C O N T E N T

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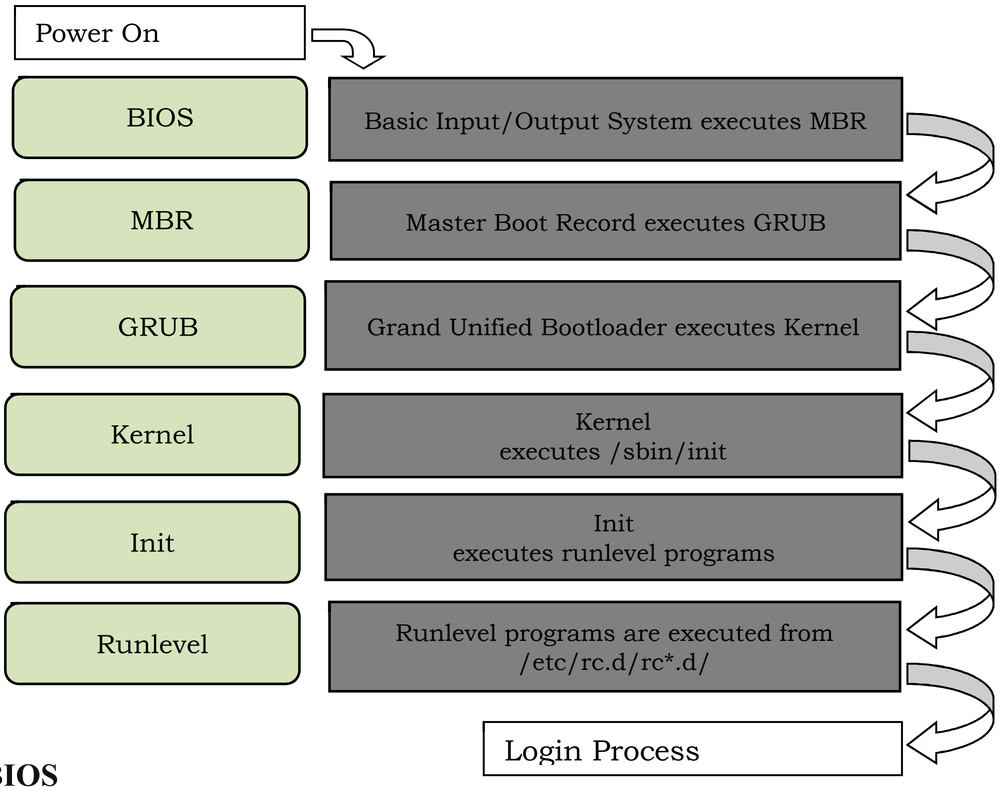
Ex. No. 1a	BOOTING PROCESS OF LINUX	Date :

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.


Power On
BIOS
Basic Input/Output System executes MBR
MBR
Master Boot Record executes GRUB
GRUB
Grand Unified Bootloader executes Kernel
Kernel
Kernel executes /sbin/init
Init
Init executes runlevel programs
Runlevel
Runlevel programs are executed from /etc/rc.d/rc*.d/
Login 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). The following is sample grub.conf of CentOS.

```
#boot=/dev/sda
default=0
timeout=5
splashimage=(hd0,0)/boot/grub/splash.xpm.gz
hiddenmenu
title CentOS(2.6.18-194.el5PAE)
root(hd0,0)
kernel/boot/vmlinuz-2.6.18-194.el5PAE ro root=LABEL=/
initrd /boot/initrd-2.6.18-194.el5PAE.img
```

- 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.

Ex. No. 1b	**BASIC LINUX COMMANDS**	**Date :**

a) Basics

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

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
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 5th & 6th 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

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Ex. No. 2a	**LINUX FILE SYSTEM**	**Date :**

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.

File System Structure
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 superuser `root`.
`/sbin`	Essential system binaries.
`/srv`	Data for services provided by the system.
`/tmp`	Temporary files.
`/usr`	Secondary hierarchy with read-only data.
`/var`	Variable data such as log files

Ex. No. 2b	EDITORS AND FILTERS	Date :

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 nth line of first file and nth line of second file are pasted as the nth 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

Q1. Write a command to cut 5 to 8 characters of the file *f1*.
$

Q2. Write a command to display user-id of all the users in your system.
$

Q3. Write a command to paste all the lines of the file *f1* into single line
$

Q4. Write a command to cut the first field of file *f1* and second field of file *f2* and paste into the file *f3*.
$

Q5. Write a command to change all small case letters to capitals of file *f2*.
$

Q6. Write a command to replace all *tab* character in the file *f2* by **:**
$

Q7. Write a command to check whether the user j*udith* is available in your system or not. (use grep)
$

Q8. Write a command to display the lines of the file *f1* starts with SRM.

$

Q9. Write a command to display the name of the files in the directory */etc/init.d* that contains the pattern *grep*.

$

Q10. Write a command to display the names of nologin users. (Hint: the command *nologin* is specified in the last filed of the file /etc/passwd for nologin users)

$

Q11. Write a command to sort the file /etc/passwd in descending order

$

Q12. Write a command to sort the file /etc/passwd by user-id numerically. (Hint : user-id is in 3rd field)

$

Q13. Write a command to sort the file *f2* and write the output into the file *f22*. Also eliminate duplicate lines.

