syllbus

- Linux Commands,
- Vi editor,
- Shell Scripting,
- Overview of OS,
- Processes,
- Scheduling & Synchronization,
- Memory management,
- File Systems,
- Case Study with Linux System Programming: Process,
- Signals,
- Semaphores & Mutex,
- Inter – Process Communication, POSIX Threads

day1

1. OS

- it is a interface between user and hardware
- core of OS is Core OS/Kernel :
    - it doing minimul basic functionalities, like
    - 1. Process management
    - 2. file I/O managaement
    - 3. memory management
    - 4. CPU Scheduling
    - 5. hardware abstraction
    - OS also does extra functionalities like
    - 1. User interfacing
    - 2. Networking
    - 3. Protection and Security

2. Linux

- linux is inspired by unix ,which was designed by denis richtie and in 1970
- unix is based on
    - file control subsystem (I/O management) and
    - process control sub system
- its logan is :
- **"file have spaces and process have lines "**
- i.e everything is a file , examples of special files are
    - data file, directory,pipe,socket,links(shortcuts),
    - block devices , where 1 sector = 512 bytes,

    - char devices , byte by byte

- process
- system calls :
- A system call is a way for programs to interact with the operating system.
- A computer program makes a system call when it makes a request to the operating system's kernel.
- System call provides the services of the operating system to the user programs via Application Program Interface(API)
- software interrupts

OS Learning

1. end users

- commands

2. administrator

- installation
- shell scripts

3. programmer

- system calls

4. designer

- OS Internals

Linux Shell

1. Shell takes input from terminal i.e from end user and runs system call i.e get them executed by kernel and shows output on terminal

- terminal is the window we give input and get output ,
- internally terminal has shell
- two types of shell
- 1. GUI Shell
    - in windows: explorer.exe
    - Linux : GNOME or KDE
- 2. CLI Shell
    - windows: cmd.exe, POWER shell
    - in linux : first was bsh then changed to bash (bourne again shell)
        - csh/tcsh
        - zsh

        - zsh
        - ksh --> Korn shell(unix)

2. LINUX folder structure

-

1. in boot

- linux kernal name : vmlinuz
- linux boot loader : grub

2. in bin

- executables/commands

3. in sbin

- system commands(admin)

4. in lib

- contains libraries (.so) and device drivers(.ko)
    - where ko: kernel objects

5. usr

- contains all installed programs/softwares

6. etc

- contains hardware and software configuration files of: system,application , hardware
    - source.list
- user password stored in

> /etc/passwd

7. dev

- contains device files(char and block)

8. proc

- for monitoring /dynamic config
- kernel window

9. sys

- for device drivermanagement

10. tmp

- its temporary file system(auto lost when shutdown)

11. mnt

- mount point (to see other file system)
- optional
- can mount cp or hdd using mount command

```
sudo mount /dev/sdb1 /mnt
```

- sbd : pendrive
- sda : pc storage
- to unmount it

```
sudo umount /mnt
```

12. root

- directory for admin user (i.e root)
-

13. home

- contains all users data like

- sunbeam
- root

- if username is sunbeam ,then it home directory is

```
/home/sunbeam
```

14. The table below shows the section numbers of the manual followed by the types of pages they contain.

- 1. User/Linux/ Executable programs or shell commands
- 2. System calls (functions provided by the kernel)
- 3. Library calls (functions within program libraries)
- 4. Special files (usually found in /dev)
- 5. File formats and conventions eg /etc/passwd
- 6. Games
- 7. Miscellaneous (including macro packages and conventions), e.g. man(7), groff(7)
- 8. System administration commands (usually only for root)
- 9. Kernel routines [Non standard]

Linux Commands:

1. Linux version

```
uname -a
```

2. List commandds

```
terminal > ls -l
# size of directory
```

```
terminal > ls -l -h
```

3. command to show shell

```
 >  ls /bin/*sh
 > /bin/bash  /bin/dash  /bin/rbash  /bin/sh  /bin/static-sh
```

4. to change shell [NOT RECOMMENDED]

```
chsh
```

- i.e change shell

5. check working shell

```
echo $SHELL
```

6. to check boot folder content

```
ls /boot
```

7. to get kernel/cpu info

```
cat /proc/cpuinfo
```

8. to create directory

- path -- w.r.t current directory

```
mkdir
```

- it does'nt start with '/'
- path with wr.t to absolute path,

```
mkdir /home/sunbeam/
```

- start with '/' : are absolute path

9. for Relative path, Special directories are

- 1. . : current directory

  ```
  ./a.out
  ```

- 2. .. :
- 3. :

10. list contents of current directory

```
ls
e.g : ls /boot
```

- list content of your home directory / long view

> ls -l ~

- where -l --- long listing (detail view)
- contains type, mode/permissions,links,user, group, size,modified timestamp,name

11. to change directory

- from absolute or relative path

> cd commands

- as not start with '/', so relative
-

12. to remove empty empty directory

> rmdir

- to delete contents in directory

> rm -r dirpath

13. cat command to create and insert file content

> cat > .txt eg:

```
cat > fruits.txt
mango
banana
# use cltr + D to come out from writing
```

