18CSC205J - Operating Systems

LAB MANUAL

Bachelor of Technology

Semester IV

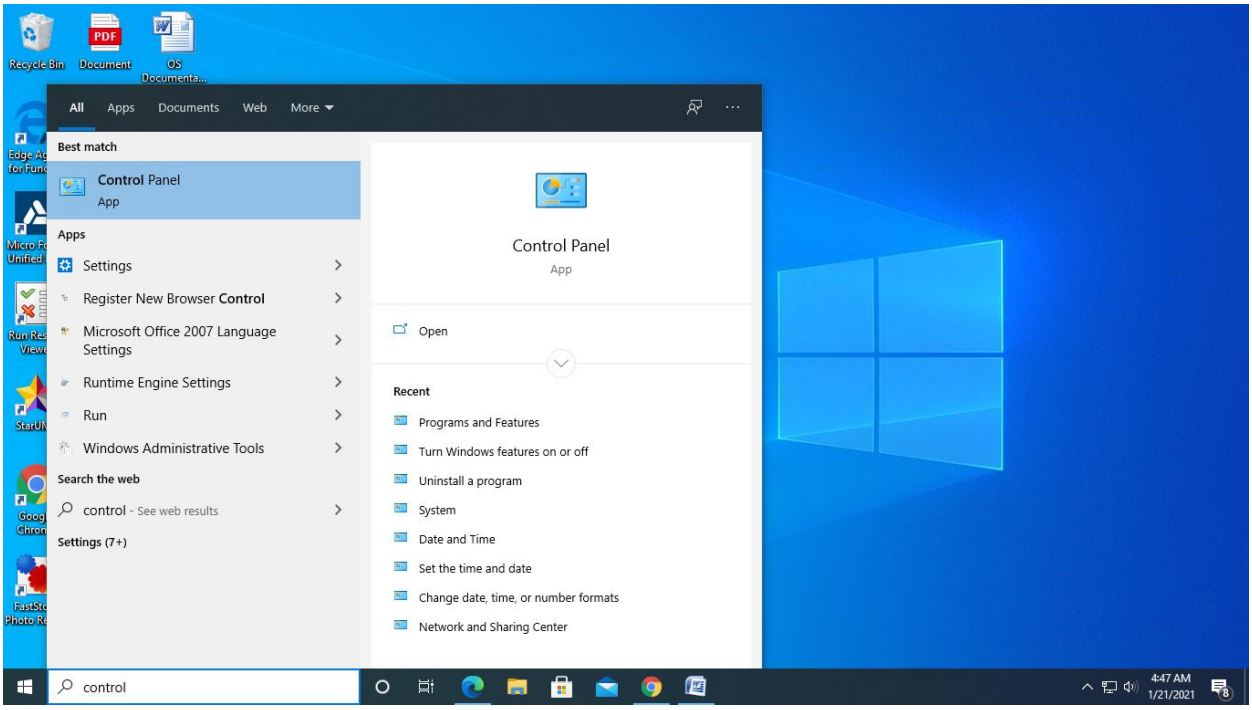
Academic Year: 2020-2021 EVEN SEMESTER

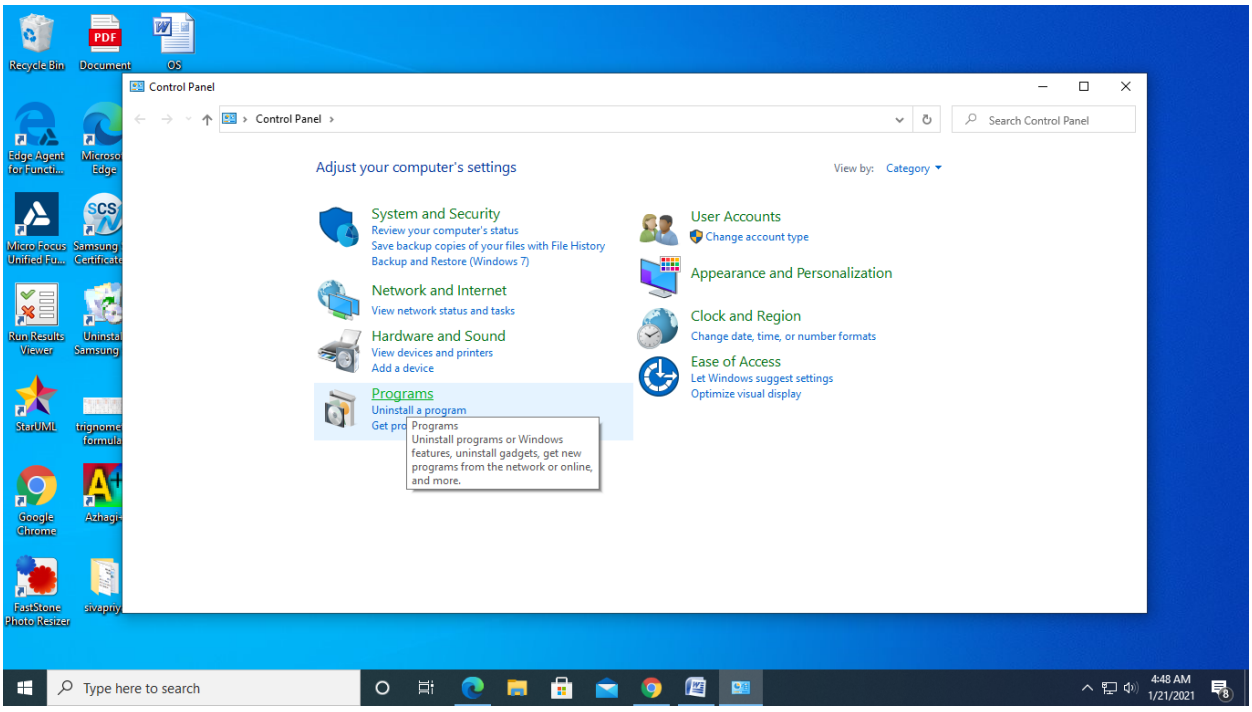
SCHOOL OF COMPUTING

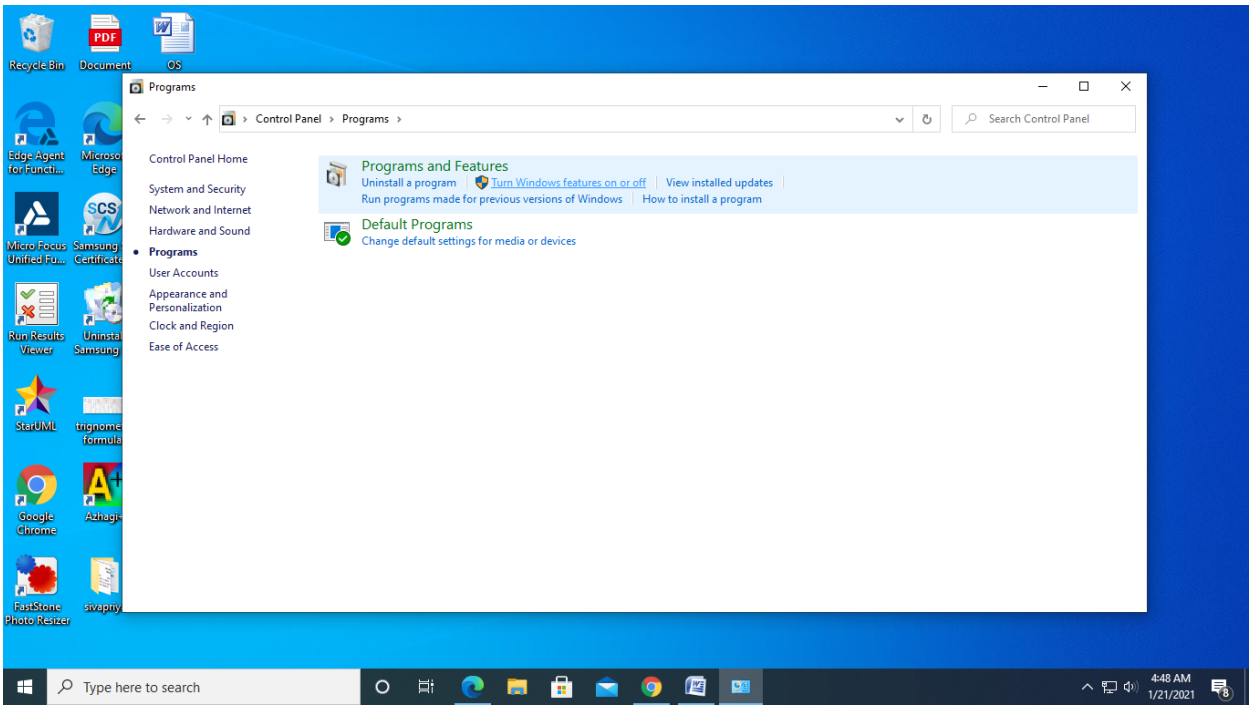
FACULTY OF ENGINEERING AND TECHNOLOGY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY
(Under section 3 of UGC Act, 1956)
SRM Nagar, Kattankulathur- 603203
Chengalpattu District

