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TATA CONSULTANCY SERVICES

PRE ILP – Unix LOUNGE

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CHAPTER 1 - INTRODUCTION TO UNIX

1.1 Objective

- Appreciate the need of an Operating System
- Have a fundamental understanding of the Unix OS architecture
- Be familiar with Unix File System

1.2 Chapter Content

1.2.1 Overview of Operating System

The Operating System (OS) is the most important program which starts up when we turn on the computer and keeps running underneath all other programs. It manages hardware, software and all the activities in a computer system   .

Tasks of Operating System

- Control Hardware - The operating system controls all the parts(memory, processors, disks etc.) of the computer and attempts to get everything working together.
- Run Applications - Another job the OS does is run application software. This would include word processors, web browsers, games, etc...
- Manage Data and Files - The OS makes it easy for you to organize your computer. Through the OS you are able to do a number of things to data, including copy, move, delete, and rename it. This makes it much easier to find and organize.
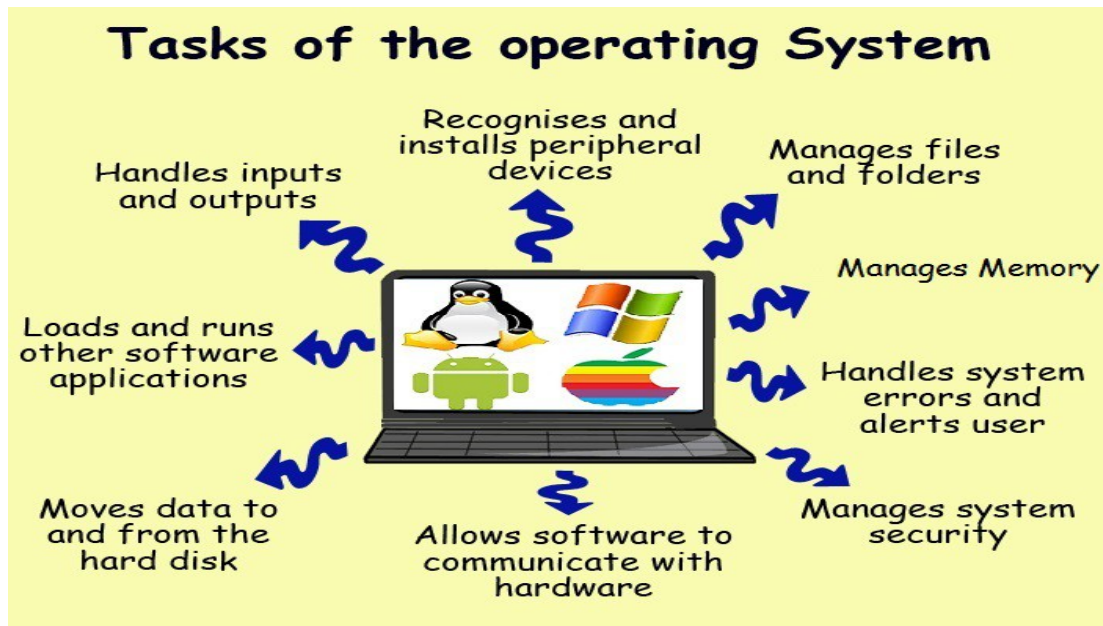
1.2.2 Introduction to Unix

Unix is a time-sharing, multi-tasking, multi-user OS with elegant, powerful file system, a   command interpreter (shell), and a set of utilities (tools/commands, over 200 programs) Developed by Ken Thompson and Ritchie originally in assembly, and later in C, thus making it portable to other machines. Supports C, Fortran, Basic, Pascal, COBOL, Lisp, Prolog, Java, Ada compilers. Unix is an OS for Programmers as shell provides the programming facility. It provides a in-built security mechanism through the user name and password, combined with the access rights associated with files .

