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Linux/Unix

UNIT-5(OS)

Linux is an open-source operating system. It is like Windows, Mac, Android, etc.

Unix is also an operating system like Linux. It is a commercial OS. It consists of three parts: Kernel, Shell and Programs. Most of the Unix and Linux commands are similar in nature.

Linux is an open-source operating system like other operating systems such as Microsoft **Windows**, Apple Mac OS, iOS, Google android, etc. An operating system is a software that enables the communication between computer hardware and software.

Evolution of Linux OS

The **Linux OS** was developed by **Linus Torvalds** in **1991**, which sprouted as an idea to improve the UNIX OS. He suggested improvements but was rejected by UNIX designers.

The **Unix** operating system is a set of programs that act as a link between the computer and the user. The computer programs that allocate the system resources and coordinate all the details of the computer's internals is called the operating system or the kernel

The main concept that unites all the versions of Unix is the following four basics –

Kernel: The kernel is the heart of the operating system. It interacts with the hardware and most of the tasks like memory management, task scheduling and file management.

Shell: The shell is the utility that processes your requests. When you type in a command at your terminal, the shell interprets the command and calls the program that you want. The shell uses standard syntax for all commands. C Shell, Bourne Shell and Korn Shell are the most famous shells which are available with most of the Unix variants.

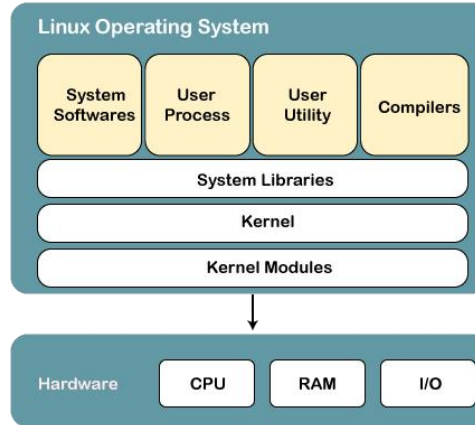
Commands and Utilities: There are various commands and utilities which you can make use of in your day to day activities. cp, mv, cat and grep, etc. are few examples of commands and utilities. There are over 250 standard commands plus numerous others provided through 3rd party software. All the commands come along with various options.

Files and Directories: All the data of Unix is organized into files. All files are then organized into directories. These directories are further organized into a tree-like structure called the filesystem.

Structure Of Linux Operating System

An operating system is a collection of software, each designed for a specific function.

Linux OS has following components:



Piping in Unix or

Linux

A pipe is a form of redirection (transfer of standard output to some other destination) that is used in Linux and other Unix-like operating systems to send the output of one command/program/process to another command/program/process for further processing. The Unix/Linux systems allow stdout of a command to be connected to stdin of another command. You can make it do so by using the pipe character '|'.

Syntax :

```
command_1 | command_2 | command_3 | .... | command_N
```

Filters in UNIX

In UNIX/Linux, filters are the set of commands that take input from standard input stream i.e. *stdin*, perform some operations and write output to standard output stream i.e. *stdout*. The *stdin* and *stdout* can be managed as per preferences using redirection and pipes. Common filter commands are: [grep](#), [more](#), [sort](#).

1. [grep](#) Command: It is a pattern or expression matching command. It searches for a pattern or regular expression that matches in files or directories and then prints found matches.

Linux Filter Commands

cat, cut, grep, comm, sed, tee, tr, uniq, wc, od, sort, gzip

Syntax:

```
$grep[options] "pattern to be matched" filename
```

Linux Features

- **Multiuser capability:** Multiple users can access the same system resources like memory, hard disk, etc. But they have to use different terminals to operate.
- **Multitasking:** More than one function can be performed simultaneously by dividing the CPU time intelligently.
- **Portability:** Portability doesn't mean it is smaller in file size or can be carried in pen drives or memory cards. It means that it support different types of hardware.
- **Security:** It provides security in three ways namely authenticating (by assigning password and login ID), authorization (by assigning permission to read, write and execute) and encryption (converts file into an unreadable format).
- **Live CD/USB:** Almost all Linux distros provide live CD/USB so that users can run/try it without installing it.
- **Graphical User Interface (X Window system):** Linux is command line based OS but it can be converted to GUI based by installing packages.
- **Support's customized keyboard:** As it is used worldwide, hence supports different languages keyboards.
- **Application support:** It has its own software repository from where users can download and install many applications.
- **File System:** Provides hierarchical file system in which files and directories are arranged.
- **Open Source:** Linux code is freely available to all and is a community based development project.