Ubuntu installation guidelines in windows

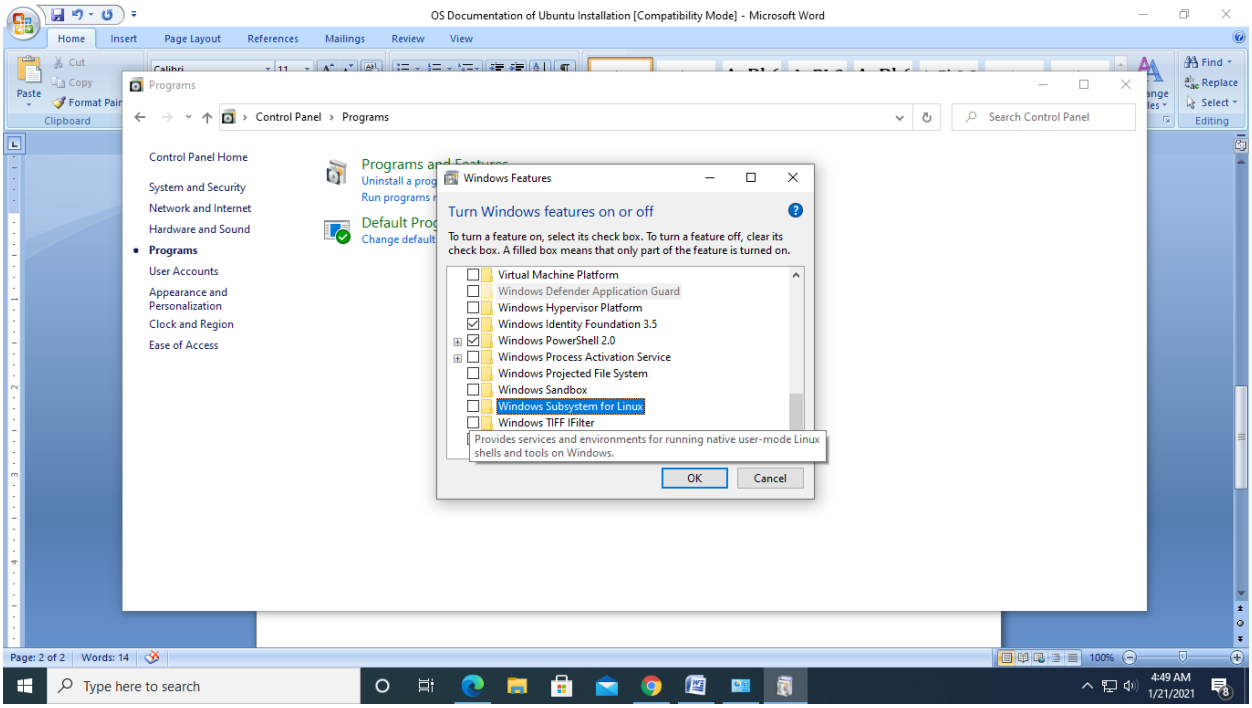
Installing Ubuntu in windows 10 64 bit



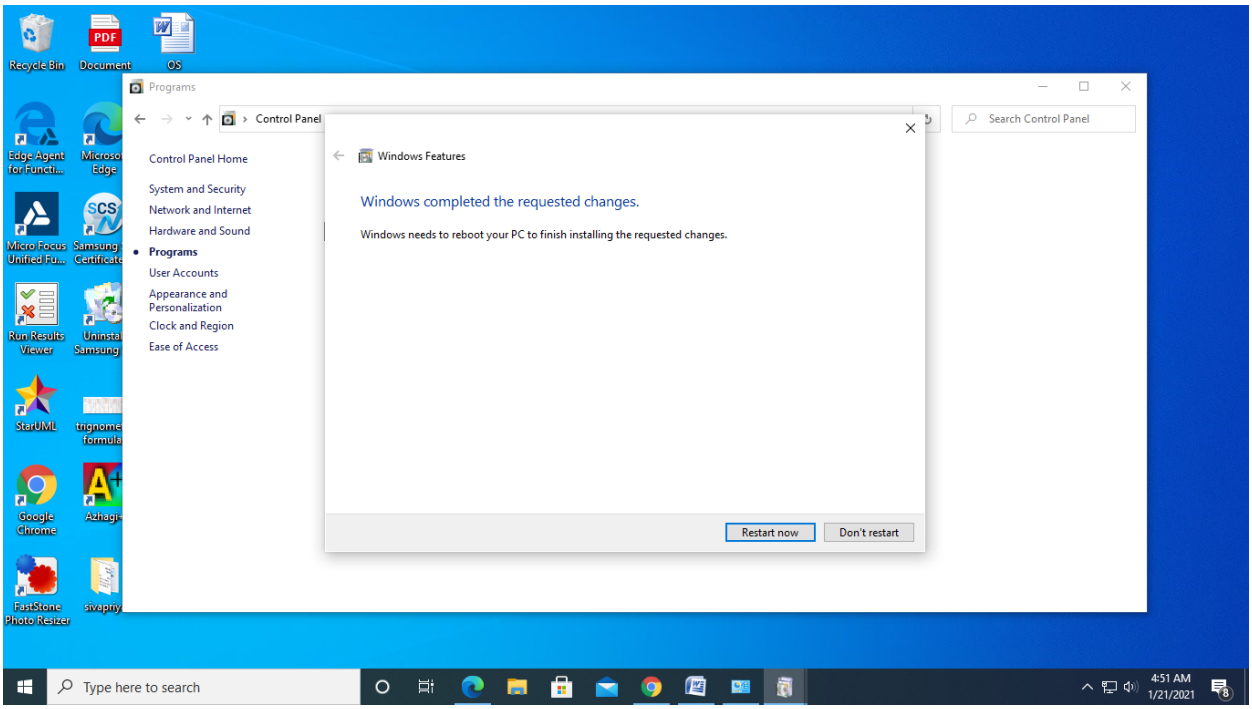




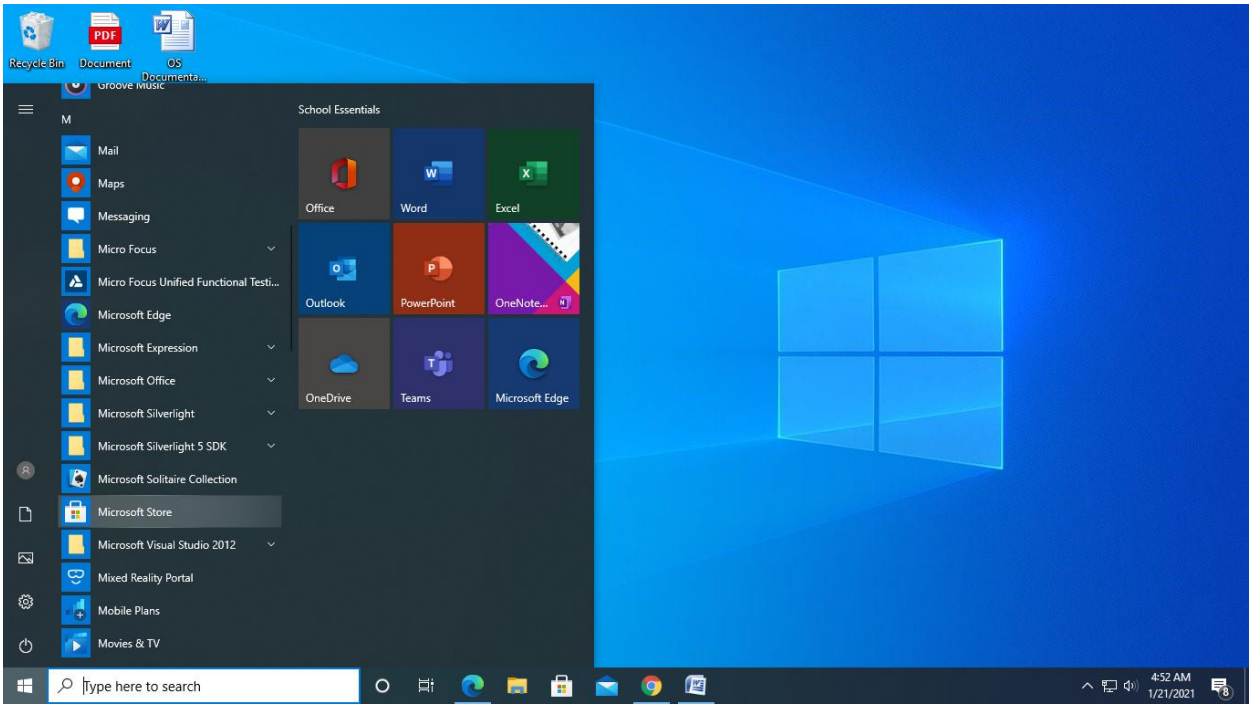
Select Turn Windows features On or Off



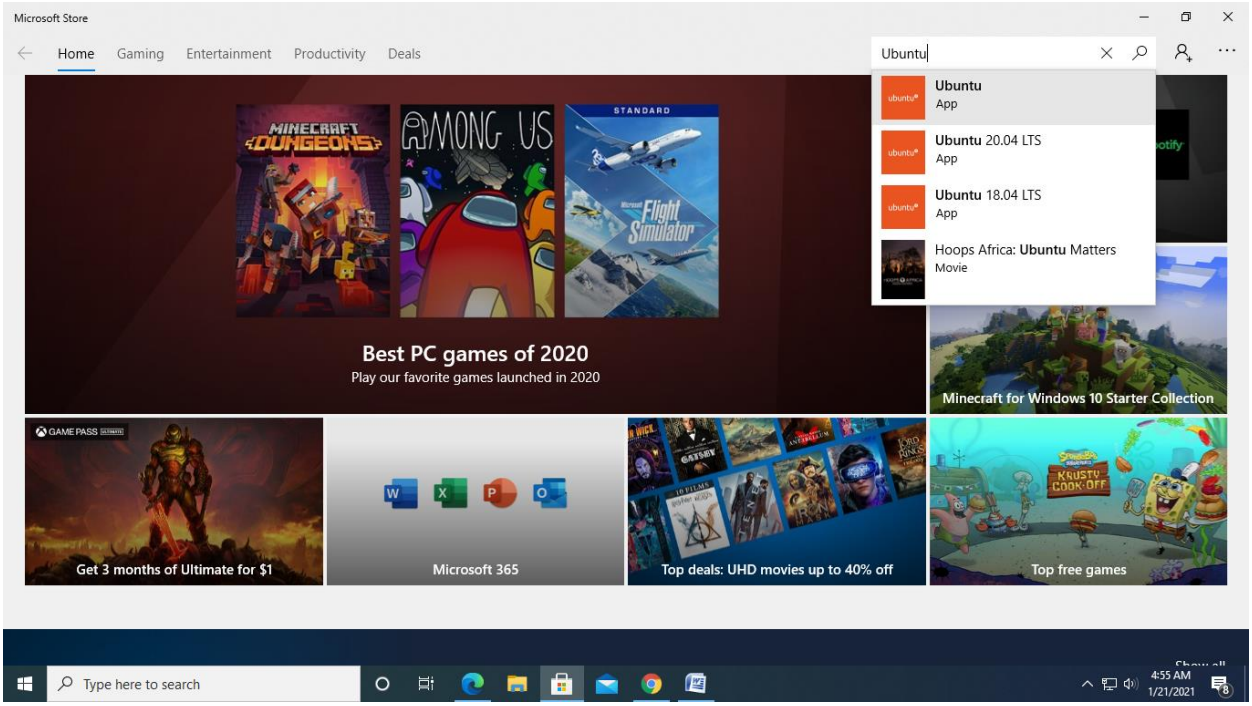
Select Windows subsystem for linux then press Ok