- to view content of the file

> cat .txt

14. copy given directory to a destination directory

> cp -r

15. move file into given directory

> mv

- also use for rename a fle

> mv -r .txt

- In linux file/directory starting with "." is hidden
- to see hidden files

> ls -a

- to see hidden file content

> cat .fruits.txt

16. IO redirection

```
> ls -l -a
# output is shown on terminal
 # now to save output in file
> ls -l -a > out.txt
# output copied to file

> cat out.txt
# we can see output of ls

# for sorting
> sort
nitin
amit
sandeep
nitin
amit
nitin
nitin
sandeep

## INPUT redirection
# input(stdin) is taken from file and output on terminal
>  sort < fruits.txt

## OUTPUT redirection
# read output from, a file and writing in another file
> sort <  fruit.txt > result.txt

# for revrse order sorting
> sort -r <   fruit.txt

## ERROR redirection
# invalid option -x
> sort -x <   fruit.txt

# error output is shown on terminal
# output is shown on terminal (stderr)



# number of standard
#stdin = 0,
# stdout = 1,
# stderr = 3
```

```
# so to write error output
> sort -x 2> err.txt
```

17.to give one command output to other commands

- for word count

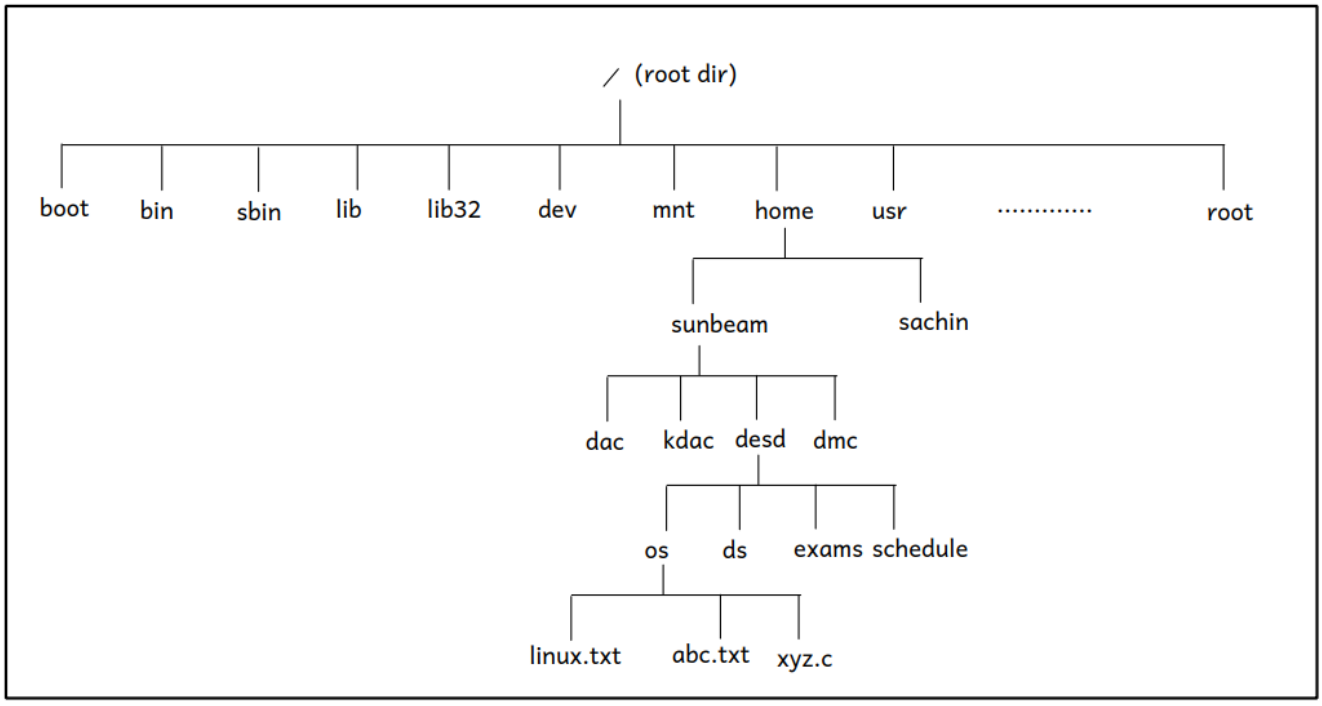
```
> wc

hello sunbeam
here
# Cltr + O
      2       3      20
#   lines    words   charcters

# to give one command output to other commands
> ls -l | wc
#left command (ls -l) output is given as input to right command(wc)
```

Lab commands

1. LinuxFileSystemStructure our application of Tree Data structure



absolute path ==> "/home/sunbeam/desd/os/linux.txt"
relative path wr.t. sunbeam ==> "/desd/os/linux.txt"