$

Q14. Write a command to display the unique lines of the sorted file *f21*. Also display the number of occurrences of each line.

$

Q15. Write a command to display the lines that are common to the files *f1* and *f2*.

$

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Ex. No. 3a	COMPILATION OF C PROGRAM	Date :

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
```

Ex. No. 3b	PROCESS CREATION	Date :

Syntax for process creation

int fork();

Returns 0 in child process and child process ID in parent 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

Virtual fork

vfork() function is similar to fork but both processes shares the same address space.

Q1. Find the output of the following program

```
#include <stdio.h>
#include<unistd.h>

int main()
{
  int a=5,b=10,pid;

  printf("Before fork a=%d b=%d \n",a,b);
  pid=fork();

  if(pid==0)
  {
    a=a+1;
    b=b+1;
    printf("In child a=%d b=%d \n",a,b);
  }
  else
  {
    sleep(1);
    a=a-1;
    b=b-1;
    printf("In Parent a=%d b=%d \n",a,b);
  }
  return 0;
}
```

Output :-

Q2. Rewrite the program in Q1 using vfork() and write the output

Q3. Calculate the number of times the text “SRMIST” is printed.

```
    #include <stdio.h>
    #include<unistd.h>

    int main()
    {
       fork();
       fork();
       fork();
       printf(“SRMIST\n”);
       return 0;
 }
```

Output :

Q4. Complete the following program as described below :
The child process calculates the sum of odd numbers and the parent process calculate the sum of even numbers up to the number ‘n’. Ensure the Parent process waits for the child process to finish.

```
#include <stdio.h>
#include<unistd.h>

int main()
{
  int pid,n,oddsum=0,evensum=0;

  printf("Enter the value of n : ",a);
  scanf(“%d”,&n);
  pid=fork();
  // Complete the program













  return 0;
}
```

Sample Output :

```
Enter the value of n          : 10
Sum of odd numbers            : 25
Sum of even numbers           : 30
```

Q5. How many child processes are created for the following code?
Hint : Check with small values of ‘n’.

```
for (i=0; i<n; i++)
        fork();
```

Output :

Q6. Write a program to print the Child process ID and Parent process ID in both Child and Parent processes

```
    #include <stdio.h>
    #include<unistd.h>
    int main()
    {









return 0;
}
```

Sample Output:

```
In Child Process
Parent Process ID       :     18
Child Process ID        :     20

In Parent Process
Parent Process ID       :     18
Child Process ID        :     20
```

Q7. How many child processes are created for the following code?

```
    #include <stdio.h>
    #include<unistd.h>

    int main()
    {
        fork();
        fork()&&fork()||fork();
        fork();
        printf("Yes ");
        return 0;
}
```

Output :

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Ex. No. 4a	SYSTEM ADMIN COMMANDS (For Ubuntu Linux)	Date :

INSTALLING SOFTWARE

To Update the package repositories
```
          sudo apt-get update
```
To update installed software
```
          sudo apt-get upgrade
```
To install a package/software
```
          sudo apt-get install  <package-name>
```
To remove a package from the system
```
          sudo apt-get remove <package-name>
```
To reinstall a package
```
          sudo apt-get install  <package-name> --reinstall
```

Q1. Update the package repositories

Q2. Install the package "simplescreenrecorder"

Q3. Remove the package "simplescreenrecorder"

MANAGING USERS

- Managing users is a critical aspect of server management.
- In Ubuntu, the root user is disabled for safety.
- Root access can be completed by using the sudo command by a user who is in the "admin" group.
- When you create a user during installation, that user is added automatically to the admin group.

To add a user:
```
      sudo adduser username
```
To disable a user:
```
      sudo passwd -l username
```
To enable a user:
```
      sudo passwd -u username
```
To delete a user:
```
           sudo userdel –r username
```
To create a group:
```
      sudo addgroup groupname
```
To delete a group:
```
      sudo delgroup groupname
```

To create a user with group:

```
       sudo adduser username groupname
```

To see the password expiry value for a user,

```
         sudo chage -l username
```

To make changes:

```
       sudo chage username
```

GUI Tool for user management

If you do not want to run the commands in terminal to manage users and groups, then you can install a GUI add-on .

```
       sudo apt install gnome-system-tools
```

Once done, type

```
       users-admin
```

Q4. Create a user 'elias'. Login to the newly created user and exit.

Q5. Disable the user 'elias', try to login and enable again.

Q6. Create a group 'cse' and add the user 'elias' in that group

Q7. List the account expiry information of the user 'elias'

Q8. Change the 'Number of days warning before password expires' as 5 for the user 'elias'

Q9. Delete the user 'elias' and then delete the group 'cse'

FILE SYSTEM

A filesystem is a permanent storage for containing data. Any non-volatile storage device like hard disk, usb etc has a filesystem in place, on top of which data is stored. While installing Linux, you may opt for either EXT4 or EXT3 file system.

Ext3 : A journaling filesystem: logs changes in a journal to increase reliability in case of power failure or system crash.

EXT4: It is an advanced file syste. This file system supports 64-bit storage limits, columns up to 1 exabytes and you may store files up to 16 terabytes

Disk Partitions can be viewed by the command `sudo fdisk -l`
File system information are available in the file `/etc/fstab`

Q10. List the partitions available in your system

Q11. What are the file systems used in your system

NETWORKING
Most networking is configured by editing two files:

- `/etc/network/interfaces`
    - Ethernet, TCP/IP, bridging
- `/etc/resolv.conf`
    - DNS

Other networking files:

- `/etc/hosts`
- `/etc/dhcp3/dhcpd.conf`

To test any host's connectivity

