywhere.
- **Resource pooling:** On-demand availability of a shared pool of computing resources to the users.
- **Rapid elasticity:** The availability of more resources whenever required.

Measured service: Easy-to-pay feature enables users to pay only for consumed services.



Working of Google Cloud Platform:

When a file is uploaded on the Google cloud, the unique metadata is inserted into a file. It helps identify the different files and track the changes made across all the copies of any particular file. All the changes made by individuals get synchronized

automatically to the main file, also called a master file. GCP further updates all the downloaded files using metadata to maintain the correct records.

The working of GCP with a general example:

Suppose that MS Office is implemented on Cloud to enable several people to work together. The primary aim of using cloud technology is to work on the same project at the same time. We can create and save a file on the cloud once we install a plugin for the MS Office suite. This will allow several people to edit a document at the same time. The owner can assign access to specific people to allow them to download and start editing the document in MS Office.

Once users are assigned as an editor, they can use and edit the document's cloud copy as desired. The combined, edited copy is generated that is known as the master document. GCP helps to assign a unique URL to each specific copy of the existing document given to different users. However, any of the authorized users' changes will be visible on all the copies of documents shared over the cloud. In case multiple changes are made to the same document, then GCP allows the owner to select the appropriate changes to keep.

Google Cloud Platform Services:

Google provides a considerable number of services with several unique features. That is the reason why Google Cloud Platform is continually expanding across the globe. Some of the significant services of GCP are:

- Compute Services ○ Networking ○ Storage Services ○ Big Data
- Security and Identity Management ○ Management
- Tools ○ Cloud AI
- IoT (Internet of Things)



Compute Services:

- **Google App Engine:** It is a cloud computing platform that follows the concept of Platform-as-aService to deploy PHP, Java and other software. It is also used to develop and deploy web-based software in Google-managed data centers. The most significant advantage of Google App Engine is its automatic scaling capability. This means that the App Engine automatically allocates more resources for the application when there is an increase in requests.

- **Compute Engine:** It is a cloud computing platform that follows the concept of Infrastructure-as-a-Service to run Windows and Linux based virtual machines. It is an essential component of GCP. It is designed on the same infrastructure used by Google search engine, YouTube and other Google services.
- **Kubernetes Engines:** This computing service is responsible for offering a platform for automatic deployment, scaling, and other operations of application containers across clusters of hosts. The engine supports several container tools like a docker, etc.

Networking:

- **VPC:** VPC stands for Virtual Private Network. The primary function of VPC is to offer a private network with routing, IP allocation, and network firewall policies. This will help to create a secure environment for the application deployments.
- **Cloud Load Balancing:** As its name states, Cloud balancing is used to distribute workload across different computing resources to balance the entire system performance. This also results in cost reduction. The process also helps in minimizing the availability and maximizing the capability of the resources.
- **Content Delivery Network:** CDN is a geographically distributed network of proxy servers and their data centers. The primary aim of using CDN is to provide maximum performance to the users. Additionally, it also helps deliver high availability of resources by equally distributing the related services to the end-users.

Storage Services:

- **Google Cloud Storage:** It is an online data storage web service that Google provides to its users to store and access data from anywhere. The service also includes a wide range of features like maximum performance, scalability, security and sharing.
- **Cloud SQL:** It is a web-service that enables users to create, manage, and use relational databases stored on Google Cloud servers. The service itself maintains and protects the databases, which helps users focus on their applications and other operations.
- **Cloud Bigtable:** It is known for its fast performance and highly manageable feature. It is a highly scalable NoSQL database service that allows collecting and retaining data from as low as 1 TB to hundreds of PB.