Features of Unix Operating System

- Multi-user and Multitasking
- Everything is a file
- Configuration data stored in text
- Small, single purpose programs
- Ability to chain programs together to perform complex task
- Facility of background processing

1.2.3 Flavors of UNIX

The widely used term flavors of UNIX refers to the many Unix-like operating systems that have been developed based on the original UNIX that was written in 1969 by Ken Thompson at Bell Labs. Few of them are:

AIX   - Developed by IBM for use on its mainframe computers
BSD/OS - a commercial version of BSD developed by Wind River for Intel
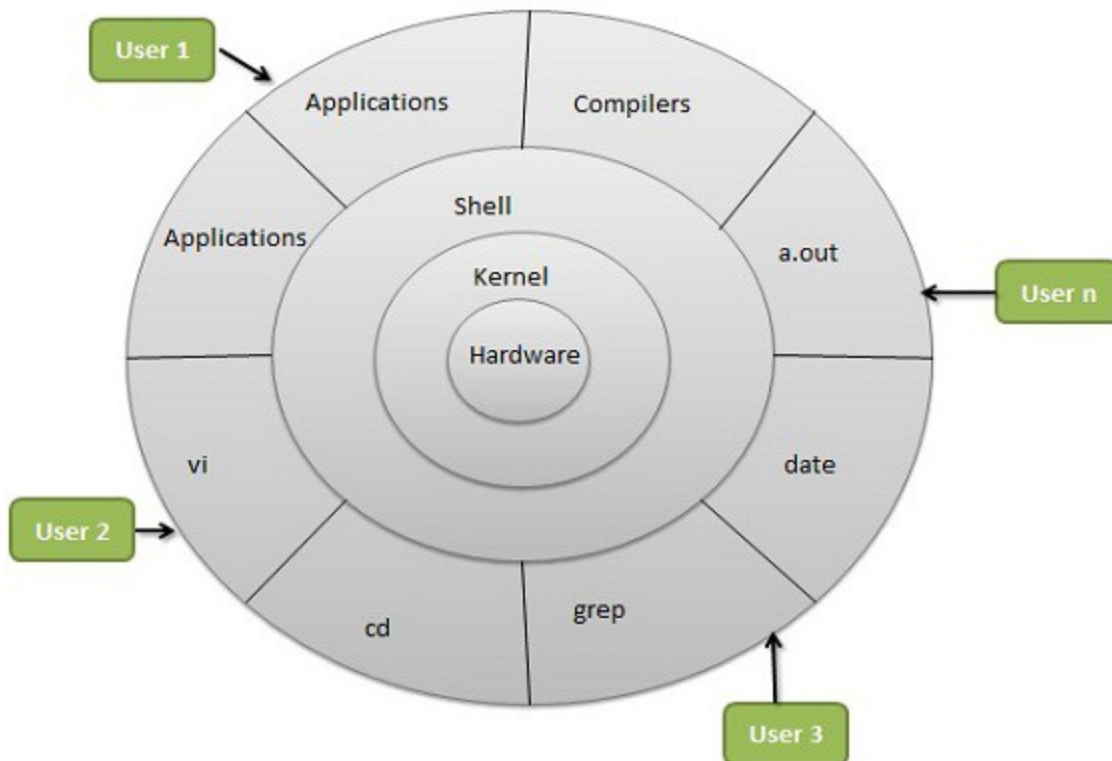
processors

HP-UX - Developed by Hewlett-Packard for its HP 9000 series of business servers

Solaris - Developed by Sun Microsystems for the SPARC platform and the most widely used proprietary flavor for web servers

Tru64 - Developed by Compaq for the Alpha processor

1.2.4 Architecture of the UNIX System

Shell and kernel together make UNIX system work.

1.2.5 The Unix Kernel

The Unix kernel is a collection of programs mostly written in C, that runs directly on the hardware. The OS parts of kernel must be customized to each system's hardware features. These programs are loaded into memory when the system is booted. Kernel is responsible to allocate time and memory to programs, handles file storage and communications in response to system calls. Performing low level jobs like, system Initialization, process/Memory/File/I-O Management, programming interface , communication Facilities are its basic services.

1.2.6 The Unix Shell

The shell acts as an interface between the user and the kernel and is the interpreter of UNIX to decipher and execute commands. (user interface to the kernel for isolating the user from the knowledge of kernel functions.). It maintains interactive dialogue with the user and is capable of Input/Output redirection. Shell can do background processing so that time-consuming, non-interactive tasks can proceed side by side. With the help of pipe, shell makes it possible to connect more than one commands. Shell includes programming language features which can be used to build shell scripts for performing complex operations.