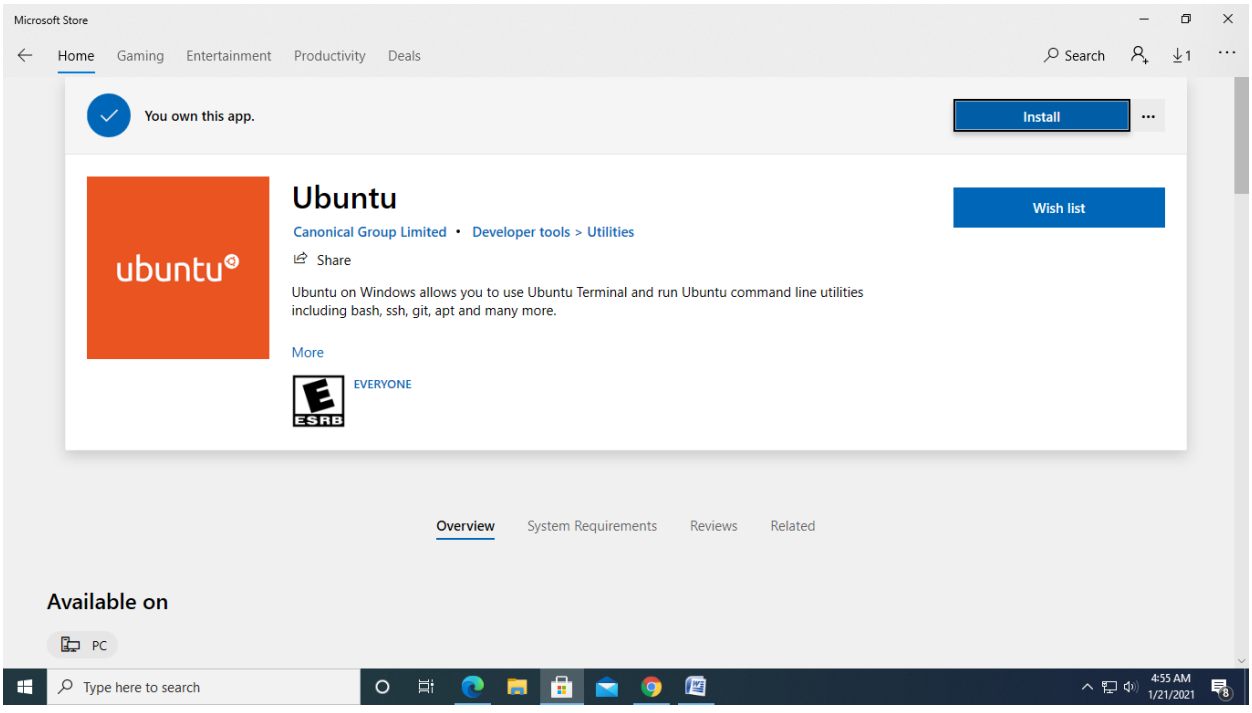


Now restart the PC to apply the changes

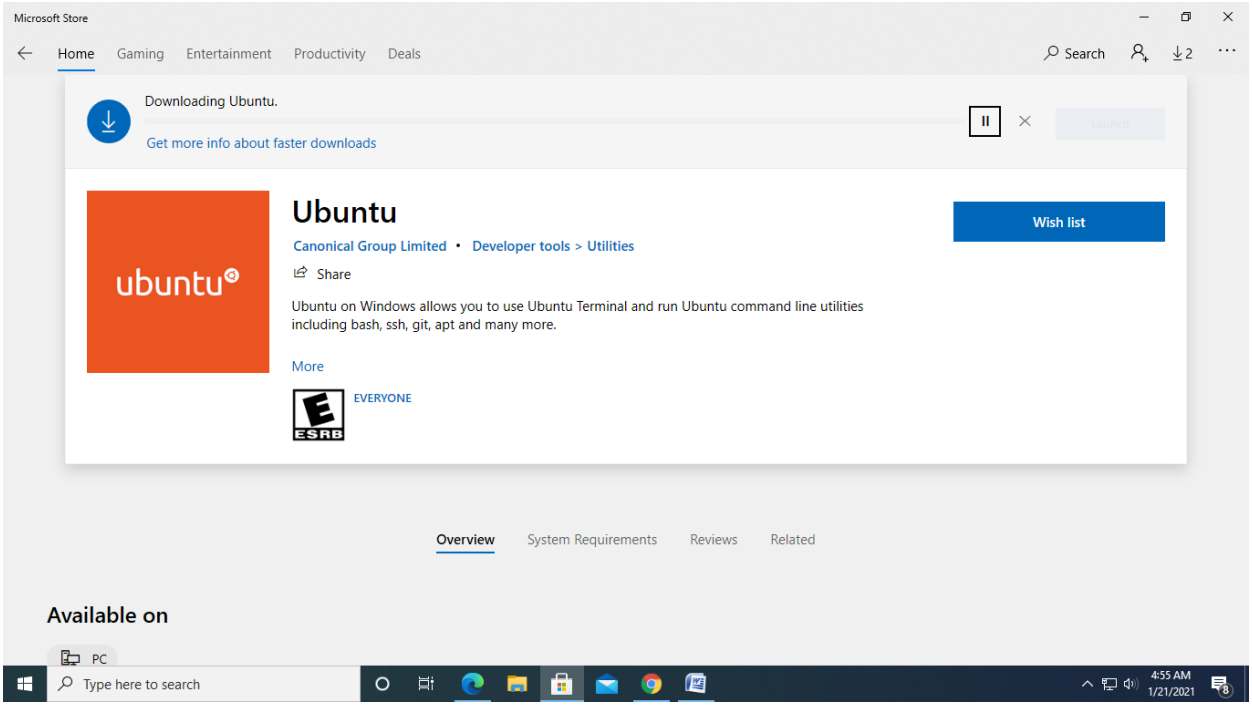


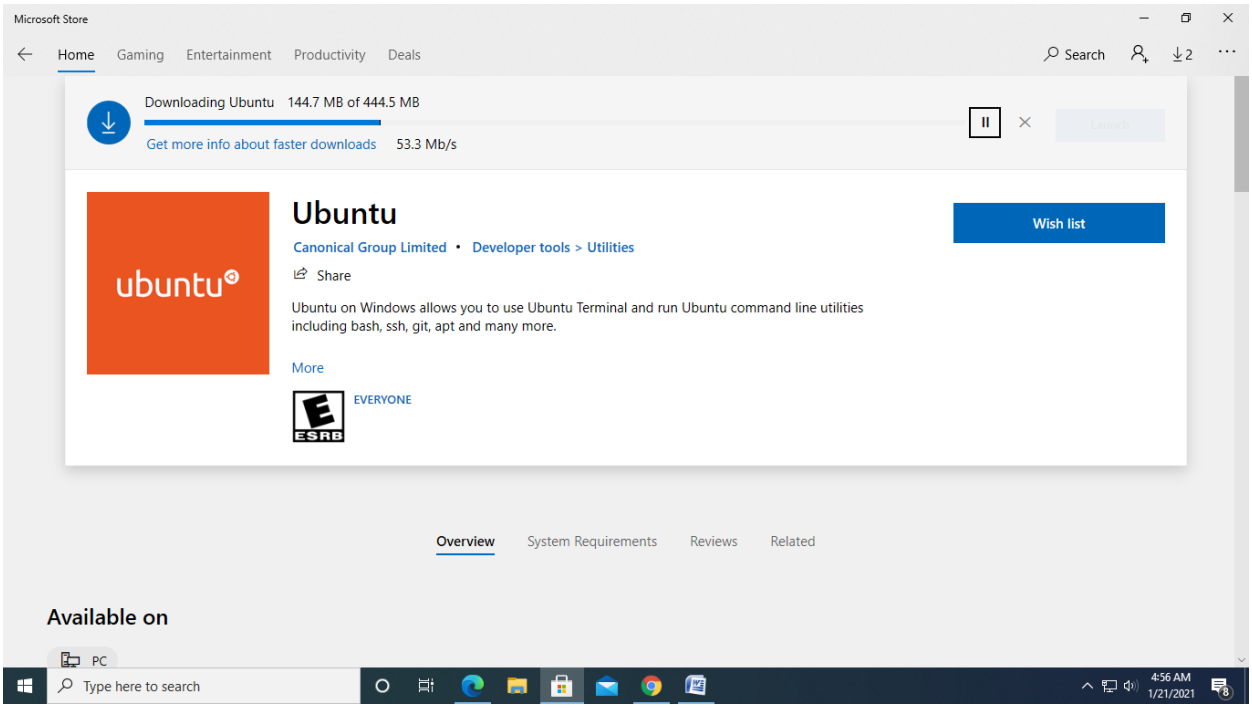
Choose Microsoft Store and search for Ubuntu and Install it