2. Lab commands I

```
# 1.  to clear screen
> clear
# or use Cltr + L

# 2. to change dir to home directory
> cd ~
# 3. to show current working dir
> pwd

# 4. create a  directory and a sub directory,
# where -p:
>   mkdir -p  os/linux_commands

# 5.changing directory
  # - from inner directory to outer
  # use '..' + outer directory
  > cd ../../..

  # to go to root dir
  > cd /
  # to go to the previous dir
  > cd -
  # stay in current dir
  > cd .
  # go to parent dir
  > cd ..

# 6. list commands
     # list content/file names in dir
     > ls
     # list  content/file with hidden, and total data block allocated
     > ls -l -a

     # shows file/content info
     # drwxr-xr-x 3 sunbeam sunbeam 4096 Dec 11 14:51 ..
     # contians : 1)type-of-file :--> d: directory, -: for regular -
     #      2) wxr: are read and write permission
     # -l : to be displayed as a list
     > ls -l

     # here -s: show no of data block got allocated
     > ls -l -s



# 7 to make multiple  subdirectory in a dir
     > mkdir /one /two /three /four

     # make sub directories recursivly
     > mkdir -p four/five/six
     # use :  -R to display list sub-directory recursively
     > ls -R four/
```

```
# 8 . cat commands
  # to create and isnert in a file
   > cat > file1.txt
    suraj
    raj
    ram
    # use Cltr + D

   #  to show the file
   > cat file1.txt

   # now if we use same cat command , content get overwritten
   > cat > file1.txt

   #to display in reverse order
   > tac > file1.txt

   #concat multiple files
   >  cat file2.txt file3.txt

# 9 to delete a file or a directory
>  rm -r <directory>/
>  rm -r <file-name>
#
```

1. list command syntax

> ls [OPTION]... [FILE]...

- where
- ... indicate : multiple arguments allowed
- FIle: IO file , if not given , takes pwd

3. Lab Linux commands

```
# copy all text files to destination
# * : used to describe as all, if used with extension so all files of that
type
> cp ./*.txt ./../../../../
# using pipe to give output to 2nd command after |
> cat 5.txt | less
#  Sort based on ASCII value
> > sort  numbers.txt | less

# to sort number in file numerically
> sort -n  numbers.txt | less

# sorter and unique
> sort -n   numbers.txt | uniq
```

```
# head print 10 lines by default , we can set no of lines
> cat numbers.txt | head  -<number of lines>
> cat numbers.txt | head  -2

# tail to print from  last
>  cat numbers.txt | tail -<number of lines>

# can use tail and head together , pass one output as input to other
> cat numbers.txt | tail -15| head -5

#  -d : delimeter on basis on which it cut
# -f1: prints 1st field
> cat sunbeam.txt | cut -d " " -f1
> cat sunbeam.txt | cut -d " " -f2

# -i:display inode no
> ls -i -l

# we can cut any list , and give which fields , like f1,f2
> ls -i -l | cut -d " " -f1,

# path of binary
> echo $PATH

# tr : commands translates from one char to another
> echo $PATH | tr ":" "\n"

# tr : translates all small case into capital
>  echo "Suraj" | tr "a-z" "A-Z"

> echo "Suraj" | tr "a-zA-Z" "A-Za-z"
- sUraj from Suraj


# chmod use for change permission , where u: user,g: group , o: other
# where w: write, r: read,x: execute
# using u+x , u-x, we can change permission
> chmod g+w india.txt
> chmod u+rwx india.txt
> chmod o-rwx india.txt
> chmod g-rwx india.txt

# r: apply ls command
# w: we can create files and sub directory
# x: we can apply cd command on it

# there are two formats/method by which we can change mode bits of a file
i.e
# we can assign /remove access permission :
# 1. human readable : r,w,x
 used as
> chmod +rwx filepath
> chmod -rwx filepath
```

```
# 2. octal formats :
# read : 4, write : 2, execute : 1
# first digit : octal digit start with zero , so lading 0 indicate octal
contant
# second digit : access permission for user/owner
# third digit : access permission for group members
# fourth digit : access permission for other members
> chmod 0641


# create a alias for command , it is for  session
> ls -l -a -i -s
# alias command: where l = alias
> alias l="ls -l -a -i -s"
# execute alias l
> l
# command to remove alias
> unalias l
```

day2

Agenda

1. Advanced Linux commands
2. Shell features
3. Shell script
4. File and File system

notes

1. **Shell wild card character** *: it is any number of any character ? : for single character

2. $? : a special shell variable , to show if your previouse commands succeeded or failed

- if $? : 0 --> success,
- !0(not zero) like 1 to 255 ---> fail

```
echo $?
```

- i.e $? ==> exit code of previous command / program

Linux commands part II

1. to create a file

```
touch f1.txt f2.txt d.txt
```

- to look only .txt file

```
ls *.txt
```

2. txt file starting with f

```
ls f*.txt
```

1. Shell wild card character
    - *: it is any number of any character
    - ? : for single character
    - for .txt with 3 character starting with f

```
ls f???.txt
```

- output : file.txt

```
ls f?.txt
```

- output f1.txt f2.txt

2. cat commands

- if no file path given , takes string as input as print output

```
cat
```

- to create insert in a file

```
cat > text.txt
```

- to append the same file

```
cat >> text.txt
```

- using combination

```
sort < text.txt > out.txt || err.txt
```

5. no of user connected

```
who
```

6. $? : a special shell variable , to show if your previouse commands succeeded or failed

- if $? : 0 --> success, !0(not zero) like 1 to 255 ---> fail

```
echo $?
```

7. test commands check a condition based on expression

```
test 12 -eq 12
```

- now we can check if it failed or success

```
echo $?
```

- where eq: equal , gt: greater than

8. for running cx program in shell

```
terminal> cat > hello.c
#include <stdio.h>
int main() {
    printf("hello world!\n");
    return 0;
}
# ctrl+D

terminal> gcc -o hello.out hello.c
terminal> echo $?
# output=0 -- success -- condition true
```