1.2.7 Types of Shells

Bourne Shell - Original command interpreter developed at AT&T by Stephen R. Bourne; fastest official shell distributed with Unix systems (executable filename sh)

C Shell - developed by William Joy and others at UCB; gets its name from C due to syntax resemblance of its programming language (executable file name csh)

Korn Shell - developed by David Korn, combines best features of both shells, not popular (executable file name ksh)

Restricted Shell - restricted version of Bourne shell, typically used for guest logins and in secure installations (executable file name).

1.2.8 The Unix File System

The Unix File System is a hierarchical collection of 3 types of files.
- **Ordinary or regular files** – This is the most common type of file in UNIX.
- **Directory files** - This is a special type of file in UNIX, which only contains a list of other files.
- **Special files (device, pipe, fifo, socket) –** These files allows access to various devices known to the system.

UNIX file is featureless because it is simply an array of bytes.Dominant file type in UNIX is the text file. System related files are also stored in text form. Separate device can be added by creating a file for it. The UFS resides on a single logical disk. A logical disk is a disk partition comprising of a set of consecutive cylinders. UFS further subdivides a partition into one or more cylinder groups and attempts to allocate inodes and related data blocks from the same cylinder group, thus minimizing the disk head movements. At the beginning of the logical disk lies the boot block of UNIX operating system containing the bootstrap program. It is followed by repetitive cylinder groups
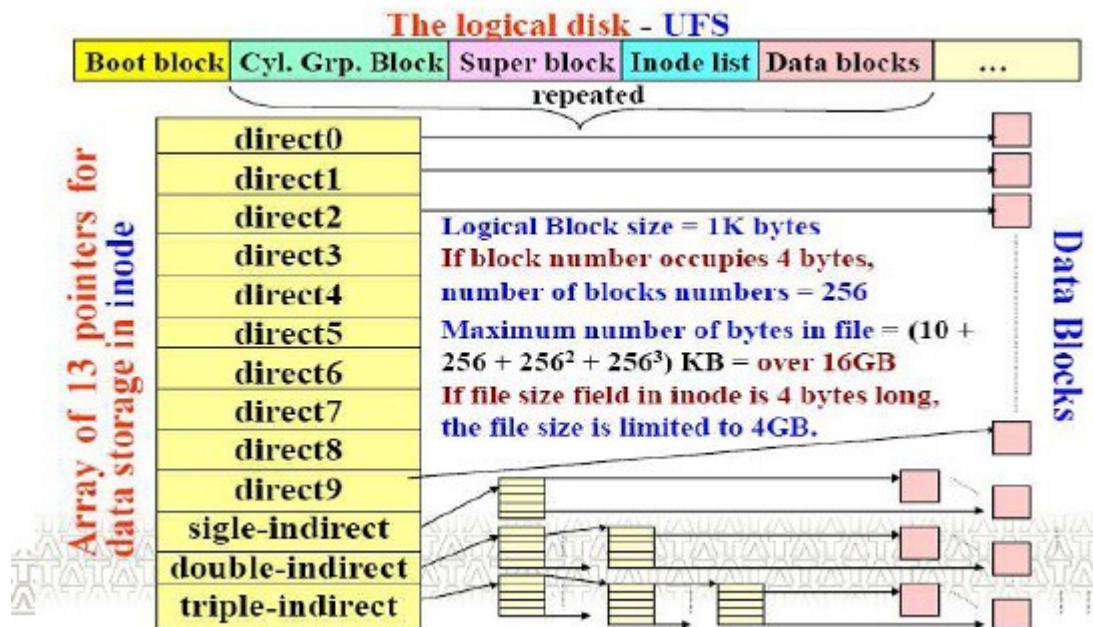
each one containing a super block, cylinder group block, inode list and the data area.

Each cylinder group contains a duplicate copy of the super block. The super block contains the size of file system, number of free blocks, index of next free block in free block list, size of inode list, number of free inodes, index of next free inode in free inode list. The cylinder group block contains a number of inodes and corresponding data blocks for that cylinder group. The block size is a power of 2 (>=4096).

Index node or inode is a disk file record of 64 bytes that maintains the permanent attributes of a file. For each file created in the system, an inode is also created. An inode is permanent and it exists until the corresponding file is removed from the system.