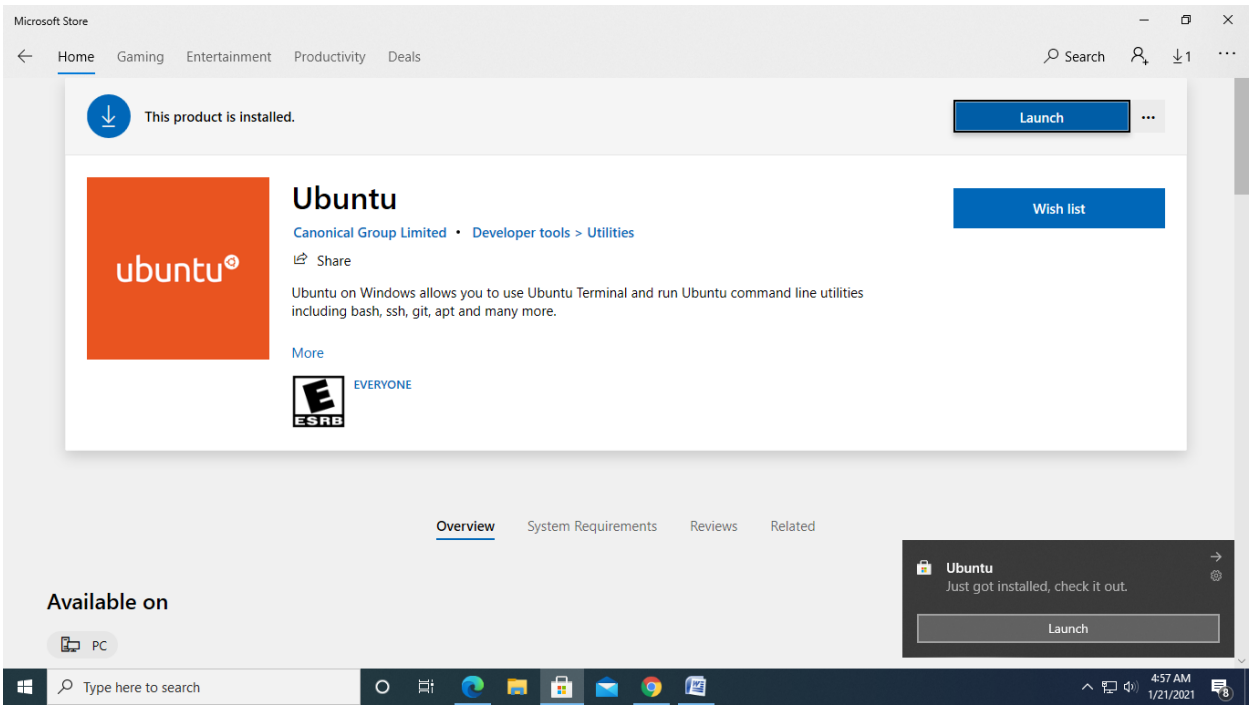




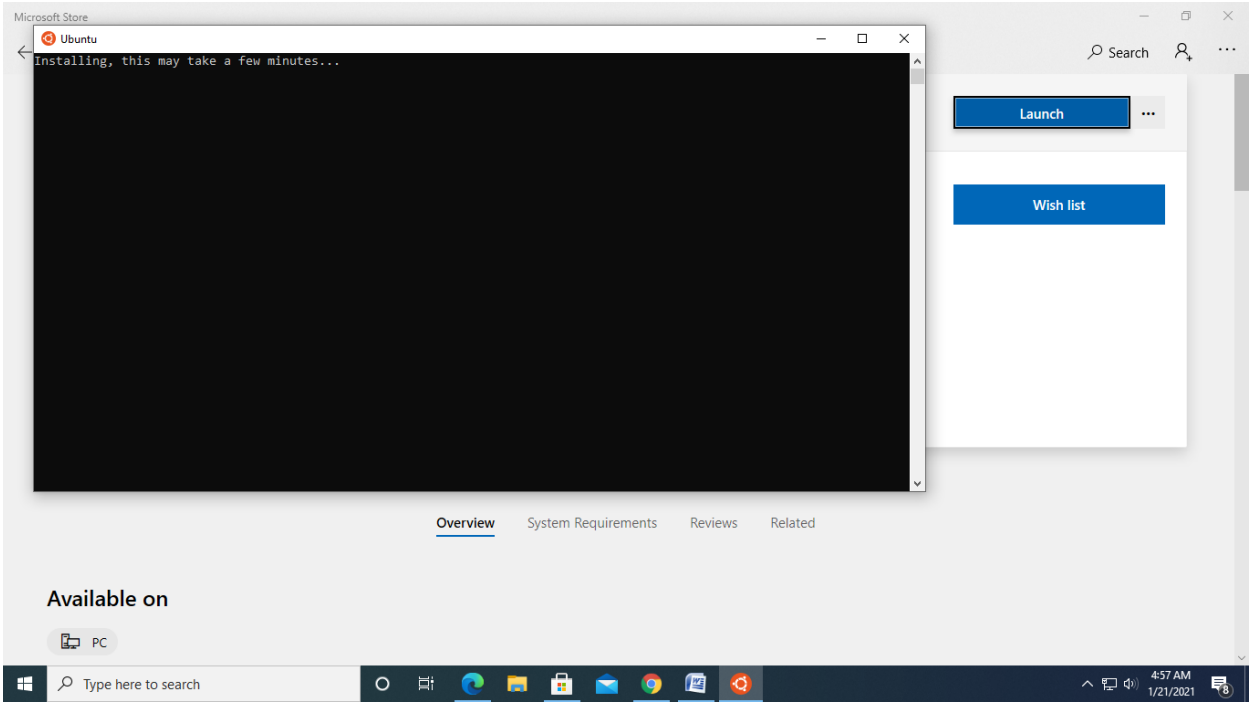
Click on Install

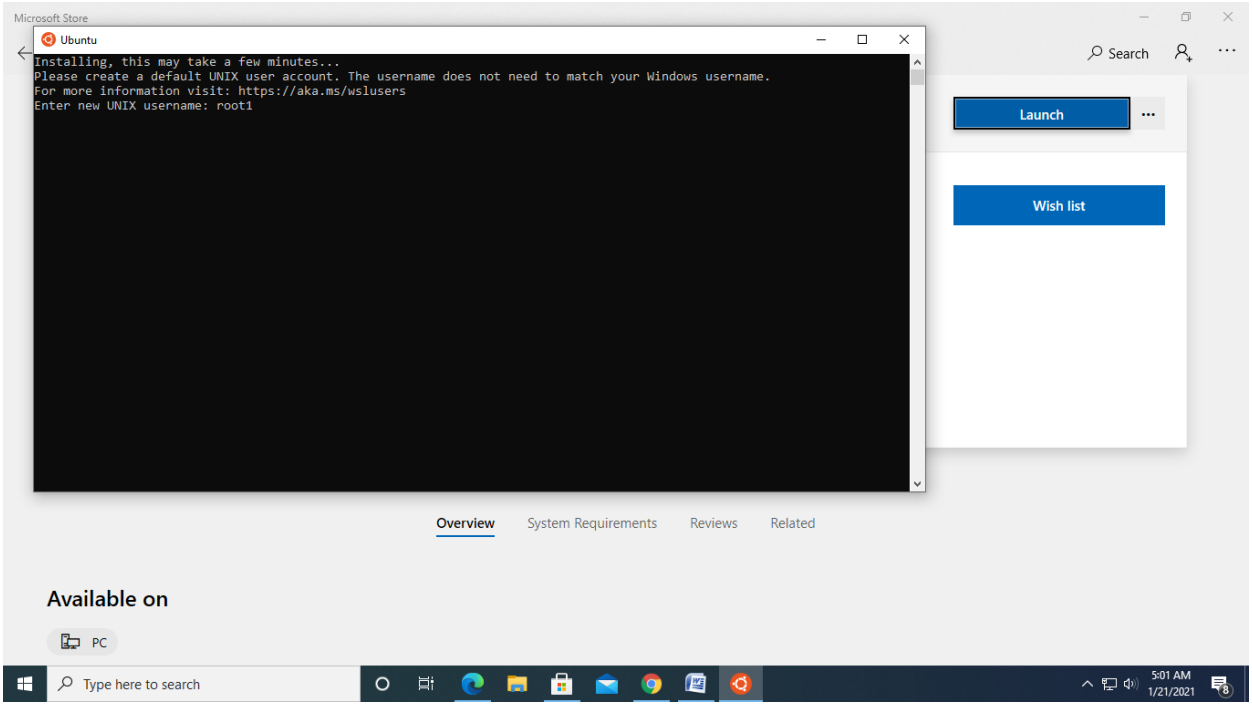

Microsoft Store
Home
Gaming
Entertainment
Productivity
Deals
Search
Downloading Ubuntu.
Get more info about faster downloads
Ubuntu
Canonical Group Limited • Developer tools > Utilities
Share
Ubuntu on Windows allows you to use Ubuntu Terminal and run Ubuntu command line utilities including bash, ssh, git, apt and many more.
More
EVERYONE
Wish list
Overview
System Requirements
Reviews
Related
Available on
PC
Type here to search
4:55 AM
1/21/2021


Microsoft Store
Home
Gaming
Entertainment
Productivity
Deals
Search
Downloading Ubuntu 144.7 MB of 444.5 MB
Get more info about faster downloads
53.3 Mb/s
Ubuntu
Canonical Group Limited • Developer tools > Utilities
Share
Ubuntu on Windows allows you to use Ubuntu Terminal and run Ubuntu command line utilities including bash, ssh, git, apt and many more.
More
EVERYONE
Wish list
Overview
System Requirements
Reviews
Related
Available on
PC
Type here to search
4:56 AM
1/21/2021