9. logical nesting of commands

- 1. &&
  - if first command successful then, run second command

```
test 12 -eq 12 && date
```

  - successfully run date

```
test 12 -gt 12 && date
```

  - failed to run date
- 2. ||
  - either 1st or 2nd command #test command have : -d : to check if it is a directory

```
test -d f1.txt && ls f1.txt
```

  - it only 1st command success, then run second

```
test -d fruits.txt || ls f1.txt
```

  - here if 1st command fails ,run second command
- 3. & (asynchronous command execution)

10. find command , is to find files , so path , by name, file name

```
find ~ -name "file.txt"
```

11. open file from shell

```
firefox
```

- here firefox will be opened , but shell prompt is not available
- shell is waiting for firefox to complete
- once firefox is closed, shell
- so for asyncronous use

```
firefox&
```

12. Regular Expression

- have 3 commands type

> grep egrep

- **regular expression Wild card characters**
- 1. ^ : starts with the character
- 2. $: end with the character
  - applicable for regular expression command
- 3. [] : any single character , search is given specific range , called scan set
- 4. . : search for any single character
- 5. / : to remove special character, or use fgrep
- 6. [^...] : inverse of scan set , i.e outside this range ,any single character accepted
-

```
> cat > food.txt
this
biscuit
isnot
tasty,
but
that
cake
is
really good.
# ctrl+D

# to print a pattern in  a file , like is in a file
> grep "is" food.txt

# for is in beginning, use carrot character : '^'
> grep "^is" food.txt

>  grep "is$" food.txt

> grep "^is$" food.txt
```

- other wild cards

```
> cat > bug.txt
bag
beg
big
bug
bog
bg
b*g
# ctrl+D
```

```
# here : . --> indicates only one character between b and g
> grep "b.g" bug.txt

# here [a-z] --> valid option to appear between b and g
> grep "b[a-z]g" bug.txt

# search is specific range indicated by : []
> grep "b[aou]g" bug.txt

# to print "b*g" : i.e special character
- use / to remove special character
> grep "b\*g" bug.txt

# for no meaning of special character,search word as it is, so no wild card
meaning
> fgrep "b*g" bug.txt
```

13. Extended Regular expression character, use egrep

- grep -> only basic wildcard characters
- egrep --> basic + extended wildcard characters
- wild card character in Regular expression
- 1. `* : zero or more occurence of previous character or group`
- 2. `+ : one or more occurence prev char /group`
- 3. ? : 0 or 1 occurence
- 4. {n}, {m,n},{m},{n} : number of occurence of prev char /group
- 5. (w1|w2|w3) : find a word form w1,w2,w3

```
terminal> cat > big.txt
bg
big
biig
biiig
biiiig
biiiiig
biiiiiig
biiiiiiig
#ctrl+D

# zero or one
>  grep "bi*g" big.txt
- fail
## Extended category
```

```
# one or none
> egrep "bi?g" big.txt
# 1 or more
terminal> egrep "bi+g" big.txt
# exactly 3
terminal> egrep "bi{3}g" big.txt
# 3 oor more
terminal> egrep "bi{3,}g" big.txt
#3 or less than 3
terminal> egrep "bi{,3}g" big.txt
# between 3 and 5
> egrep "bi{3,5}g" big.txt

# for wit or  condition from  multiple values using |
>  egrep "(cake|biscuit|good)" food.txt
```

14. Regular Expression : flags

- 1. -c : count
- 2. -n : gives line search character found

```
> grep -c "printf" hello.c
> grep -c "b[a-z]g" big.txt

# * zero or more occurence of  previous character or group
terminal> grep -n "big" *.txt

terminal> grep -R -n "big"
# to check in all directory
> grep -R -n "goto" ~
#  grep,  recursively all files, - print line , check expression , file
path
```

15. build regex

- 1. for 10 digit mobile number, regrex

  > "^[0-9]{10}$"

  - i.e start ^ [scan-set] {no on character} end $

Shell Script using VIM Editor

1. VIM Editor related

- Vim Editor worlds best editor for terminal
- question on vi editor : copy on VI editor
- started as VI editor,, developed by Bill Joy
- now,we use Vim editor :VI improved editor

1. **VI editor modes :**

- 1. command mode
- press "Esc"
- 2. insert (edit)
- to insert = press "i"
- 3. write/save = :w
- 4. quit = :q
- 5. write and quit = :wq
- 6. quit without saving :q!

cltr + s suspend and cltr + q resume

- 7. :ls
  - to list VI files
- 8. :next

- to jumb forward to other files in VI

```
:3next
```

  - to jump forward by 3 files
- 9. : prev

```
:2prev
```

  - to jump back by 3 files , can be seen by :ls
- 10. : wqa
  - write and quit all
- 11. -O : open two files vertical tab

```
vim -O one.h one.c
```

- 12. -o : open two files in horizontal tab

```
vim -o one.h one.c
```

- 13. Cltr+ W+W
  - switch between tabs use
- 14. to copy content in file

```
use 2yy
take cursor to dest , press p
```

- 15. to open VIM editor

```
vim <filename.extension>
```

2. **commands for Setting/customize VI**

```
# set tab stop : how many spaces
: set tabstop = 8
# set spaces on press of shift
: set shiftwidth=4

# no color
: syntax off

# color
: syntax on

# write and quit all files
: wqa

# to open two files, side by side
: vim -o one.c header.c

# set nowrap
: set nowrap

# set write all default
: set autowriteall
```