Sample details of an inode :
- Owner and group identifiers
- File type and file size
- Number of links for this file
- Times of file creation
- Time of last file access and modification
- Time of last inode modification
- List of access rights – read/write/execute permissions
- Reference count showing number of times file is opened
- Physical address of file on the disk : array of 13 pointers for data storage

Whenever a file is opened, its inode is brought into main memory. The active inode is kept there until the file is closed and is used to locate the beginning of an open file on disk and to verify that every I/O request comes from a valid user as per specified access permissions.

The logical disk - UFS

Boot block	Cyl. Grp. Block	Super block	Inode list	Data blocks	...

repeated

Array of 13 pointers for data storage in inode

- direct0
- direct1
- direct2
- direct3
- direct4
- direct5
- direct6
- direct7
- direct8
- direct9
- sigle-indirect
- double-indirect
- triple-indirect

Logical Block size = 1K bytes
If block number occupies 4 bytes,
number of blocks numbers = 256
Maximum number of bytes in file = $(10 + 256 + 256^2 + 256^3)$ KB = over 16GB
If file size field in inode is 4 bytes long,
the file size is limited to 4GB.

Data Blocks

Some Important Directories in Linux File System are displayed in the following diagram

root

bin | dev | etc | home | lib | ... | tmp | usr | var

fd hd tty group passwd

admin | faculty | ... | students

bin | lib | ... | local

bobk | ... | sarwar

courses | ... | personal

ee231 | ... | ee446

letter   taxes01

☐ Directory file

◯ Non-directory file
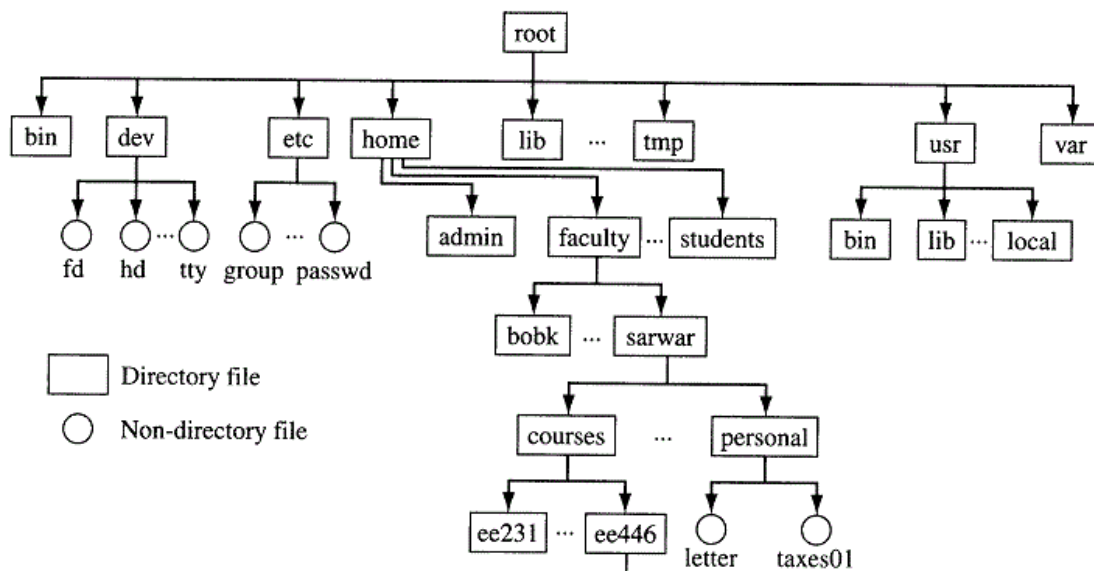
/bin   – Holds many of the basic Linux programs/commands; bin stands for
      binaries, files that are executable.
/dev – Holds device files. All info sent to /dev/null is thrown into trash. Your
      terminal is one of the /dev/tty files.
/etc – It and its subdirectories hold many of Linux config files.

/home – Holds normal user's home directories.
/lib - Contains different Libraries
/tmp - Contains temporary files
/usr   – Holds many user-oriented directories:
          bin – Holds user-oriented Linux programs.
          sbin – Holds system administration files.
          spool – Sub directories inclues,
               .   mail   holds mail files
               .   spool holds files to be printed
        docs – various documents including useful Linux info
        man – man pages accessed by typing the man <command>
/sbin – Holds system files that are usually run automatically.