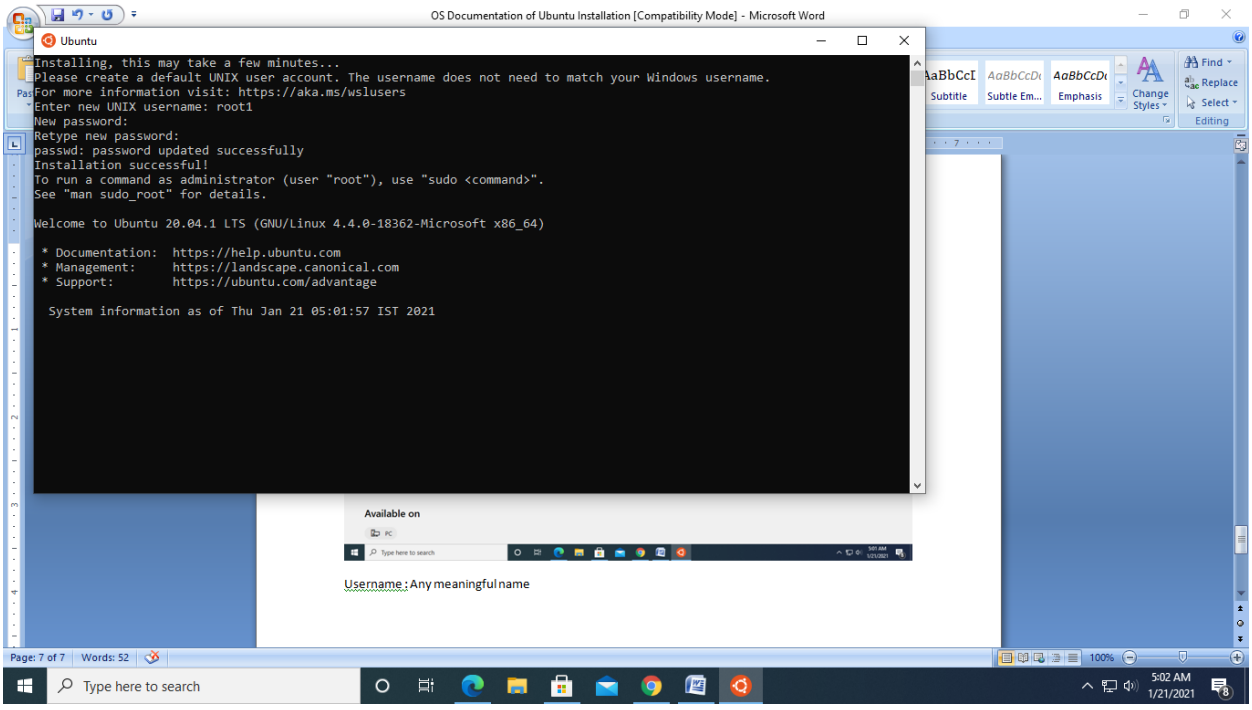
Now Launch the Ubuntu

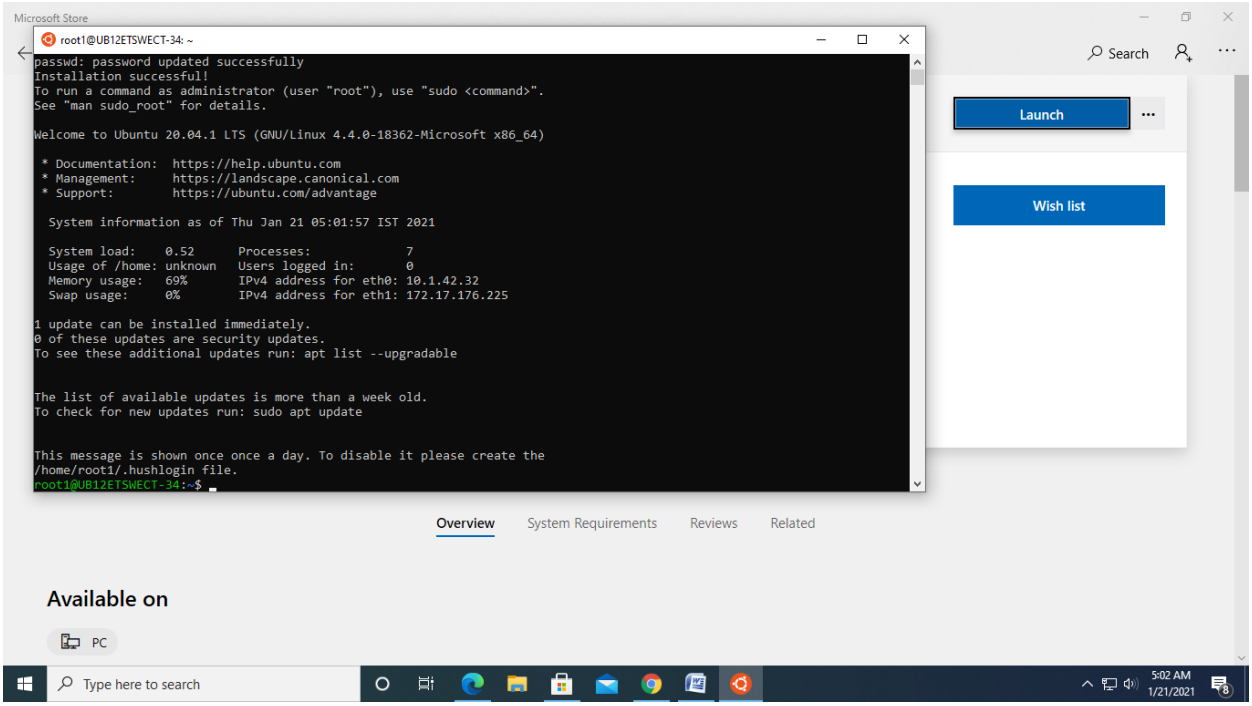




Username : Any meaningful name

Password: any name





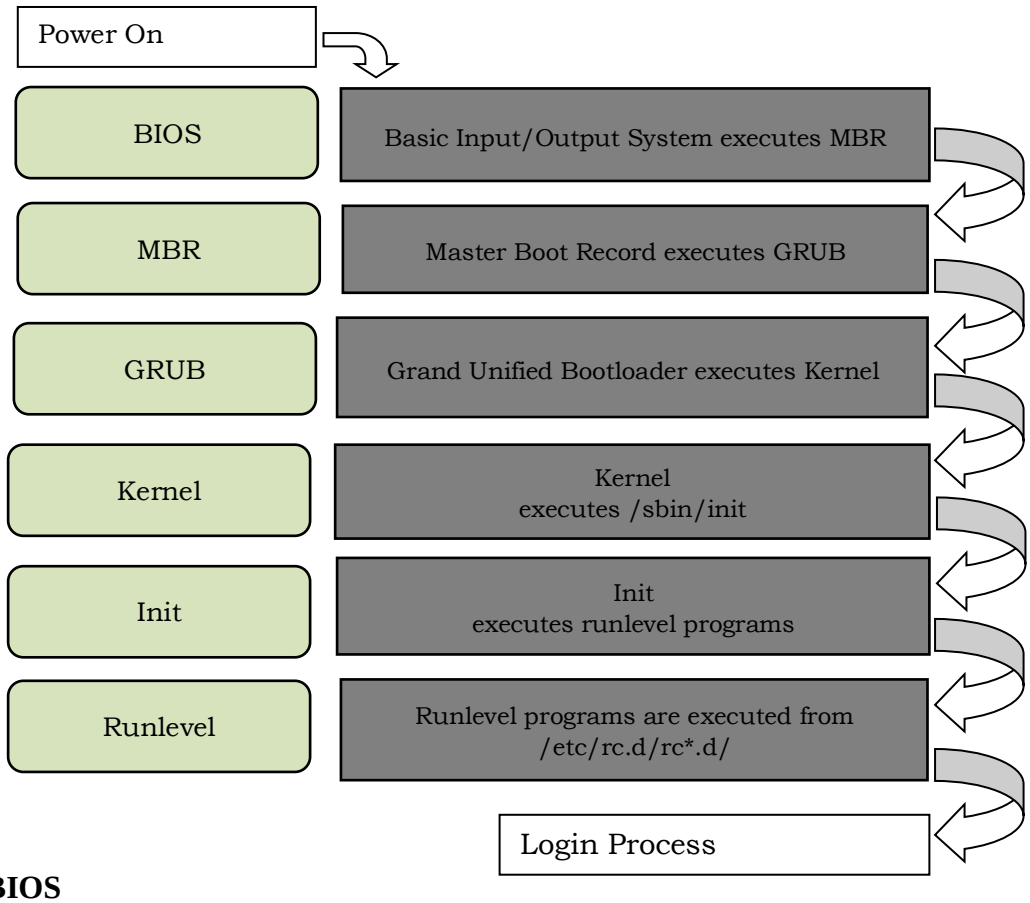
Finally you will get the prompt on successful installation of Ubuntu in windows 10 64 bit

Ex. No. 1a	BOOTING PROCESS OF LINUX

Objective:

To study various stages of Linux boot process.

Press the power button on your system, and after few moments you see the Linux login prompt. From the time you press the power button until the Linux login prompt appears, the following sequence occurs. The following are the 6 high level stages of a typical Linux boot process.



Step 1.BIOS

- BIOS stands for Basic Input/ Output System
- Performs some system integrity checks
- Searches, loads, and executes the boot loader program.
- It looks for boot loader in floppy, CD-ROMs, or hard drive. You can press a key (typically F12 or F2, but it depends on your system) during the BIOS startup to change the boot sequence.
- Once the boot loader program is detected and loaded into the memory, BIOS gives the control to it.
- So, in simple terms BIOS loads and executes the MBR boot loader.

Step 2. MBR

- MBR stands for Master Boot Record.
- It is located in the 1st sector of the bootable disk. Typically /dev/hda, or /dev/sda
- MBR is less than 512 bytes in size. This has three components 1) primary boot loader info in 1st 446 bytes 2) partition table info in next 64 bytes 3) mbr validation check in last 2 bytes.
- It contains information about GRUB (or LILO in old systems).
- So, in simple terms MBR loads and executes the GRUB boot loader.

Step 3. GRUB

- GRUB stands for Grand Unified Bootloader.
- If you have multiple kernel images installed on your system, you can choose which one to be executed.
- GRUB displays a splash screen, waits for few seconds, if you don't enter anything, it loads the default kernel image as specified in the grub configuration file.
- GRUB has the knowledge of the filesystem (the older Linux loader LILO didn't understand filesystem).
- Grub configuration file is /boot/grub/grub.conf (/etc/grub.conf is a link to this).
- As you notice from the above info, it contains kernel and initrd image.
- So, in simple terms GRUB just loads and executes Kernel and initrd images.

Step 4. Kernel

- Mounts the root file system as specified in the "root=" in grub.conf
- Kernel executes the /sbin/init program