3. **for specifying setting only once , for VI** .vimrc file : content/commamds in it , are auto executed, when vi editor starts

- located in user's home directory

```
# to open .vimrc file
> vim ~/.vimrc

# to insert
: i
 set number
 set tabstop=4
 set shiftwidth=4
 set autoindent
 set nowrap
 set autowriteall
 syntax on


: wq
```

4. **data Manipulation Commands in VI editor**

- 1. to copy
  - yy --> copies current lin
  - 4yy --> copies 4 line from cursor

    - :6,9y ---> copies line 6 to line 9
    - yw --> copies current word (from cursor)
    - 3yw --> copies 3 words from cursor
- 2. to paste
    - p ---> paste from the cursor
- 3. u ---> undo
    - for undo
- 4. cltr+R ---> redo
    - for redo
- 5. to cut
    - dd --> cut current lin
    - 4dd --> cut 4 line from cursor
    - :6,9d ---> cut line 6 to line 9
    - dw --> cut current word (from cursor)
    - 3dw --> cut 3 words from cursor
    - using cut we can delete too
- 6. to find
    - use / and filename to find

```
Esc ---> :/word
```

        - n ---> to find sub-sequent occurences

```
:/printf
```

    - to find printf
- 7. to find and replace use

```
    - Esc --> :%s/find/replace/#g --> replace all occurrences :%s/find/replace :%s/printf/scanf
```

- here can use #g for global at end

```
:%s/printf/scanf/#g
```

- 8. Indentation

```
Esc --> gg=G
```

    - gg --> first line
    - G --> last line
    - = --> Indentation
- 9. Go to line

```
Esc --> :34
```

    - Jump to line 34

10. how do you run bash command from VI editor , use Esc ---> :!command

```
Esc --> :!command
```

- to compile c file

> Esc ---> :!gcc -o hello.out hello.c

```
# to compile and run c program from Vim editor
Esc --> :!gcc -o one.out one.c

Esc --> :!./one.out
```

2. Shell Script (SS)

1. Shell script is collection of shell commands along with programming constructs lijke if-else,loop,case,functions.
2. it is interpreted language

- line by line execution
- 1. pros :
  - simplified syntax
  - quick development
- 2. cons :
  - fixed syntax (not free-form),not required spaces can give error
  - tough debugging
  - slower execution ,based on system (nowadays configure of pc better, so execution speed increased)

3. Applications of SS i.e .sh files

- 1. Installers
  - .sh files , installion command files can be made
- 2. Administrator
  - to fix some issues, having common set of instructions, use .sh file, so can be used by multiple
- 3. Automation job
  - like testing job

3. Shell Scripts demo

-

1. demo to write and run shell script file

- simplest shell script is set of commands
- the first line contains path of shell program to execute this script followed by #!
- when script is executed (./hello.sh), then OS invoke the shell program to execute this script
- 1. create SS

```
> vim hello.sh

#!/bin/bash
#the first line contains path of shell program to execute this script
```

```
followed by #!
#when script is executed (./hello.sh), then OS invoke the shell program to
execute this script
cal
uname -a
who

# Esc ---> :wq
```

- 2. to run SS using bash
  - used during development

```
bash hello.sh
```

- 3. to give execute permission to SS file

```
chmod +x hello.sh
```

- 4. now we can execute it using ./
  - using during production

```
./hello.sh
```

- 5. by default run with current shell(if sheband line is missing)
  - so run only by bash shell , for this in VIM , opening our .sh file
    - first line of code must be

```
#!/bin/bash
```

  - this command is known as Shebang line
  - it starts with # i.e comment for shell interpretor (/bin/bash)
  - so bash skip this command, but OS reads this line as its first line, as we used #! , and execute it
  - the first line contains path of shell program to execute this script followed by #!
  - when script is executed (./hello.sh), then OS invoke the shell program to execute this script

Note :

- 1. on Linux , group are created, which contains number of users,and those not in group are other

```
# so permission is shown in terminal as
  rwx    rwx    rwx
  user   group  other

> rw-r-----
# now change permission use chmod
```

2. demo 2 on shell varaible and operation

- shell variables created as

> var=value

- to print variable

> echo "$value"

- command substituation

```
#!/bin/bash

#while assigning value to variable do not use dollor
#no space before/after assign operator
num1=101
num2=5
# -n : skip trailing new line
echo -n "Unix is simple. "
echo "It need a "
# -e  to enable escape sequence
echo -e "Unix is very  \n user friendly"
# to access/read value of variable use $
echo "num1 value is $num1"
echo "num2 value is $num2"
# only integer arithmetic possible in shell
# for expression use expr compulsort
# using space between variable expression compulsory
expr $num1 + $num2
# traditional syntax, use backquote `` to compute and store, command
substitutation or command expansion
# can use var=$(command) also
result=`expr $num1 - $num2`
echo "sub is $result"
```