1.2.9 Video 1: Linux OS Essential Concepts

http://www.youtube.com/watch?v=_gCwCOhMcog

1.2.10 Quiz Time

Q1. Which is not a feature of UNIX?

A. Multiuser
B. Multi-tasking
C. Small programs for single processes
D. Background processing not possible

Answer: D

Q2. Tasks of operating system exclude:

A. Control Hardware
B. Run Applications
C. Manage Data and Files
D. None of these
E. All of these

Answer: D

Q3. _____ is not a type of file in Unix

A. Ordinary Files
B. Video Files
C. Special Files
D. Directory Files

Answer: B

Q4. The Unix kernel,

A. is a compiler
B. is a collection of C programs
C. is a hardware system
D. none of these

Answer: B

Q5. The metadata for a file is stored in,

A. arrays
B. pointers
C. inodes
D. file properties

Answer: C

CHAPTER 2 - BASIC UNIX COMMANDS

2.1 Basic UNIX commands

The basic Unix commands discussed in this lesson are:
- ls
- pwd
- man
- date
- cal

2.2 Course Content

2.2.1 The ls Command

⇧ Lists the contents of any directory (current directory if no directory specified).

⇧ Sorts entries without option

```
$ ls [option(s)] [filename]
```

Option	Description
- a, - - all	Shows all files including HIDDEN FILES
- A	Shows all files except Current(.) and Parent(..) directories
- i	Shows the INODE number and File Name
- l	Shows the long list
- r	Sorts in reverse order
- R	Lists Directories and Sub Directories recursively
- S	Sort by file Size (Descending)
- t	Sort by Modification time (last modified at the Top)

```
$ ls Games
Indoor Ourdoor
```

Lists the content of directory Games.

```
$ ls -a Games
. .. Indoor Ourdoor
.hidden_official_files
```

Lists the content of directory Games including the hidden files

```
$ ls -r Games
Ourdoor Indoor
```

Lists the content in reverse order

ls with -l option prints the long listing

```
$ ls -l Games
drwxr-xr-x 1 user group 4096 2014-02-08 7:14 Indoor
drwxr-xr-x 1 user group 4096 2014-02-08 7:15 Outdoor
```

```
$ ls -il Games
1254532 drwxr-xr-x 1 user group 4096 2014-02-08 7:14 Indoor
1254536 -rw-r--r-- 1 user group 1000 2014-02-08 8:40 Manual
1254534 drwxr-xr-x 1 user group 4096 2014-02-08 7:15 Outdoor
```

```
$ ls -lS Games
drwxr-xr-x 1 user group 4096 2014-02-08 7:14 Indoor
drwxr-xr-x 1 user group 4096 2014-02-08 7:15 Outdoor
-rw-r--r-- 1 user group 1000 2014-02-08 8:40 Manual
```

```
$ ls -lr Games
drwxr-xr-x 1 user group 4096 2014-02-08 7:15 Outdoor
-rw-r--r-- 1 user group 1000 2014-02-08 8:40 Manual
drwxr-xr-x 1 user group 4096 2014-02-08 7:14 Indoor
```

```
$ ls -lt Games
-rw-r--r-- 1 user group 1000 2014-02-08 8:40 Manual
drwxr-xr-x 1 user group 4096 2014-02-08 7:14 Indoor
drwxr-xr-x 1 user group 4096 2014-02-08 7:15 Outdoor
```

2.2.2 The pwd Command

⇧ Prints the fully resolved name of present working directory.

```
$ pwd [option]
```

```
[01HW191084 - bin] $ pwd
/usr/local/bin
```

Present working directory is /usr/local/bin

```
[01HW191084 - bin] $ cd ..
[01HW191084 - local] $ pwd
/usr/local
```

Changed directory to parent. Now present working directory is /usr/local

2.2.3 The man Command

⇧ man command displays the manual pages available for a command, function, or file.

```
$ man [command]
```

```
$ man ls
```

Displays Manual page for ls command

```
LS(1)                        User Commands                        LS(1)

NAME
      ls - list directory contents

SYNOPSIS
      ls [OPTION]... [FILE]...

DESCRIPTION
      List  information  about  the FILEs (the current directory by default).
      Sort entries alphabetically if none of -cftuvSUX nor --sort.

      Mandatory arguments to long options are  mandatory  for  short  options
      too.

      -a, --all
            do not ignore entries starting with .
```

2.2.4 The date Command

Prints or sets the system date and time.