- Since init was the 1st program to be executed by Linux Kernel, it has the process id (PID) of 1. Do a 'ps -ef | grep init' and check the pid.
- initrd stands for Initial RAM Disk.
- initrd is used by kernel as temporary root file system until kernel is booted and the real root file system is mounted. It also contains necessary drivers compiled inside, which helps it to access the hard drive partitions, and other hardware.

Step 5. Init

- Looks at the /etc/inittab file to decide the Linux run level.
- Following are the available run levels
    - 0 – halt
    - 1 – Single user mode
    - 2 – Multiuser, without NFS
    - 3 – Full multiuser mode
    - 4 – unused
    - 5 – X11
    - 6 – reboot

- Init identifies the default initlevel from /etc/inittab and uses that to load all appropriate program.
- Execute 'grep initdefault /etc/inittab' on your system to identify the default run level
- If you want to get into trouble, you can set the default run level to 0 or 6. Since you know what 0 and 6 means, probably you might not do that.
- Typically you would set the default run level to either 3 or 5.

Step 6. Runlevel programs

- When the Linux system is booting up, you might see various services getting started. For example, it might say "starting sendmail …. OK". Those are the runlevel programs, executed from the run level directory as defined by your run level.
- Depending on your default init level setting, the system will execute the programs from one of the following directories.
    - Run level 0 – /etc/rc.d/rc0.d/
    - Run level 1 – /etc/rc.d/rc1.d/
    - Run level 2 – /etc/rc.d/rc2.d/
    - Run level 3 – /etc/rc.d/rc3.d/
    - Run level 4 – /etc/rc.d/rc4.d/
    - Run level 5 – /etc/rc.d/rc5.d/
    - Run level 6 – /etc/rc.d/rc6.d/
- Please note that there are also symbolic links available for these directory under /etc directly. So, /etc/rc0.d is linked to /etc/rc.d/rc0.d.
- Under the /etc/rc.d/rc*.d/ directories, you would see programs that start with S and K.
- Programs starts with S are used during startup. S for startup.
- Programs starts with K are used during shutdown. K for kill.
- There are numbers right next to S and K in the program names. Those are the sequence number in which the programs should be started or killed.
- For example, S12syslog is to start the syslog deamon, which has the sequence number of 12. S80sendmail is to start the sendmail daemon, which has the sequence number of 80. So, syslog program will be started before sendmail.