Linux Bash

The Linux Bash is also known as '**Bourne-again Shell.**' It is a **command language interpreter** for the Linux based system. It is a replacement of Bourne shell (sh). It was developed under the GNU Project and written by **Brian Fox**. Nowadays, Bash is the default user shell of most of the Linux distributions.

The Linux/Unix shell allows us to interact with the Linux system through the commands. It let us invoke an executable file to create a running process. Moreover, it also allows us to interact with the Linux file system. It is designed in such a way that we can perform all the Linux operations through Bash.

Linux Directories

What are Commands

A command is an instruction given to our computer by us to do whatever we want. In Mac OS, and Linux it is called terminal, whereas, in windows it is called command prompt. Commands are always case sensitive.

Commands are executed by typing in at the command line followed by pressing enter key.

Linux Directory Commands

Directory Command	Description
<code>pwd</code>	The pwd command stands for (print working directory). It displays the current working location or directory of the user. It displays the whole working path starting with /. It is a built-in command.
<code>ls</code>	The ls command is used to show the list of a folder. It will list out all the files in the directed folder.
<code>cd</code>	The cd command stands for (change directory). It is used to change to the directory you want to work from the present directory.
<code>mkdir</code>	With mkdir command you can create your own directory.

rmdir	The rmdir command is used to remove a directory from your system.
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Linux command List

Let's see the list of **Linux commands** which are commonly used. This list is helpful for beginners and professionals both.

Commands	Description
alias	Converts complex commands into simpler ones.
bzip2 / bunzip2	Compresses a file / Decompress a bzip2 file.
bzcat / bzipmore	Displays files compressed with bzip2.
cal	Displays calendar.
cat	It is a multi-function command.
cd	Changes the current working directory.
chage	Sets an expiration date for a user account.
chgrp	Changes group.
chmod	Changes permission for a file or directory.
chown	Changes the owner of a file or directory.
chsh	Changes the shell.
clear	Clears the terminal.
comm	Compares two streams or files.
cp	Copies file content from one file to another file.
cut	Used to display the desired column from a file.
date	Displays the current date.
df	Checks the disk space in the system.
echo	Prints the typed word on the terminal.
exit	Exits from the current user group to the last group.
export	Exports shell variables to other shells.
file	Displays the type of file.
find	Finds files for a particular search.
gpsswd	Transfers group membership to another user.
grep	Filters lines of text containing a certain string.
groupadd	Creates a group.
groupdel	Permanently removes a group.
groupmod	Changes group name.
groups	Displays the group name to which the current user belongs to.

gzip / gunzip	Compresses a file / Decompress a gzip file.
head	Displays the first ten lines of a file.
history	Displays older commands from the shell command history.
HISTSIZE	Determines the number of commands to be stored in the current environment.
HISTFILE	Displays the file that contains the history.
HISTFILESIZE	Sets the number of commands kept in the history file.
id	Tells about the user's id in the system.
less	Displays file content according to the width of the terminal.
locate	Searches a file in the database.
ls	Lists all the files of a directory.
man	Displays the manual page for the specified command.
mkdir	Creates directory.
more	Displays one output screen at a time.
mv	Renames directories or files.
od	Displays a file content in octal format.
passwd	Set a password for a user group.
pwd	Display the current working directory location.
PS1	Change the prompt name in the terminal.
rename	Renames more than one file at once.
rm	Removes a file.
rmdir	Removes a directory.
set -o noclobber	Prevents file from getting overwritten.
set +o noclobber	Allows overwriting in the existing file.
set -u	Displays undefined variables as an error.
set +u	Displays nothing for an undefined variable.
set -x	Displays shell expansion.
set +x	Disables shell expansion.
sed	Performs editing in streams.
sleep	Waits for the specified number of seconds.
sort	sorts the content in alphabetical order.
su	It allows a user to run a shell as another user.
sudo	It allows a user to start a program with the credentials of another user.
tac	Displays file content in the opposite order.

tail	Displays the last ten lines of a file.
tar	Compresses a directory.
tee	Puts stdin on stdout and then into a file.
time	Displays time taken to execute a command.
touch	It creates an empty file.
tr	Translates characters.
type	Displays information about command type.
uniq	Sorts and display multi times repeating lines only once.
unset	Removes a variable from a shell.
useradd	Adds users.
userdel	Deletes users.
usermod	Modifies the properties of a user.
vi	Opens vi editor to write a program.
w	Displays who is logged on and what are they doing.
wc	Counts words, lines, and characters.
who	Tells who is logged on the system.
whoami	Tells the name of the user.
who am i	Displays the line pointing to your current session.