3. calculate area of rect using shell

- scale ---> for decimal points in result of expression
- bc --> indicates basic calculator for floating point calculation,
    - now bc prints on screen
- read : read input from user

```
echo "2.34 / 2"|bc

echo "scale=3;2.34 / 2"|bc
```

```
 #/bin/bash

 #calculate area of rect
```

```
 echo -n "enter length: "
 read len

 echo -n "enter breadth: "
 read br

  area=`expr $len \* $br`

  echo "area $area"

  echo -n "enter radius : "
  read rad

  # for floating point calculation, use bc --> i.e basic calculator
  # with  we can also use scale , no do decimal points it should be
accurate
  area=`echo "scale=4; 3.1415 * $rad * $rad"| bc`
  echo "area of circle : $area"
```

4. code for leap year in shell

- -eq --> equal to , -ne --> not equal to

```
 #!/bin/bash

 echo -n "enter year : "
 read y

 # c--> y%4==0 && y%100!-0 || y%400==0
 if [ `expr $y % 4` -eq 0 -a `expr $y % 100` -ne 0 -o `expr $y % 400` -eq 0
]
 then
     echo "leap year"
else
    echo "not leap year"
fi
```

5.code for loop

```
 #!bin/bash

 # print table of given number

 echo -n "enter a num: "
 read num

 i=1
```

```
while [ $i -le 10 ]
do
  res=`expr $num \* $i`
    echo "$res"
    i=`expr $i + 1`
done

for (( i=1; i<=10; i++ ))
 do
    res=`expr $num \* $i`
    echo "$res"
done
```

day4

notes

1. using [] in loop , is same as test command
2. tr command
3. loop use: continue and break commands in shell , for program like prime no
4. Special variable in Positional Parameters

- $0 : file name
- $1,$2...$9 :

5. shift commands: to shift/scrap first n arguments , and the further arguments are renumbered as $1,$2
6. bedefault user id = 1000, root user id = 0 [EUID]
7. Positional parameters

> terminal> ./script.sh arg1 arg2 arg3

- 1. Special variables
  - $0 --> for file name
  - $1, $2, , $9 --> for Command line argument(CLA)
  - $# ---> for count of collection/CLA
  - $* ---> for all collection element
- 2. shift command
  - to scrap/reset CLA specified in command , so we can use them again

  > shift number

8. BASH functions

```
# function declare and define
function my_func() {
}
```

```
result=$(my_func a g1 a g2
)
```

9. Array

- array declaration

```
arr=( al1 al2 al3 )
```

- printing array element

```
echo " ${arr[0]}, ${arr[1]} "
```

- collection of values/all elements of array

```
${arr[*]}
```

- count of values

```
${#arr[*]}
```

10. Strings

- string declaration

```
str='string value'
```

- string length

```
${#str}
```

- for substring

```
${str:start_index}
```

- for substring count

```
${str:start_index:count}
```

- **special syntac for regular expression**

```
if [[ $str =~regex ]]
 then echo "true"
  fi
```

- **to find and replace words in string str**

```
${str/find/replace}
```

10. Directory operations

- to go to a directory and put it in stack

> pushd dirpath

- LIFO approach , using popd we go back one directory

> popd

- show directory stack

> dirs -v

demos , Positional Parameters (in c Command line arguments)

0. syntax for loop

- 1. switch case

```
case expr in
c1)
   ...
   ;;
c2)
   ...
   ;;
c3)
   ...
   ;;
*)
   ...
esac
```

- 2. syntax for for loop

```
• for loop
# C like for loop
for (( initialization; condition; modification ))
do
   ...
done

# for-each loop

for var in collection
do
    ...
done
```

- 3. syntax for if-else

```
if [ condition ]
then
     ...
fi

# if elif fi

if [ condition ]
then
     ...
elif [condition]
then
    ...
else
    ...
fi
```

- 4. while loop

```
while [ condition ]
do
  ...
done
```

- syntax for until loop

```
until [ condition ]
do
  ...
done
```

1. using for loop for fixed array

```
  1 #!/bin/bash
  2
  3 #for=each loop demo
  4
  5 for num in 11 22 33 44 55
  6 do
  7  echo "$num"
  8 done
  9
~
```

2. using for and if loop

```
#!/bin/bash

# print all executable  files from given directory

echo -n "enter dir path : "
read dirpath

if [ -d $dirpath ]
then
  for file in `ls $dirpath`
  do
    if [ -x $file ]
    then
        echo "$file"
    fi
  done
else
   echo "invalid dir path"
fi

```

3. switch case

```
  #!/bin/bash

# print no ofday  in a month

echo -n "enter a month "
read month

case $month in
1|jan|january)
  echo "Jan has 31 days"
  ;;
2|feb|february)
  echo "Feb has 28/29 days"
  ;;
*)
  echo "dont know "
esac