Login Process

1. Users enter their username and password
2. The operating system confirms your name and password.
3. A "shell" is created for you based on your entry in the "/etc/passwd" file
4. You are "placed" in your "home"directory.
5. Start-up information is read from the file named "/etc/profile". This file is known as the system login file. When every user logs in, they read the information in this file.
6. Additional information is read from the file named ".profile" that is located in your "home" directory. This file is known as your personal login file.

Outcome:

Learned the various stages of Linux boot process.

Ex. No. 1b	BASIC LINUX COMMANDS

Objective:

To practice various basic Linux commands.

a) Basics Commands

1. echo SRM → to display the string SRM
2. clear → to clear the screen
3. date → to display the current date and time
4. cal 2003 → to display the calendar for the year 2003
   cal 6 2003 → to display the calendar for the June-2003
5. passwd → to change password
6. free –m → to view the size of RAM in MB
   free –g → to view the size of RAM in GB
7. df –h → to view the disk space available and used.
8. uptime → to view the system up time
9. bc → to open a basic calculator
10. ps → to view the current terminal running processes
11. history → to get the history of all the past commands
12. whoami → to know which user i am

b) Working with Files

1. ls → list files in the present working directory
   ls –l → list files with detailed information (long list)
   ls –a → list all files including the hidden files
   ls –r root → list the directory recursively
   ls –lh → list the current location content in human redable format
   ls –lt → to list the files based on modification time
   ls –li → to view the inode number of files and directories
   lscpu → to view the system specifications
2. cat > f1 → to create a file (Press ^d to finish typing)
3. cat f1 → display the content of the file f1
4. wc f1 → list no. of characters, words & lines of a file f1
   wc –c f1 → list only no. of characters of file f1
   wc –w f1 → list only no. of words of file f1

wc –l f1 → list only no. of lines of file f1

5. cp f1 f2 → copy file f1 into f2

6. mv f1 f2 → rename file f1 as f2

7. rm f1 → remove the file f1

8. head –5 f1 → list first 5 lines of the file f1
   tail –5 f1 → list last 5 lines of the file f1

c) Working with Directories

1. mkdir elias → to create the directory elias
2. cd elias → to change the directory as elias
3. rmdir elias → to remove the directory elias

4. pwd → to display the path of the present working directory

5. cd → to go to the home directory
   cd .. → to go to the parent directory
   cd - → to go to the previous working directory
   cd / → to go to the root directory

d) File name substitution

1. ls f? → list files start with 'f' and followed by any one character
2. ls *.c → list files with extension 'c'
3. ls [gpy]et → list files whose first letter is any one of the character g, p or y and followed by the word et
4. ls [a-d,l-m]ring → list files whose first letter is any one of the character from a to d and l to m and followed by the word ring.

e) I/O Redirection

1. Input redirection

   wc –l < ex1 → To find the number of lines of the file 'ex1'

2. Output redirection

   who > f2 → the output of 'who' will be redirected to file f2

3. cat >> f1 → to append more into the file f1

f) Piping

Syntax : Command1 | command2

Output of the command1 is transferred to the command2 as input. Finally output of the command2 will be displayed on the monitor.

ex. cat f1 | more → list the contents of file f1 screen by screen

head –6 f1 |tail –2 → prints the 5^{th} & 6^{th} lines of the file f1.

g) Environment variables

1. echo $HOME → display the path of the home directory
2. echo $PS1 → display the prompt string $
3. echo $PS2 → display the second prompt string (> symbol by default)
4. echo $LOGNAME → login name
5. echo $PATH → list of pathname where the OS searches for an executable file

h) File Permission

-- chmod command is used to change the access permission of a file.

Method-1

Syntax : chmod [ugo] [+/-] [rwxa] filename

u : user, g : group, o : others
+ : Add permission - : Remove the permission
r : read, w : write, x : execute, a : all permissions

ex. chmod ug+rw f1
adding 'read & write' permissions of file f1 to both user and group members.

Method-2

Syntax : chmod octnum file1

The 3 digit octal number represents as follows

- first digit -- file permissions for the user
- second digit -- file permissions for the group
- third digit -- file permissions for others

Each digit is specified as the sum of following
4 – read permission, 2 – write permission, 1 – execute permission

ex. chmod 754 f1

it change the file permission for the file as follows

- read, write & execute permissions for the user ie; 4+2+1 = 7
- read, & execute permissions for the group members ie; 4+0+1 = 5
- only read permission for others ie; 4+0+0 = 4
-

Outcome:

Various basic Linux commands are learned and executed.

Ex. No. 2a	LINUX FILE SYSTEM

Objective:

To study various Linux file system and file system structure.

Linux File System

Linux File System or any file system generally is a layer which is under the operating system that handles the positioning of your data on the storage, without it; the system cannot knows which file starts from where and ends where.

Linux offers many file systems types like:

- **Ext**: an old one and no longer used due to limitations.
- **Ext2**: first Linux file system that allows 2 terabytes of data allowed.
- **Ext3**: came from Ext2, but with upgrades and backward compatibility.
- **Ext4**: faster and allow large files with significant speed. (Best Linux File System). It is a very good option for SSD disks and you notice when you try to install any Linux distro that this one is the default file system that Linux suggests.
- **JFS**: old file system made by IBM. It works very well with small and big files, but it failed and files corrupted after long time use, reports say.
- **XFS**: old file system and works slowly with small files.
- **Btrfs:** made by Oracle. It is not stable as Ext in some distros, but you can say that it is a replacement for it if you have to. It has a good performance.
- **Nfs:** The network file system used to access disks located on remote computers.
- **Ntfs:** replaces Microsoft Window's FAT file systems (VFAT, FAT32). It has reliability, performance, and space- utilization.
- **Umsdos: It** is an extended DOS file system used by Linux.

File System Structure

A file system is a logical collection of files on a partition or disk. A partition is a container for information and can span an entire hard drive if desired. UNIX uses a hierarchical file system structure, much like an upside-down tree, with root (/) at the base of the file system and all other directories spreading from there.

The following table provides a short overview of the most important higher-level directories you find on a Linux system

Directory	Contents
/	Root directory—the starting point of the directory tree.
/bin	Essential binary files. Binary Executable files
/boot	Static files of the boot loader.
/dev	Files needed to access host-specific devices.
/etc	Host-specific system configuration files.
/lib	Essential shared libraries and kernel modules.
/media	Mount points for removable media.
/mnt	Mount point for temporarily mounting a file system.
/opt	Add-on application software packages.
/root	Home directory for the super user root.
/sbin	Essential system binaries.
/srv	Data for services provided by the system.
/proc	Contains all processes marked as a file by process number or other information that is dynamic to the system
/tmp	Temporary files.
/usr	Secondary hierarchy with read-only data.
/var	Variable data such as log files
/kernal	Contains kernel files

Outcome:

Learned the various Linux file system and file system structure.

Ex. No. 2b	EDITORS AND FILTERS

Objective:

To practice VI editor and various filter commands in Linux.

VI EDITOR

- vi fname → to open the file fname

- There are two types of mode in vi editor
  Escape mode – used to give commands – to switch to escape mode, press <Esc> key
  Command mode – used to edit the text – to switch to command mode, press any one the following inserting text command

a) Inserting Text

i → insert text before the cursor
a → append text after the cursor
I → insert text at the beginning of the line
A → append text to the end of the line
r → replace character under the cursor with the next character typed
R → Overwrite characters until the end of the line
o → (small o) open new line after the current line to type text
O → (capital O) open new line before the current line to type text

b) Cursor movements

h → left
j → down
k →up
l → right
(The arrow keys usually work also)

^**F** →forward one screen
^**B** →back one screen
^**D** →down half screen
^**U** →up half screen
(^ indicates control key; case does not matter)

0 → (zero) beginning of line
$ → end of line

c) Deleting text

Note : (n) indicates a number, and is optional

dd → deletes current line
(n)**dd** → deletes (n) line(s) ex. 5dd → deletes 5 lines
(n)**dw** → deletes (n) word(s)
D → deletes from cursor to end of line

x → deletes current character
(n)**x** → deletes (n) character(s)
X → deletes previous character

d) Saving files

:w → to save & resume editing (write & resume)
:wq → to save & exit (write & quit)
:q! → quit without save

e) Cut, Copy and Paste

yy → copies current line
(n) yy → copies (n) lines from the current line. ex. 4yy copies 4 lines.
p → paste deleted or yanked (copied) lines after the cursor

FILTERS

1. cut

- Used to cut characters or fileds from a file/input

Syntax : **cut** **-c**chars filename
-ffieldnos filename

- By default, tab is the filed separator(delimiter). If the fileds of the files are separated by any other character, we need to specify explicitly by **–d** option

cut **-d**delimitchar **-f**fileds filname

2. paste

- Paste files vertically. That is n^{th} line of first file and n^{th} line of second file are pasted as the n^{th} line of result

Syntax : **paste** file1 file2

-ddchar option is used to paste the lines using the delimiting character *dchar*
-s option is used paste the lines of the file in a single line

3. tr

- Used to translate characters from standard input

Syntax : **tr** char1 char2 < filename

It translates char1 into char2 in file filename

- Octal representation characters can also be used

Octal value	**Character**
'\7'	Bell
'\10'	Backspace
'\11'	Tab

'\12'	Newline
'\33'	Escape

Ex. tr : '\11' < f1 *translates all* **:** *into tab of f ile f1*

-s Option translate multiple occurrences of a character by single character.
-d Option is to delete a character

4. grep

- Used to search one or more files for a particular pattern.