Kill Process Linux

In an operating system, there are many programs that take place on computer's RAM. These programs may be run by OS itself or a user, such programs are called '**Processes**.' Usually, a process has its life cycle and get terminated by its own when it is completed or when we quit it manually. But, sometimes, a process may hang up due to error in process scheduling or because of consuming a lot of RAM or CPU. In such cases, we need to kill the processes manually to save our machine from unexpected hang up.

Linux Memory Directory

Memory directory contains files of the whole system. All the device information, process running in data or system related information are stored in this directory.

Memory directory contains the following directories.

- /dev
- /proc
- /sys

AWK Command

The **awk command** is used for **text processing** in Linux. Although, the sed command is also used for text processing, but it has some limitations, so the awk command becomes a handy option for text processing. It provides powerful control to the data.

Linux I/O Redirection

Redirection can be defined as changing the way from where commands read input to where commands sends output. You can redirect input and output of a command.

For redirection, meta characters are used. Redirection can be into a **file** (shell meta characters are angle **brackets** '<', '>') or a **program** (shell meta characters are **pipe** symbol '|').

Standard Streams In I/O Redirection

The bash shell has three standard streams in I/O redirection:

- **standard input (stdin)** : The stdin stream is numbered as stdin (0). The bash shell takes input from stdin. By default, keyboard is used as input.
- **standard output (stdout)** : The stdout stream is numbered as stdout (1). The bash shell sends output to stdout. Output goes to display.
- **standard error (stderr)** : The stderr stream is numbered as stderr (2). The bash shell sends error message to stderr. Error message goes to display.

Vi Editor with Commands

What is vi

The vi editor is elaborated as **visual** editor. It is installed in every Unix system. In other words, it is available in all Linux distros. It is user-friendly and works same on different distros and platforms. It is a very powerful application. An improved version of vi editor is **vim**.

The vi editor has two modes:

- **Command Mode:** In command mode, actions are taken on the file. The vi editor starts in command mode. Here, the typed words will act as commands in vi editor. To pass a command, you need to be in command mode.
- **Insert Mode:** In insert mode, entered text will be inserted into the file. The **Esc** key will take you to the command mode from insert mode.

To save and quit

You can save and quit vi editor from command mode. Before writing save or quit command you have to press colon (:). Colon allows you to give instructions to vi.

exit vi table:

Commands	Action
----------	--------

:wq	Save and quit
:w	Save
:q	Quit
:w fname	Save as fname
ZZ	Save and quit
:q!	Quit discarding changes made
:w!	Save (and write to non-writable file)

Kernel in Operating System

Kernel is central component of an operating system that manages operations of computer and hardware. It basically manages operations of memory and CPU time. It is core component of an operating system. Kernel acts as a bridge between applications and data processing performed at hardware level using inter-process communication and system calls.

Objectives of Kernel :

- To establish communication between user level application and hardware.
- To decide state of incoming processes.
- To control disk management.
- To control memory management.
- To control task management.

Types of Kernel :

1. Monolithic Kernel –

It is one of types of kernel where all operating system services operate in kernel space. It has dependencies between systems components. It has huge lines of code which is complex.

Example :

Unix, Linux, Open VMS, XTS-400 etc.

- **Advantage :**
It has good performance.
- **Disadvantage :**
It has dependencies between system component and lines of code in millions.

2. Micro Kernel –

It is kernel types which has minimalist approach. It has virtual memory and thread scheduling. It is more stable with less services in kernel space. It puts rest in user space.

Example :

Mach, L4, AmigaOS, Minix, K42 etc

- **Advantage :**
It is more stable.
- **Disadvantage :**
There are lots of system calls and context switches.

3. Hybrid Kernel –

It is the combination of both monolithic kernel and microkernel. It has speed and design of monolithic kernel and modularity and stability of microkernel.

Example :

Windows NT, Netware, BeOS etc.

- **Advantage :**
It combines both monolithic kernel and microkernel.
- **Disadvantage :**
It is still similar to monolithic kernel.