```
ping <ip-address>
```

To start/stop/restart/reload networking services

```
sudo /etc/init.d/mnetworking <function>
```

Note : <function> can be any one of `stop` or `start` or `reload` or `restart`

Q12. Stop the networking service and then start the service

Q13. Check the connectivity of the host with IP address `127.0.0.1`

Q14. Find the IP address of the `localhost`

Q15. Find the IP address of the `DNS Server (name server)`

INSTALLING INTERNET SERVICES

Installing Apache server
```
     sudo apt-get install apache2
```

Configuration file for Apache server
```
     apache2.conf
```

Restart apache services after any configuration changes made
```
          sudo /etc/init.d/mnetworking restart
```

Similarly all services can be installed, configured and restarted

Q16. Install `mysql` server

Q17. Restart `mysql` server

Q18. Check the configuration file for `mysql` server

Q19. Log on as root into `mysql` server

Q20. Create a new database for `mysql` server

Verified by

Staff In-charge Sign :	**Date :**

Ex. No. 4b	**SIMPLE TASK AUTOMATION**	**Date :**

Linux Cron utility is an effective way to schedule a routine background job at a specific time and/or day on an on-going basis. You can use this to schedule activities, either as one-time events or as recurring tasks.

Crontab Syntax `m  h  dom  mon  dow  command`

`m` – The minute when the cron job will run (0-59)
`h` - a numeric value determining the hour when the tasks will run (0-23)
`dom` – Day of the Month when the cron job will run (1-31)
`mon` - The month when the cron job will run (1-12)
`dow` – Day Of the Week from 0-6 with Sunday being 0
`command`- The linux command you wish to execute

Scheduling of Tasks (For Ubuntu)

Step 1 : Open terminal and type the command

```
crontab  -e
```

Step 2 : Choose the editor. Better to select `nano` editor
Step 3 : Edit the file based on the syntax given above
Step 4 : Save and Exit the file
Step 5 : Start cron daemon using the following command

```
systemctl  start cron
```

Example of crontab entry

```
0 8 * * 1 echo Have a Good Week > >tmpfile
```

Every Monday 8:00 am the message "Have a Good Week" transferred to the file 'tmpfile'

Special Crontab Characters

`*` represents all possible value
`/` represents partial value. Ex. `*/10` in minute column specifies every 10 minutes
`-` represent range of values. Ex. `6-9` in hour column specifies 6am to 9 am
`,` (Comma) represent different set of values. Ex. `1,4` in month specifies Jan and Apr month

Q1. Schedule a task to display the following message on the monitor for every 2 minutes.

Q2. Schedule a task to take backup of your important file (say file `f1`) for every 30 minutes

Q3. Schedule a task to take backup of login information everyday 9:30am

Verified by

Staff In-charge Sign :	**Date :**

Ex. No. 5	SHELL PROGRAMS	Date :

How to run a Shell Script

- Edit and save your program using editor
- Add execute permission by `chmod` command
- Run your program using the name of your program

```
./program-name
```

Important Hints

- No space before and after the assignment operator Ex. `sum=0`
- *Single quote* ignores all special characters. Dollar sign, Back quote and Back slash are not ignored inside *Double quote*. *Back quote* is used as command substitution. *Back slash* is used to remove the special meaning of a character.
- Arithmetic expression can be written as follows : `i=$((i+1)` or `i=$(expr $i + 1)`
- Command line arguments are referred inside the programme as `$1, $2`, ..and so on
- `$*` represents all arguments, `$#` specifies the number of arguments
- `read` statement is used to get input from input device. Ex. `read a b`

Syntax for if statement

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

Syntax for case structure

```
case value in
pat1)  ...
              statement;;
pat2)  ...
              Statement;;
*)     ...
              Statement;;
esac
```

Syntax for for-loop

```
for var in list-of-values
do
          ...
          ...
done
```

Syntax for While loop

```
while commandt
do
         ...
         ...
done
```

Syntax for printf statement

```
printf  "string and format"  arg1  arg2 … …
```

- Break and continue statements functions similar to C programming
- Relational operators are –lt, -le, -gt, -ge, -eq,-ne
- Ex. (i>= 10) is written as [$i -ge 10]
- Logical operators (and, or, not) are -o, -a, !
- Ex. (a>b) && (a>c) is written as [$a –gt $b –a $a –gt $c]
- Two strings can be compared using = operator

Q1. Given the following values

num=10, x=*, y=`date` a="Hello, 'he said'"

Execute and write the output of the following commands

Command	**Output**
echo num	
echo $num	
echo $x	
echo '$x'	
echo "$x"	
echo $y	
echo $(date)	
echo $a	
echo \$num	
echo \$$num	

Q1. Find the output of the following shell scripts

```
$ vi  ex51
    echo Enter value for n
    read n
    sum=0
    i=1
    while [ $i –le $n ]
    do
          sum=$((sum+i))
          i=$((i+2))
    done
    echo Sum is $sum
```

Output :

Q2. Write a program to check whether the file has execute permission or not. If not, add the permission.