$ date [option]

Option	Description
+%D	Shows date; same as %m/%d/%y format
+%H	Shows current hour (00..23 format)
+%I	Shows current hour (00..12 format)
+%j	Shows the current day of year (001..366 format)
+%M	Shows current minute (00..59 format)
+%T	Shows time; same as %H:%M:%S format
+%Y	Shows full year info in YYYY format
+%d	Shows the current day of month (e.g, 01)
+%m	Shows month information (01..12 format)
+%y	Shows last two digits of year (00..99 format)

```
sh-3.2$ date
Fri Feb  7 14:02:20 IST 2014
```

Command date without any option displays date and time

```
sh-3.2$ date +%T
14:10:59
```

Option +%T
displays the current time

```
sh-3.2$ date "+%d %m %y"
07 02 14
```

Formatted output can be displayed by combining several option

2.2.5 The cal command

Displays the calendar of current month.

$ cal [option] [month] [year]

Option	Description
- 1	Display single month output.
-3	Display previous / current / next month output.
- s	Display Sunday as the first day of the week.
- m	Display Monday as the first day of the week.
- j	Display Julian dates (days one-based, numbered from January 1).
- y	Display a calendar for the current year.

> The command cal 2013
> displays the calendar for year 2013

```
sh-3.2$ cal 2013

        January                 February                  March
Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa
       1  2  3  4  5                    1  2                    1  2
 6  7  8  9 10 11 12     3  4  5  6  7  8  9     3  4  5  6  7  8  9
13 14 15 16 17 18 19    10 11 12 13 14 15 16    10 11 12 13 14 15 16
20 21 22 23 24 25 26    17 18 19 20 21 22 23    17 18 19 20 21 22 23
27 28 29 30 31          24 25 26 27 28          24 25 26 27 28 29 30
                                                31
         April                    May                     June
Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa
    1  2  3  4  5  6              1  2  3  4                       1
 7  8  9 10 11 12 13     5  6  7  8  9 10 11     2  3  4  5  6  7  8
14 15 16 17 18 19 20    12 13 14 15 16 17 18     9 10 11 12 13 14 15
21 22 23 24 25 26 27    19 20 21 22 23 24 25    16 17 18 19 20 21 22
28 29 30                26 27 28 29 30 31       23 24 25 26 27 28 29
                                                30
         July                   August                 September
Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa
    1  2  3  4  5  6                 1  2  3     1  2  3  4  5  6  7
 7  8  9 10 11 12 13     4  5  6  7  8  9 10     8  9 10 11 12 13 14
14 15 16 17 18 19 20    11 12 13 14 15 16 17    15 16 17 18 19 20 21
21 22 23 24 25 26 27    18 19 20 21 22 23 24    22 23 24 25 26 27 28
28 29 30 31             25 26 27 28 29 30 31    29 30
       October                 November                December
Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa    Su Mo Tu We Th Fr Sa
       1  2  3  4  5                    1  2     1  2  3  4  5  6  7
 6  7  8  9 10 11 12     3  4  5  6  7  8  9     8  9 10 11 12 13 14
13 14 15 16 17 18 19    10 11 12 13 14 15 16    15 16 17 18 19 20 21
20 21 22 23 24 25 26    17 18 19 20 21 22 23    22 23 24 25 26 27 28
27 28 29 30 31          24 25 26 27 28 29 30    29 30 31
```

2.3 Video 2 : Basic Commands

http://www.youtube.com/watch?v=AO0jzD1hpXc&list=PL8A83A276F0D85E70

2.4 Quiz Time

Q1. Which command is used to list all the files, including the hidden files in a directory?

A. ll -h
B. ls -h
C. ls -a
D. ls -l
Answer: C

Q2. Which is the correct way of getting manual pages for the grep command?
A. grep –help
B. grep -man
C. man grep
D. grep manual
Answer: C

Q3. Which command will give you the absolute path for your current working directory?
A. currdir
B. path
C. pwd
D. dirname

Answer: C

Q4. Which command will help you in getting the current date and time?

A. systemdate
B. currentdate
C. today
D. date
Answer: D
Q5. cal command is used to get,

A. calculator
B. calendar
C. calligraphy

D. call

Answer: B. calendar