4. Exo Kernel –

It is the type of kernel which follows end-to-end principle. It has fewest hardware abstractions as possible. It allocates physical resources to applications.

Example :

Nemesis, ExOS etc.

- **Advantage :**
It has fewest hardware abstractions.
- **Disadvantage :**
There is more work for application developers.

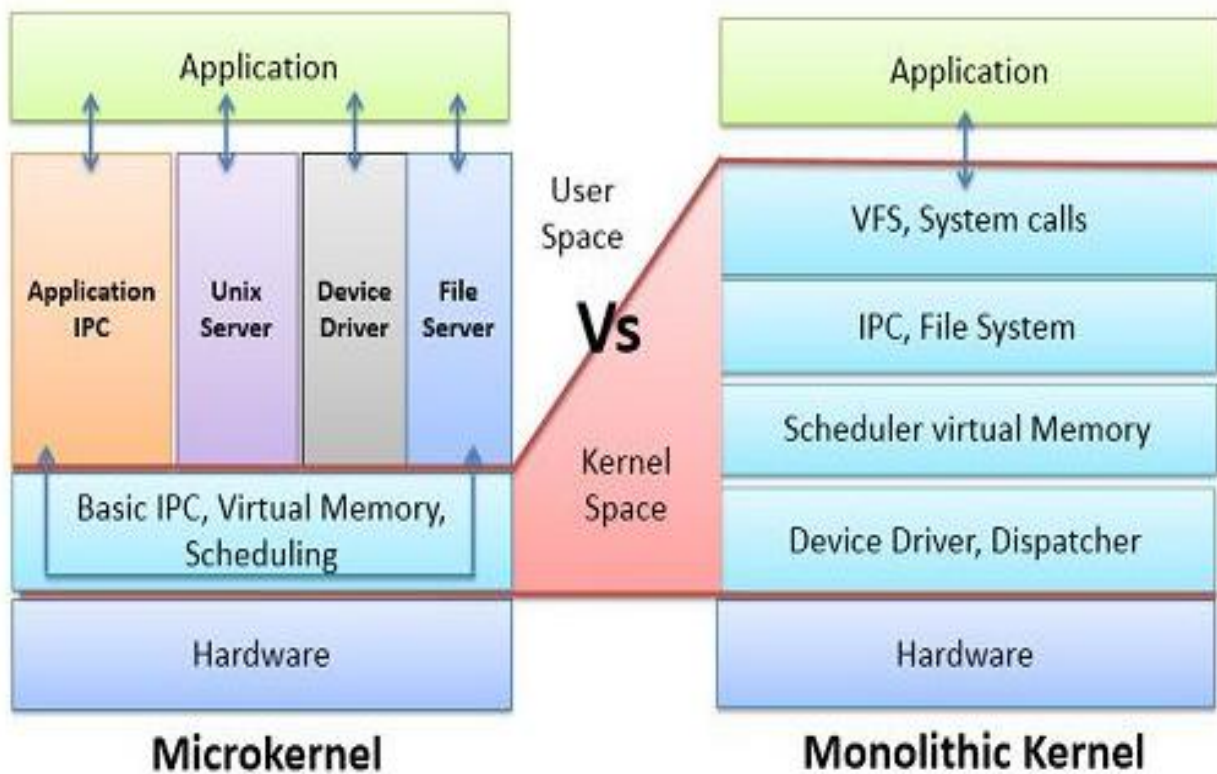
5. Nano Kernel –

It is the type of kernel that offers hardware abstraction but without system services. Micro Kernel also does not have system services therefore the Micro Kernel and Nano Kernel have become analogous.

Example :

EROS etc.

- **Advantage :**
It offers hardware abstractions without system services.
- **Disadvantage :**
It is quite same as Micro kernel hence it is less used.