```
$ vi ex52
```

Q3. Write a shell script to print a greeting as specified below.
If hour is greater than or equal to 0 (midnight) and less than or equal to 11 (up to 11:59:59), "Good morning" is displayed.
If hour is greater than or equal to 12 (noon) and less than or equal to 17 (up to 5:59:59 p.m.), "Good afternoon" is displayed.
If neither of the preceding two conditions is satisfied, "Good evening" is displayed.

```
$ vi  ex53
  hour=$(date | cut -c12-13)
  if [ "$hour" -ge 0 -a "$hour" -le 11 ]
  then                                    ← complete the program
```

Q4. Write a shell script to list only the name of sub directories in the present working directory

```
$ vi ex54
```

Q5. Write a program to check all the files in the present working directory for a pattern (passed through command line) and display the name of the file followed by a message stating that the pattern is available or not available.

```
$ vi ex55
```

Verified by

Staff In-charge Sign :	**Date :**

Ex. No. 6	OVERLAY CONCEPTS	Date :

Exec() System Call – Overlay Calling process and run new Program
The exec() system call replaces (**overwrites**) the current process with the new process image**.** The PID of the new process remains the same however code, data, heap and stack of the process are replaced by the new program.

There are 6 system calls in the family of exec().All of these functions mentioned below are layered on top of execve(), and they differ from one another and from execve() only in the way in which the program name, argument list, and environment of the new program are specified.

Syntax

```
int execl(const char* path, const char* arg, …)
int execlp(const char* file, const char* arg, …)
int execle(const char* path, const char* arg, …, char* const envp[])
int execv(const char* path, const char* argv[])
int execvp(const char* file, const char* argv[])
int execvpe(const char* file, const char* argv[], char *const envp[])
```

- The names of the first five of above functions are of the form **exec*XY***.
- X is either l or v depending upon whether arguments are given in the list format (arg0, arg1, ..., NULL) or arguments are passed in an array (vector).
- Y is either absent or is either a p or an e. In case Y is p, the PATH environment variable is used to search for the program. If Y is e, then the environment passed in *envp* array is used.
- In case of execvpe, X is v and Y is e. The execvpe function is a GNU extension. It is named so as to differentiate it from the execve system call.

Q1. Execute the Following Program and write the output

```
$vi ex61.c
     #include <stdio.h>
     #include<unistd.h>
     int main()
     {
       printf("Transfer to execlp function \n");
       execlp("head", "head","-2","f1",NULL);
       printf("This line will not execute \n");
       return 0;
     }
```

Output :

Why second printf statement is not executing? ____________________

____

Q2. Rewrite question Q1 with execl() function. Pass the 3rd and 4th argument of the function execl() through command line arguments.

```
$vi ex62.c
```

Input : `./a.out    -3 f1`
Output :

Q3. Rewrite question Q1 with execv() function.

```
$vi ex63.c
```

Output :

Q4. Rewrite question Q1 with execv() function.

```
$vi ex64.c
```

Output :

Q5. a. Write a program (ex651.c) to find the factorial of a given number.
b. Write a program (ex652.c) to find the sum of numbers from 1 to n.
c. Write a program (ex653.c) to execute the program ex651.c in child process and the program ex562.c in parent process
Note : Pass the values through command line arguments for the above programs

```
$vi ex651.c
```

```
$vi ex652.c
```

```
$vi ex653.c
```

Verified by

Staff In-charge Sign :	**Date :**

Ex. No. 7	**PIPES**	**Date :**

Pipe is a communication medium between two or more processes. The system call for creating pipe is

```
int pipe(int p[2]);
```

This system call would create a pipe for one-way communication i.e., it creates two descriptors, first one is connected to read from the pipe and other one is connected to write into the pipe.
Descriptor p[0] is for reading and p[1] is for writing. Whatever is written into p[1] can be read from p[0].

Q1. Write the output of the following program

```
#include <stdio.h>
#include<unistd.h>
#include<sys/wait.h>
int main()
{
  int p[2];
  char buff[25];
  if(fork()==0)
  {
    printf("Child : Writing to pipe \n");
    write(p[1],”Welcome”,8);
    printf("Child Exiting\n");
  }
  else
  {
    wait(NULL);
    printf("Parent : Reading from pipe \n");
    read(p[0],buff,8);
    printf("Pipe content is : %s \n",buff);
  }
  return 0;
}
```

Output :

Implementing command line pipe using exec() family of functions00
Follow the steps to transfer the output of a process to pipe:
(i) Close the standard output descriptor
(ii) Use the following system calls, to take duplicate of output file descriptor of the pipe