Big Data:

- **BigQuery:** It is a fully managed data analysis service by Google. The primary aim of Google BigQuery service is to help businesses to analyze Big Data. It offers a highly scalable data management option. This means BigQuery allows users to perform ad-hoc queries and share data insights across the web.
- **Google Cloud Datastore:** Google Cloud Datastore is a kind of datastore service that is fully managed, schema-less, and non-relational. This service enables businesses to perform automatic transactions and a rich set of queries. The main advantage of Google Cloud Datastore is the capability of automatic scaling. This means that the service can itself scale up and down, depending on the requirement of resources.
- **Google Cloud Dataproc:** It is a very fast and easy to use big data service offered by Google. It mainly helps in managing Hadoop and Spark services for distributed data processing. The service allows users to create Hadoop or Spark clusters sized according to the overall workload and can be accessed whenever users want them.

Security and Identity Management:

- **Cloud Data Loss Prevention API:** It is mainly designed to manage sensitive data. It helps users manage sensitive data elements like credit card details, debit card details, passport numbers, etc.
- It offers fast and scalable classification for sensitive data.
- **Cloud IAM:** It stands for Cloud Identity and Access Management. It is a framework that contains rules and policies and validates the authentication of the users for accessing the technology resources. That is why it is also known as Identity Management (IdM).

Management Tools:

- **Google Stackdriver:** Google Stackdriver service is primarily responsible for displaying the overall performance and diagnostics information. This may include insights of data monitoring, tracing, logging, error reporting, etc. The service also prompts an alert notification to the public cloud users.
- **Google Cloud Console App:** It is a native mobile application powered by Google. The primary aim of this service is to enable users to manage the core features of Google Cloud services directly from their mobile devices anytime, anywhere. The primary functions of this service are alerting, monitoring, and performing critical actions on resources.

Cloud AI:

- **Cloud Machine Learning Engine:** It is another fully managed service that allows users to create Machine Learning models. The service is mainly used for those ML models, which are based on mainstream frameworks.
- **Cloud AutoML:** It is the type of service that is based on Machine Learning. It helps users to enter their data sets and gain access to quality trained pre-designed ML models. The service works by following Google's transfer learning and Neural Architecture Search method.

IoT (Internet of Things):

- **Cloud IoT Core:** It is one of the fully managed core services. It allows users to connect, control, and ingest data from various devices that are securely connected to the Internet. This allows other Google cloud services to analyze, process, collect and visualize IoT data in real-time.
- **Cloud IoT Edge:** The Edge computing service brings memory and other computing-power resources near to the location where it is required.

Advantages of Google Cloud Platform:

- **Google Cloud Offers Quick and Easy Collaboration:** Multiple users can access the data and simultaneously contribute their information. This is possible because the data is stored on the cloud servers, not on the user's personal computers.
- **Higher Productivity with Continuous Development:** Google is always working on adding new features and functionalities to provide higher productivity to the customers. Therefore, Google delivers frequent updates to its products and services.
- **Less Disruption with Adopting New Features:** Instead of pushing huge disruptive updates of changes, Google provides small updates weekly. This helps users to understand and adopt new features easily.

- **Least or Minimal Data is stored on Vulnerable Devices:** Google does not store data on local devices unless a user explicitly tries to do it. This is because the data stored on local devices may get compromised compared to the cloud's data.
- **Users can access Google Cloud from Anywhere:** The best thing is that a user can easily access the information stored on Google cloud from anywhere because it is operated through web-based applications.
- **Google provides Maximum Security with its Robust Structure:** Google hires leading security professionals to protect user's data. Users get process-based and physical security features made by Google.
- **Users have Full Control over their Data:** Users gain full control over services and the data stored in Google Cloud. If a user does not want to use Google services any longer and wants to delete the cloud data, it can be easily performed.
- **Google provides Higher Uptime and Reliability:** Google uses several resources to provide higher and reliable up-time servers. If a data center is not working for technical issues, the system will automatically communicate with the secondary center without interruption visible to users.

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| Class Performance | |
| Record | |
| Viva | |
| Total | |

RESULT:

Thus, the study on Amazon EC2/Microsoft Azure/Google Cloud Platform is done successfully.