Syntax : **grep** pattern filename(s)

- Lines that contain the *pattern* in the file(s) get displayed
- pattern can be any regular expressions
- More than one files can be searched for a pattern

-v option displays the lines that do not contain the *pattern*
-l list only name of the files that contain the *pattern*
-n displays also the line number along with the lines that matches the *pattern*

5. sort

- Used to sort the file in order

Syntax : **sort** filename

- Sorts the data as text by default
- Sorts by the first filed by default

-r option sorts the file in descending order
-u eliminates duplicate lines
-o filename writes sorted data into the file *fname*
-tdchar sorts the file in which fileds are separated by *dchar*
-n sorts the data as number
+1n skip first filed and sort the file by second filed numerically

6. Uniq

- Displays unique lines of a sorted file

Syntax : **uniq** filename

-d option displays only the duplicate lines
-c displays unique lines with no. of occurrences.

7. cmp

- Used to compare two files

Syntax : **cmp** f1 f2
compare two files f1 & f2 and prints the line of first difference .

8. diff

- Used to differentiate two files

Syntax : **diff** f1 f2

compare two files f1 & f2 and prints all the lines that are differed between f1 & f2.

9. comm

- Used to compare two sorted files

Syntax : **comm** file1 file2

Three columns of output will be displayed.
First column displays the lines that are unique to file1
Second column displays the lines that are unique to file2
Third column displays the lines that are appears in both the files

-1	option suppress first column
-2	option suppress second column
-3	option suppress third column
-12	option display only third column
-13	option display only second column
-23	option display only first column

Outcome:

Learned and used VI editor, and various filter commands in Linux are learned and executed.

Ex. No. 3a	COMPILATION OF C PROGRAM

Objective:

To practice how to create and execute C Programs in Linux.

Compilation of C Program

Step 1: Open the terminal and edit your program using vi editor/gedit editor and save with extension ".c"

Ex. vi test.c
(or)
gedit text.c

Step 2: Compile your program using gcc compiler

Ex. gcc test.c → Output file will be "a.out"
(or)
gcc –o test text.c → Output file will be "test"

Step 3: Correct the errors if any and run the program

Ex. ./a.out
or
./test

Optional Step: In order to avoid. / prefix each time a program is to be executed, insert the following as the last line in the file **.profile**

export PATH=.:$PATH

This Step needs only to be done once.

Debug C Programs using gdb debugger

Step 1 : Compile C program with debugging option –g

Ex. gcc –g test.c

Step 2 : Launch gdb. You will get gdb prompt

Ex. gdb a.out

Step 3 : Step break points inside C program

Ex. (gdb) b 10

Break points set up at line number 10. We can have any number of break points

Step 4: Run the program inside gdb

Ex. (gdb) r

Step 5: Print variable to get the intermediate values of the variables at break point

Ex. (gdb) p i → Prints the value of the variable 'i'

Step 6: Continue or stepping over the program using the following gdb commands

c → continue till the next break

n → Execute the next line. Treats function as single statement

s → Similar to 'n' but executes function statements line by line

l → List the program statements

Step 7: Quit the debugger

(gdb) q

Outcome:

Learned and practiced how to create and execute C Programs in Linux.

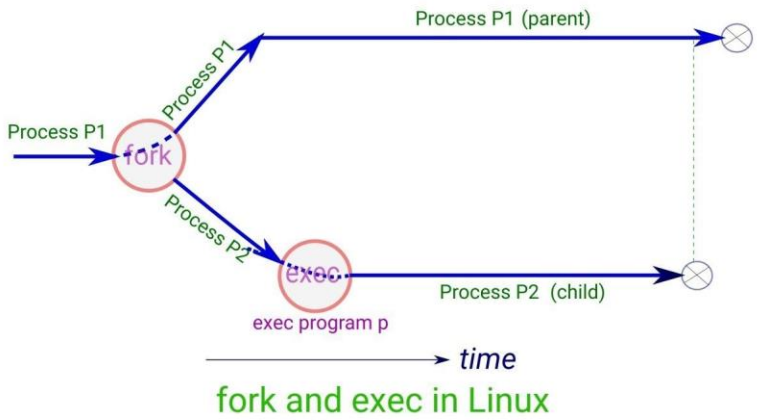
Ex. No. 3b	PROCESS CREATION

Objective:

To practice how to create and execute process in Linux using C.

Process creation

Fork system call is used for creating a new process, which is called child process, which runs concurrently with the process that makes the fork() call (parent process). After a new child process is created, both processes will execute the next instruction following the fork() system call. A child process uses the same pc (program counter), same CPU registers, and same open files which use in the parent process.



Syntax:
int fork();

It takes no parameters and returns an integer value. Below are different values returned by fork().

Negative Value: creation of a child process was unsuccessful.
Zero: Returned to the newly created child process.
Positive value: Returned to parent or caller. The value contains process ID of newly created child process.

Other Related Functions

int getpid()	→ returns the current process ID
int getppid()	→ returns the parent process ID
wait()	→ makes a process wait for other process to complete
vfork()	→Create a virtual process
exit()	→exit the shell where it is currently running

getppid() : returns the process ID of the parent of the calling process. If the calling process was created by the fork() function and the parent process still exists at the time of the getppid function call, this function returns the process ID of the parent process. Otherwise, this function returns a value of 1 which is the process id for init process.

Syntax:
pid_t getppid(void);

Return type: getppid() returns the process ID of the parent of the current process. It never throws any error therefore is always successful.

getpid() : returns the process ID of the calling process. This is often used by routines that generate unique temporary filenames.

Syntax:
pid_t getpid(void);

Return type: getpid() returns the process ID of the current process. It never throws any error therefore is always successful.

wait():A call to wait() blocks the calling process until one of its child processes exits or a signal is received. After child process terminates, parent continues its execution after wait system call instruction.

Syntax:
pid_t wait(int *stat_loc);

vfork() is a special case of clone. It is used to create new processes without copying the page tables of the parent process. Code of child process is same as code of its parent process. Child process suspends execution of parent process until child process completes its execution as both processes share the same address space.

Syntax:
pid_t vfork(void);

exit() command in linux is used to exit the shell where it is currently running. It takes one more parameter as [N] and exits the shell with a return of status N. If n is not provided, then it simply returns the status of last command that is executed.

Syntax:
exit [n]

1. Process Creation using C.

Procedure:

Step 1: Create a child process using fork () command
Display the child process content
Step 2: Display the content from current process
Step 3: Stop the process

Expected Output:

SRMIST
SRMIST

2. Display process details using C.

Procedure:

Step 1: Create a process
Step 2: Create a parent process
Step 3: Get the process ID
Step 4: Display the process ID
Step 5: Get the Parent process ID
Step 6: Display the Parent process ID
Step 7: Stop the process

Expected Output:

The process id: 2219
The process id of parent function: 2214

3. Different process Execution for parent and child process using C.

Procedure:

Step 1: Create a child process
Step 2: If the process is called by child
Step 3: Execute the child process
Step 4: else
Step 5: Execute the parent process
Step 6: End if
Step 7: stop the process

Expected Output:

The Underlying process is the parent process
process id:2193
Parent id:2188
The Underlying process is Child process
child id:2194
Parent id:2193

4. Clone process execution using C.

Procedure:

Step 1: Create a clone process
Step 2: If the process is called by clone
Step 3: Execute the clone process
Step 4: else
Step 5: Execute the parent process
Step 6: End if
Step 7: stop the process

Expected Output:

Child process started
value of n: 10
Now i am coming back to parent process
value of n: 594325573

Outcome:

Learned and executed various process commands in Linux using C.

Reference:

Bryant O"Hallaxn, Computer systems- A Programmer"s Perspective,Pearson, 2015
https://www.linuxtechi.com/learn-use-fork-vfork-wait-exec-system-calls-linux/