```
int dup(int fd);
int dup2(int oldfd, int newfd);
```

(iii) Close the input file descriptor of the pipe
(iv) Now execute the process

Follow the steps to get the input from the pipe for a process:

(i) Close the standard input descriptor
(ii) Take the duplicate of input file descriptor of the pipe using dup() system call
(iii) Close the output file descriptor of the pipe
(iv) Now execute the process

Q2. Write a program to implement the following command line pipe using pipe() and dup()

```
ls –l | wc -l
```

Named pipe

Named pipe (also known as FIFO) is one of the inter process communication tool. The system for FIFO is as follows

```
int mkfifo(const char *pathname, mode_t mode);
```

mkfifo() makes a FIFO special file with name **pathname**. Here **mode** specifies the FIFO's permissions. The permission can be like : O_CREAT|0644

Open FIFO in read-mode (O_RDONLY) to read and write-mode (O_WRONLY) to write

Q3. Write the output of the following program

```
#include<fcntl.h>
#include<sys/types.h>
#include<sys/stat.h>
#include<unistd.h>

int main()
{
  char buff[25];
  int rfd,wfd;

  mkfifo("fif1",O_CREAT|0644);

  if (fork()==0)
  {
    printf("Child writing into FIFO\n");
    wfd=open("fif1",O_WRONLY);
    write(wfd,”Hello”,6);
  }
  else
  {
    rfd=open("fif1",O_RDONLY);
    read(rfd,buff,6);
    printf("Parent reads from FIFO : %s\n",buff);
  }
  return 0;
}
```

Output :

Verified by

Staff In-charge Sign :	**Date :**

Ex. No. 8	MESSAGE QUEUE & SHARED MEMORY	Date :

Message Queue
Message queue is one of the interprocess communication mechanisms. here are two varieties of message queues, System V message queues and POSIX message queues. Both provide almost the same functionality but system calls for the two are different.

There are three system wide limits regarding the message queues. These are, `MSGMNI`, maximum number of queues in the system, `MSGMAX`, maximum size of a message in bytes and `MSGMNB`, which is the maximum size of a message queue. We can see these limits with the `ipcs -l` command

Include the following header files for system V message queues
```
<sys/msg.h>, <sys/ipc.h>, <sys/types.h>
```

System V <u>Message Queue</u> System Calls
To create a message queue,
```
int msgget (key_t key, int msg_flags);
```
key → Message queue identifier ex. (key_t)77
flags → `IPC_CREAT|0664` : to create a message queue with permission 0644
`IPC_CREATE|IPC_EXCL|0664` : to create message if doesn't exists

To control the message queue,
```
int msgctl(int msqid, int cmd, struct msqid_ds *buf);
```
msquid→ Message id returned by msgget()
cmd → `IPC_STAT` : to get the status of a message queue
`IPC_SET` : to change the properties of a message queue
`IPC_RMID` : to remove a message queue

To send a message into message queue,
```
int msgsnd(int msquid, const void *msgp, size_t msqsz, int msgflg);
```
msquid→ Message id returned by msgget()
msgp → message to be sent. Buffer or message structure is used here.
```
struct buffer {
        int len;            // length of the message
        int mtype;          // message number
        char buf[50];       // buffer
    }x;
```
msqsz → size of the message
msgflg → `IPC_NOWAIT` or `IPC_WAIT` for blocking/non-blocking I/O

To receive a message from message queue,
```
int msgrcv(int msquid, void *msgp, size_t msqsz, long msgtyp, int msgflg);
```
msqp → the buffer/message structure to receive the message
msgtyp → message number
msquid, msqsz, msgflg arguments are similar to msgsnd()

Q1. Write a program to send a message (pass through command line arguments) into a message queue. Send few messages with unique message numbers

```
$ vi ex81.c
```

Q2. Write a program to receive a particular message from the message queue. Use message number to receive the particular message

```
$ vi ex82.c
```

Linux Commands to control the Interprocess communication tools (Message queue/ semaphore/ shared memory)

ipcs	→ to list all IPC information
ipcs –l	→ to list the limits of each IPC tools
ipcs –q	→ to list message queues details
ipcs –s	→ to list semaphore details
ipcs –m	→ to list all shared memory details
ipcs –u	→ to get the current usage of IPC tools
ipcs –h	→ ipcs help

ipcrm –q <msgid>	→ to remove a message queue with message-id <msgid>
ipcrm –m <shmid>	→ to remove a shared memory
ipcrm –s <semid>	→ to remove a semaphore
ipcrm –h	→ ipcrm help

Shared memory

Inter Process Communication through shared memory is a concept where two or more process can access the common memory. And communication is done via this shared memory where changes made by one process can be viewed by another process.

Include the following header files for shared memory

```
<sys/ipc.h>,  <sys/shm.h>, <sys/types.h>
```

System V <u>Shared memory</u> System Calls

To create a shared memory,

```
int shmget(key_t key, size_t size, int shmflg)
```

key → shared memory id

size → shared memory size in bytes

shmflg → `IPC_CREATE|0664` : to create a new shared memory segment

`IPC_EXCL|IPC_CREAT|0664` : to create new segment and the call fails, if the segment already exists

To attach the shared memory segment to the address space of the calling process