```

4. using tr command for translation from upper to lower vica-versa

```
tr - translate or delete characters
```

```
SYNOPSIS
       tr [OPTION]... SET1 [SET2]

DESCRIPTION
       Translate, squeeze, and/or delete characters from standard input,
writ-
       ing to standard output.

       -c, -C, --complement
              use the complement of SET1

       -d, --delete
              delete characters in SET1, do not translate

       -s, --squeeze-repeats
              replace each sequence of a repeated character that is listed
in
              the last specified SET, with a single occurrence of that
charac-
              ter

       -t, --truncate-set1
              first truncate SET1 to length of SET2

  [:alnum:]
              all letters and digits

       [:alpha:]
              all letters

       [:blank:]
              all horizontal whitespace

       [:cntrl:]
              all control characters

       [:digit:]
              all digits

       [:graph:]
              all printable characters, not including space

       [:lower:]
              all lower case letters

       [:print:]
              all printable characters, including space

       [:punct:]
              all punctuation characters

       [:space:]
              all horizontal or vertical whitespace
```

```
        [:upper:]
               all upper case letters

        [:xdigit:]
               all hexadecimal digits
```

```
#!/bin/bash

# print no ofday  in a month

echo -n "enter a month "
read month
month=`echo "$month" | tr "A-Z" "a-z"`

case $month in
1|jan|january)
  echo "Jan has 31 days"
  ;;
2|feb|february)
  echo "Feb has 28/29 days"
  ;;
*)
  echo "dont know "
esac
```

5. command line argument are

- $0 ---> file name
- $1,$2,..$9 ---> command line arguments
- $#--> no of arguments taken from CLI

```
#!/bin/bash
# shebang line

# addition of two numbers --passed on command line

if [ $# -ne 2 ]
then
    echo "invalid argu"
    exit
fi

result=`expr $1 + $2`
echo "result : $result"
```

```
18
19 # terminal> chmod +x demo8.sh
20 # terminal> ./demo8.sh 11 33
21
22 #$0 ---> name of script --> demo8.sh
23 # $1 --> arg1 ---> 11
24 # $2 ---> arg2 ---> 333
25 # $3,...,$9
26
27 # $# ---> count of arguments ---> 2 arguments for this program
28 # file name is excluded
29
```

6. passing all arguments in CommandLine argument, using $*

```
#!/bin/bash
 2
 3 # addition of all numbers passed on args
 4
 5 # terminal > ./demo9.sh 1 2 3 4 5
 6 # $* ---> collection of args
 7
 8 sum=0
 9
10 for num in $*
11 do
12   sum=`expr $sum + $num`
13 done
14
15 echo "sum = $sum"
16
```

7. **Shift Command : mcq question**

```
#!/bin/bash
 2
 3 echo "arg1 : $1"
 4
 5 echo "arg2 : $2"
 6
 7 echo "arg3 : $3"
 8 echo "arg4 : $4"
 9
10 echo "arg5 : $5"
11 echo "arg6 : $6"
12 echo "arg7 : $7"
13 echo "arg8 : $8"
14 echo "arg9 : $9"
15 shift 9
```

```
 16
 17 echo "arg10 : $1"
 18 echo "arg11 : $2"
 19 echo "arg12 : $3"
 20 echo "arg13 : $4"
 21
 22 # terminal > ./demo10.sh A B C D E F G H I J K L M N
 23
 24 # args: $1, $2, ..., $9
 25 # HERE $10 AS ARGUMENT NOT AALLOWED
 26 # 1 way then is SO USE loop
 27 # 2 way , use shift command
 28 # shift n command
 29 #  shift "n" args to left (left "n" args are discarded)
 30
~
```

8. function in shell

```
1 #!/bin/bash
  2
  3 # write a function to substract two numbers
  4 # here echo in function are used for taking result to buffer ,again use
echo after function call to print res
  5 function substract()
  6 {
  7  res=`expr $1 - $2`
  8  echo "$res"
  9 }
 10
 11 function multiply()
 12 {
 13 res=`expr $1 \* $2`
 14 echo "$res"
 15
 16 }
 17
 18 echo -n "enter two numbers"
 19 read num1 num2
 20 result=$(substract $num1 $num2)
 21 echo "result : $result"
 22
 23 multiply $num1 $num2
```

9. array declaration

```
1 #!/bin/bash
  2
  3 # array demo
```

```
 4
 5 declare -a arr      # optional array declaration
 6 arr=(11 22 33 44 55)
 7
 8 echo "element 0: ${arr[0]}"
 9 echo "element 1: ${arr[1]}"
10 echo "element 2: ${arr[2]}"
11 echo "element 3: ${arr[3]}"
12
13 echo "array element count: ${#arr[*]}"
14
15 for num in ${arr[*]}
16 do
17     echo "in for loop - ele: $num"
18 done
19
20 i=0
21 while [ $i -lt ${#arr[*]} ]
22 do
23     echo "in while loop - ele: ${arr[$i]}"
24     i=`expr $i + 1`
25 done
```

10. string related

```
 1 #!/bin/bash
 2
 3 str1='sunbeam'
 4 str2='infotech'
 5
 6 str="$str1$str2"
 7
 8 echo "cat string : $str"
 9
10 echo "string length : ${#str} "
11
12 echo "substring of a string "
13 # substring ffrom index 3 to last char
14 echo "${str:3}"
15 # substring from index 7 to next 4 char
16 echo "${str:7:4}"
17
18 echo "compare strings "
19
20 if [ $str1 = $str2 ]
21  then
22     echo "equal strings"
23 else
24    echo "two strings not equal"
25 fi
26
27 echo -n "enter phone number : "
```

```
read phone
# instead of regex we can use ready made syntax to  validate phone no
if [[ $phone =~ ^[0-9]{10}$ ]]
then
    echo "valid phone no : $phone"
else
    echo "invalid no "
fi

# find and replace
newstr=${str/tech/com}
```

```
# to make first digit non zero
if [[ $phone =~ ^[1-9][0-9]{9}$ ]]
```