Parameter	Linux	Windows
Access	Users can access the source code of kernel in Linux and can alter the kernel according to need.	Usually, users cannot access the source code. However, members of some groups can have access to it.
Variety	Linux has several distributions that are highly customizable.	Windows have fewer options to customize.
Command-line	The command line usually referred to as Terminal , which is the most useful tool of the Linux system. It used for administration and daily tasks. For the end-users, it does not look so effective.	Windows also have a command line, but it is not such effective as a comparison to the Linux terminal. Most users prefer the GUI options for daily tasks.
Installation	The Linux installation process is a bit complicated to set up as it requires many user inputs. It takes less time than Windows to install.	Windows OS is easy to install and set up on a machine; it requires fewer user input options during installation. However, it takes more time to install as compared to Linux.
Ease of use	The Linux OS is meant to be for the technical user because you must have some exposure to various Linux commands. Users may take more time to be a handy user of Linux. The troubleshooting process is also complicated as compared to Windows.	Windows comes with simple and rich GUI options, so it is easy to use it. It can be simply used by technical as well as non-technical users. The troubleshooting process is also much easy than Linux.
Written in	Linux is written in assembly language and C .	Windows is written in C++ and assembly language .
Reliability	Linux is highly reliable and secure. It has well-established system security, process management, and uptime.	Windows is not as much reliable as Linux. However, now Windows has improved reliability but still has some security weaknesses and system instabilities.
Support	Linux has a good support as it has a huge community of user forums and online search.	Windows also provide good support to its user. It provides free as well as paid support. It has an easily accessible online forum.

Update	Linux provides full control to its users on updates. A user can install the update whenever needed. Also, it takes less time to install an update.	Windows updates are annoying. The updates will come at any time and take too much time to install. Sometimes, you power on your machine, and updates are automatically getting started. Unfortunately, the user does not have much control over updates.
Security	Linux OS is more secure than Windows. It is hard for the hackers and attackers to find a loophole in it. So, Linux is hard to breakthrough.	Windows is less secure than Linux. Attackers primarily target the Windows for malware and virus. Windows is most vulnerable without anti-virus.
License	Linux is distributed under the GPL(GNU General Public License) license .	Windows is distributed under a Proprietary commercial software license .

Difference between Linux and Unix

Comparison	Linux	Unix
Definition	It is an open-source operating system which is freely available to everyone.	It is an operating system which can be only used by its copyrighters.
Examples	It has different distros like Ubuntu, Redhat, Fedora, etc	IBM AIX, HP-UX and Sun Solaris.
Users	Nowadays, Linux is in great demand. Anyone can use Linux whether a home user, developer or a student.	It was developed mainly for servers, workstations and mainframes.
Usage	Linux is used everywhere from servers, PC, smartphones, tablets to mainframes and supercomputers.	It is used in servers, workstations and PCs.
Cost	Linux is freely distributed,downloaded, and distributed through magazines also. And priced distros of Linux are also cheaper than Windows.	Unix copyright vendors decide different costs for their respective Unix Operating systems.
Development	As it is open source, it is developed by sharing and collaboration of codes by world-wide developers.	Unix was developed by AT&T Labs, various commercial vendors and non-profit organizations.
Manufacturer	Linux kernel is developed by the community of developers from different parts of the world. Although the father of Linux, Linus Torvalds oversees things.	Unix has three distributions IBM AIX, HP-UX and Sun Solaris. Apple also uses Unix to make OSX operating system.
GUI	Linux is command based but some distros provide GUI based Linux. Gnome and KDE are mostly used GUI.	Initially it was command based OS, but later Common Desktop Environment was created. Most Unix distributions use Gnome.
Interface	The default interface is BASH (Bourne Again SHell). But some distros have developed their own interfaces.	It originally used Bourne shell. But is also compatible with other GUIs.
File system support	Linux supports more file system than Unix.	It also supports file system but lesser than Linux.
Coding	Linux is a Unix clone,behaves like Unix but doesn't contain its code.	Unix contain a completely different coding developed by AT&T Labs.
Operating system	Linux is just the kernel.	Unix is a complete package of Operating system.
Security	It provides higher security. Linux has about 60-100 viruses listed till date.	Unix is also highly secured. It has about 85-120 viruses listed till date

Error detection and solution	As Linux is open-source, whenever a user post any kind of threat, developers from all over the world start working on it. And hence, it provides faster solution.	In Unix, users have to wait for some time for the problem to be resolved.
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Linux export Command

The **export** command is a built-in utility of Linux Bash shell. It is used to ensure the environment variables and functions to be passed to child processes. It does not affect the existing environment variable.