```
void * shmat(int shmid, const void *shmaddr, int shmflg)
```

shmid → Shared memory id returned by shmget()

shmaddr → the attaching address. If shmaddr is NULL, the system by default chooses the suitable address. If shmaddr is not NULL and SHM_RND is specified in shmflg, the attach is equal to the address of the nearest multiple of SHMLBA (Lower Boundary AddressShmflg → SHM_RND (rounding off address to SHMLBA) or SHM_EXEC (allows the contents of segment to be executed) or SHM_RDONLY (attaches the segment for read-only purpose, by default it is read-write) or SHM_REMAP (replaces the existing mapping in the range specified by shmaddr and continuing till the end of segment)

To control the shared memory segment,

```
int shmctl(int shmid, int cmd, struct shmid_ds *buf)
```

To detach the shared memory segment from the address space of the calling process

```
int shmdt(const void *shmaddr)
```

shmaddr → address of the shared memory to detach

Q3. Write a program to do the following:

- Create two processes, one is for writing into the shared memory (shm_write.c) and another is for reading from the shared memory (shm_read.c)
- In the shared memory, the writing process, creates a shared memory of size 1K (and flags) and attaches the shared memory
- The write process writes the data read from the standard input into the shared memory. Last byte signifies the end of buffer
- Read process would read from the shared memory and write to the standard output

```
$ vi ex82.c
```

Verified by

Staff In-charge Sign :	**Date :**

Ex. No. 9	**PROCESS SYNCHRONIZATION**	**Date :**

Semaphore
Semaphore is used to implement process synchronization. This is to protect critical region shared among multiples processes.

Include the following header files for shared memory
```
    <sys/ipc.h>,  <sys/sem.h>, <sys/types.h>
```

System V Semaphore System Calls
To create a semaphore array,
```
  int semget(key_t key, int nsems, int semflg)
```

key → semaphore id
nsems → no. of semaphores in the semaphore array
semflg → `IPC_CREATE|0664` : to create a new semaphore
`IPC_EXCL|IPC_CREAT|0664` : to create new semaphore and the call fails if the semaphore already exists

To perform operations on the semaphore sets viz., allocating resources, waiting for the resources or freeing the resources,
```
  int semop(int semid, struct sembuf *semops, size_t nsemops)
```

semid → semaphore id returned by semget()
nsemops → the number of operations in that array
semops → The pointer to an array of operations to be performed on the semaphore set. The structure is as follows
```
    struct sembuf {
         unsigned short sem_num;   /* Semaphore set num */
         short sem_op;             /* Semaphore operation */
         short sem_flg;  /*Operation flags, IPC_NOWAIT, SEM_UNDO */
      };
```

Element, sem_op, in the above structure, indicates the operation that needs to be performed −

- If sem_op is –ve, allocate or obtain resources. Blocks the calling process until enough resources have been freed by other processes, so that this process can allocate.
- If sem_op is zero, the calling process waits or sleeps until semaphore value reaches 0.
- If sem_op is +ve, release resources.

To perform control operation on semaphore,
```
     int semctl(int semid, int semnum, int cmd,…);
```

semid → identifier of the semaphore returned by semget()
semnum → semaphore number
cmd → the command to perform on the semaphore. Ex. GETVAL, SETVAL
semun → value depends on the cmd. For few cases, this is not applicable.

Q1. Execute and write the output of the following program for *mutual exclusion*.

```
#include<sys/ipc.h>
#include<sys/sem.h>
int main()
{
 int pid,semid,val;
 struct sembuf sop;

 semid=semget((key_t)6,1,IPC_CREAT|0666);

 pid=fork();

 sop.sem_num=0;
 sop.sem_op=0;
 sop.sem_flg=0;