11. to record or maintain directory track we can use

- Directory stack
- to go in and come out like : /bin --> /lib ---> /usr and come out i nreverse
- cd = change directory
- 1. so to go to dir and put it on stack use

```
pushd dirpath
```

- 2. to pop to present dir from stack and fo to that dir

```
popd
```

- 3.to get directory path in stack from directory stack use

```
dirs
```

```
sunbeam@sunbeam-Inspiron-3583:~/dac/OS/OS-module/classwork/Day4$ dirs
~/dac/OS/OS-module/classwork/Day4
sunbeam@sunbeam-Inspiron-3583:~/dac/OS/OS-module/classwork/Day4$ pushd
bash: pushd: no other directory
sunbeam@sunbeam-Inspiron-3583:~/dac/OS/OS-module/classwork/Day4$ pushd /bin
/bin ~/dac/OS/OS-module/classwork/Day4
sunbeam@sunbeam-Inspiron-3583:/bin$ dirs
/bin ~/dac/OS/OS-module/classwork/Day4
sunbeam@sunbeam-Inspiron-3583:/bin$ pushd /lib
/lib /bin ~/dac/OS/OS-module/classwork/Day4
sunbeam@sunbeam-Inspiron-3583:/lib$ dirs
/lib /bin ~/dac/OS/OS-module/classwork/Day4
sunbeam@sunbeam-Inspiron-3583:/lib$ popd
/bin ~/dac/OS/OS-module/classwork/Day4
sunbeam@sunbeam-Inspiron-3583:/bin$ popd
~/dac/OS/OS-module/classwork/Day4
```

afternoon session : Networking commands

12. ssh command

- ssh : secured shell
    - here data/communication is encrypted
    - based on Tcp protocol
    - ssh by default run on port 22
    - option of ssh or scp client
    - to check sssh server is on
    - where d : demain
    - most server run on bakcend no GUI , so caleed demain thread

```
systemctl status sshd
```

    - sshd running on port no given by

```
netstat -t lnp
```

    - port no of telnet : 23
    - port no of apache server : 80
    - port no of sql : 3306
    -

- telnet
    - shell, bash ,communication , not cncrypted

```

```

13.

- 1. ssh
    - encrypted communication
    - sshd server -- port=22
- 2. telnet
    - non-encry comm
    - telnet server --portno = 23
- 3. netcat command
    - create messaging app
    - to make a communication on port given : like 4321

```
terminal 1> netcat -l 4321 terminal 2> netcat localhost 4321
```

- 4. to get port listening
    - here,
    - -t -- tcp sockets
        - -l -- listening sockets (server sockets)

    - -n -- show port number
    - -p -- show process name

```
sudo netstat -tlnp
```

- 5. to get ip address

```
ip addr ifconfig
```

- 6.
- 7.
- 8.
- 9.

```

```

14. two ways to run shell

- 1. Interactive shell

- i.e bash prompt, at time of login, ssh,
- we can get interactive shell by

```
cltr +alt + F1 or F2 or F3 or f4 or F5 or F6 or F7
```

    - one of which is gui terminal, get prompt

- 2. non interactive shell

```
bash demo.sh
```

- internally bash command /program is executed
- to execute given script

- 3. env command
    - environment variable
    - it has import info about system
    - example
    - to get path

```
$PATH
```

    - to get user

```
$USER, $HOME
```

    - get running shell

> $SHELL

- get your shell prompt

> $PS1

```
\[\e]0;\u@\h: \w\a\]${debian_chroot:+($debian_chroot)}\
[\033[01;32m\]\u@\h\[\033[00m\]:\[\033[01;34m\]\w\[\033[00m\]\$
```

- to change env variable value , use

> export var=value

- in c main we have envp environment variable

```
int main (int argc, char * argv[],char * envp[])
{ }
```

- after login shell aviable is called login shell

- 4. special shell script files in bash called based on type of file
  - 1. for new bash shell , when pc started i.e (login shell)
    - profile in bash shell, login in c shell ,were first used, both are same
    - use profile file mostly

> ~/.bash_profile ~/.bash_login

  - 2. for bsh and bash shell
  - for each login shell (GUI/CLI)
  - Internally calls .bashrc

> ~/.profile

  - new terminal in GUI (interactive non-login shell)
  - for each interactive shell

> ~/.bashrc

  - at the time of logout

> ~/.bash_logout

- so to make changes in shell window
  - we can make changes to shell from it

> vim ~/.profile vim ~/.bashrc

  - we can view them for login i.e for profile file changes use

> ssh localhost

15. ALIAS for terminal

-

1. alias for every terminal

- it can be created using

> alias c=clear

  - alias by default get destroyed when terminal is closed
  - we can remove it using

> unalias c

  - if you want to keep it running every where , so save it in .bashrc file

> vim ~/.bashrc

2. to get alias to run in running terminal/shell using shell script

> vim demo9-alias.sh

```
1 #!/bin/bash
2
3 alias u='echo $USER'
```

- now in termial , need to use
- it add alias to terminal

> source demo9-alias.sh

- or we can use this , to set alias to terminal

> . ./demo9-alias.sh

-

3. to switch to root login

> sudo su

- to switch back

16. for each command there is a file in bin

- can be look at it, with

> ls -l /bin/mkdir