Syntax:

1. `export [-f] [-n] [name[=value] ...] or export -p`

File Commands (Sir 's notes)

- ◆ Unix directory structure revisited
- ◆ `'cd ~'` change directory to your home
- ◆ `'cd ~ram'` change directory to home
- ◆ `'cd ..'` change directory to upper directory
- ◆ `'cd /'` change directory to root
- ◆ Use tabs to complete the file name (write partial file name and then use tab)

- ◆ Some other general commands
- ◆ `ls`, list the files,
- ◆ `'-a'` option means 'list all', will show hidden files as well
- ◆ all filenames starting with `.` are hidden file
- ◆ Other options you can try is `'-l'`, `'--color'`
- ◆ `mkdir`, making new directories
- ◆ `rm`, removing a file
- ◆ There is no recycle bin in Unix
- ◆ `'rm -i'` will ask "are you sure that you want to delete"
- ◆ `rmdir`, remove directory
- ◆ `'cp'`, means copy `'mv'`, means rename or move

- ◆ Permissions – important for sharing your files and restricting access on your work
- ◆ `'chmod 755'` => `rxw rxw rxw` (user group all)
- ◆ `'chmod a+r'` => `(u/g/a) (+/ -) (r/w/x)`
- ◆ `'file'` utility tells type of file like text, word or pdf
- ◆ Helpful when extension is not given

- ◆ Backups
- ◆ Zip and Tar, `gzip`, `gunzip`
- ◆ Various extentions – `Z`, `bz2`, `zip`, `gzip`, `tgz`, `tar.gz`
- ◆ Tar oprtions `c,x,z,v,f`
- ◆ `'c'` for compress, `'x'` for expend, `'z'` for zip, `'v'` for verbose, `'f'` force
- ◆ For compression `'tar -czvf file.tar.gz ./dirname'`
- ◆ For Decompression `'tar -xzvf file.tar.gz'`

◆ Internet

- ◆ Tools- netscape, mozilla, firefox
- ◆ Use tabs in mozilla
- ◆ Proxy settings
- ◆ Edit -> preference -> advance -> proxy
- ◆ OR Tools -> Options -> Connection Settings
- ◆ Server name: pushpa(10.20.5.2), port: 8080
- ◆ Use pine for mails: fast and easy for local mails
- ◆ Configuring pine,
- ◆ copy ~neeraj/.pinerc to your home and change to your login name replacing 'neeraj' in .pinerc file
- ◆ In pine, all commands are given on bottom of editor

◆ Miscellaneous

- ◆ Unix process – ps, fg, bg, kill, &
- ◆ 'ps' gives the list of processes
- ◆ 'kill' can kill a process, you have to write pid given by ps
- ◆ Writing '&' in and of a command will force process to run in background
- ◆ 'ctrl z' for suspending a process, 'ctrl c' to kill a process
- ◆ 'bg' running a process in background
- ◆ 'fg' bringing a process in foreground
- ◆ Finger, who, rwho
- ◆ 'finger' gives list of user on a machine
- ◆ 'finger username' will give some details about user – name shell etc
- ◆ 'finger user@desh' will tell when user has last checked his mails
- ◆ 'who' gives all users on a machine
- ◆ 'rwho' gives all users on all the machines

◆ Important Utilities

- ◆ ooffice: OpenOffice, for word, presentation, spreadsheets
- ◆ xfig, for drawing figures.
- ◆ Can be exported to eps, jpeg, gif or any format
- ◆ gimp – Viewing and editing images
- ◆ eog – (Eye of Gnome) for viewing images
- ◆ acroread – Acrobat reader for PDF files
- ◆ gnumeric – Spreadsheet viewer and editor in Linux
- ◆ Editors: vi, emacs, pico, gedit

◆ Programming in Unix

- ◆ Unix made by programmer for programming
- ◆ Gcc compiler – for 'c', g++ for 'c++'
- ◆ Various options, -O, -c, -g, -l

- ◆ '-O' sets optimization level
- ◆ '-c' only compile not link
- ◆ '-g' for debug
- ◆ '-l' for pre-processing only
- ◆ Linking with -l
- ◆ All the files are previously compiled and then linked by giving library information
- ◆ Debugger- gdb
- ◆ Use 'gdb a.out' for debugging

What is the state?

The state of the system informs that if resources are allocated to different processes then the system undergoes deadlock or not.

What is a safe state? Describe how a safe state helps to avoid deadlock

If the system can allocate resources to the process in such a way that it can avoid deadlock. Then the system is in a safe state.

What is an unsafe state?

If the system can't allocate resources to the process safely, then the system is in an unsafe state.

Note: Unsafe state not always cause deadlock.

If a system is in a safe state, are we guaranteed it will never deadlock?

It's true that "All safe states are deadlock free", but don't forget that "all unsafe states not always lead to deadlocks".