 if (pid!=0)
 {
   sleep(1);
   printf("The Parent waits for WAIT signal\n");
   semop(semid,&sop,1);
   printf("The Parent WAKED UP & doing her job\n");
   sleep(10);
   printf("Parent Over\n");
 }
 else
 {
   printf("The Child sets WAIT signal & doing her job\n");
   semctl(semid,0,SETVAL,1);
   sleep(10);
   printf("The Child sets WAKE signal & finished her job\n");
   semctl(semid,0,SETVAL,0);
   printf("Child Over\n");
 }
 return 0;
}
```

Output :

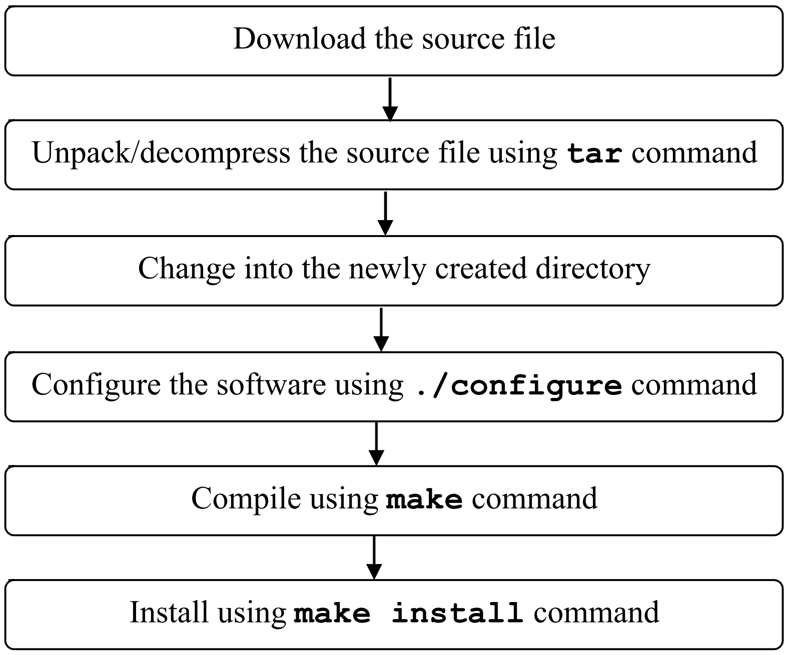
Q2. Write a program to perform process synchronization in producer-consumer problem

Verified by

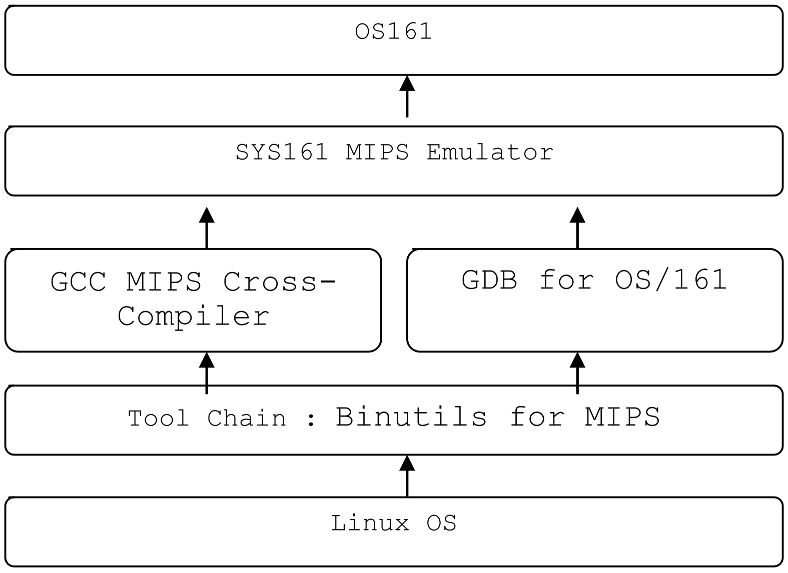
Staff In-charge Sign :	**Date :**

Ex. No. 10	STUDY OF OS161	Date :

STEPS TO BUILD SOFTWARE FROM SOURCE FILE


Download the source file
Unpack/decompress the source file using tar command
Change into the newly created directory
Configure the software using ./configure command
Compile using make command
Install using make install command

BUILD SOFTWARE FRAMEWORK FOR OS/161



OS/161 INSTALLATION

Prerequisites

- Linux desktop with UBUNTU Version 12.04 or later.
- Internet connections to download and install packages

Pre Installation Steps

1. Install the packages gettext (to translate native language statements into English) , textinfo (to transalate source code into other formats) and libncurses5-dev (allows users to write text-base GUI)

```
sudo apt-get install gettext
sudo apt-get install texinfo
sudo apt-get install libncurses5-dev
```

2. Include the paths `$HOME/sys161/bin` and `$HOME/sys161/tools/bin` into PATH environment variable. Add the following line at the end of the file **`.bashrc`**

```
export PATH=$HOME/sys161/bin:$HOME/sys161/tools/bin:$PATH
```

   Now logout and login to get the PATH updated. You can check the current setting of the `PATH` environment variable using the command

```
printenv PATH
```

Installation Steps

STEP 1: Download the following source codes one by one

- **Binutils for MIPS**
  http://www.student.cs.uwaterloo.ca/~cs350/os161_repository/os161-binutils.tar.gz

- **GCC MIPS Cross-Compiler**
  http://www.student.cs.uwaterloo.ca/~cs350/os161_repository/os161-gcc.tar.gz

- **GDB for Use with OS/161**
  http://www.student.cs.uwaterloo.ca/~cs350/os161_repository/os161-gdb.tar.gz

- **bmake for use with OS/161**
  http://www.student.cs.uwaterloo.ca/~cs350/os161_repository/os161-bmake.tar.gz

- **mk for use with OS/161**
  http://www.student.cs.uwaterloo.ca/~cs350/os161_repository/os161-mk.tar.gz

- **sys/161**
  http://www.student.cs.uwaterloo.ca/~cs350/os161_repository/sys161.tar.gz

- **OS/161**
  http://www.student.cs.uwaterloo.ca/~cs350/os161_repository/os161.tar.gz

Note : `bmake` and `mk` utilities are BSD make utilities used for OS161

STEP 2: Build and Install the Binary Utilities (Binutils)

Unpack the binutils archive:

```
tar -xzf os161-binutils.tar.gz
```

Move into the newly-created directory:

```
cd binutils-2.17+os161-2.0.1
```

Configure binutils:

```
./configure --nfp --disable-werror --target=mips-
harvard-os161 --prefix=$HOME/sys161/tools
```

Make binutils:

```
make
```

Finally, once **make** has succeeded, install the binutils into their final location:

```
make install
```

This will create the directory **`$HOME/sys161/tools/`** and populate it.

Step 3: Install the GCC MIPS Cross-Compiler

Unpack the gcc archive:

```
tar -xzf os161-gcc.tar.gz
```

Move into the newly-created directory:

```
cd gcc-4.1.2+os161-2.0
```

Configure gcc

```
./configure -nfp --disable-shared --disable-threads --
disable-libmudflap --disable-libssp --target=mips-
harvard-os161 --prefix=$HOME/sys161/tools
```

Make it and install it:

```
make
make install
```

Step 4: Install GDB

Unpack the gdb archive:

```
tar -xzf os161-gdb.tar.gz
```

Move into the newly-created directory:

```
cd gdb-6.6+os161-2.0
```

Configure gdb

```
./configure --target=mips-harvard-os161 --
prefix=$HOME/sys161/tools --disable-werror
```

Make it and install it:

```
make
make install
```

Step 5: Install bmake

Unpack the bmake archive:

```
tar -xzf os161-bmake.tar.gz
```

Move into the newly-created directory:

```
cd bmake
```

Unpack mk within the bmake directory:

```
tar -xzf ../os161-mk.tar.gz
```

Run the bmake bootstrap script

```
./boot-strap --prefix=$HOME/sys161/tools
```

As the **boot-strap** script finishes, it should print a list of commands that you can run to install bmake under **`$HOME/sys161/tools.`** The list should look something like this:

```
mkdir -p /home/kmsalem/sys161/tools/bin
cp /home/kmsalem/bmake/Linux/bmake
/home/kmsalem/sys161/tools/bin/bmake-20101215
rm -f /home/kmsalem/sys161/tools/bin/bmake
ln -s bmake-20101215 /home/kmsalem/sys161/tools/bin/bmake
mkdir -p /home/kmsalem/sys161/tools/share/man/cat1
cp /home/kmsalem/bmake/bmake.cat1
/home/kmsalem/sys161/tools/share/man/cat1/bmake.1
sh /home/kmsalem/bmake/mk/install-mk
/home/kmsalem/sys161/tools/share/mk
```

Run the commands printed by boot-strap in the order in which they are listed in your terminal screen.

Step 6: Set Up Links for Toolchain Binaries

```
mkdir $HOME/sys161/bin
cd $HOME/sys161/tools/bin

sh -c 'for i in mips-*; do ln -s $HOME/sys161/tools/bin/$i
$HOME/sys161/bin/cs350-`echo $i | cut -d- -f4-`; done'

ln -s $HOME/sys161/tools/bin/bmake $HOME/sys161/bin/bmake
```

When you are finished with these steps, a listing of the directory **`$HOME/sys161/bin`** should look similar to this:

```
bmake@             cs350-gcc@         cs350-ld@         cs350-run@
cs350-addr2line@   cs350-gcc-4.1.2@   cs350-nm@         cs350-size@
cs350-ar@          cs350-gccbug@      cs350-objcopy@    cs350-strings@
cs350-as@          cs350-gcov@        cs350-objdump@    cs350-strip@
cs350-c++filt@     cs350-gdb@         cs350-ranlib@
cs350-cpp@         cs350-gdbtui@      cs350-readelf@
```

Step 7: Build and Install the sys161 Simulator

Unpack the sys161 archive:

```
tar -xzf sys161.tar.gz
```

Move into the newly-created directory:

```
cd sys161-1.99.06
```

Next, configure sys161:

```
./configure --prefix=$HOME/sys161 mipseb
```

Build sys161 and install it:

```
make
make install
```

Finally, set up a link to a sample sys161 configuration file

```
cd $HOME/sys161
ln -s share/examples/sys161/sys161.conf.sample
sys161.conf
```

Step 8: Install OS/161

First, create a directory to hold the OS/161 source code, your compiled OS/161 kernels, and related test programs.

```
cd $HOME
mkdir cs350-os161
```

Next, move the OS/161 archive into your new directory and unpack it:

```
mv os161.tar.gz cs350-os161
cd cs350-os161
tar -xzf os161.tar.gz
```

This will create a directory called **`os161-1.99`** (under **`cs350-os161`**) containing the OS/161 source code. You should now be able build, install, and run an OS/161 kernel and related application and test programs by following steps.

Step 9: Configure OS/161 and Build the OS/161 Kernel

The next step is to configure OS/161 and compile the kernel. From the **`cs350-os161`** directory, do the following:

```
     cd os161-1.99
     ./configure --ostree=$HOME/cs350-os161/root --
     toolprefix=cs350-
     cd kern/conf
     ./config ASST0
     cd ../compile/ASST0
     bmake depend
     bmake
     bmake install
```

Step 10: Build the OS/161 User-level Programs

Next, build the OS/161 user level utilities and test programs:

```
cd $HOME/cs350-os161/os161-1.99
bmake
bmake install
```

Step 11: Try Running OS/161

You should now be able to use the SYS/161 simulator to run the OS/161 kernel that you built and installed. The SYS/161 simulator requires a configuration file in order to run. To obtain one, do this:

```
cd $HOME/cs350-os161/root
cp $HOME/sys161/sys161.conf sys161.conf
sys161 kernel-ASST0
```

You should see some output that looks something like this:

```
sys161: System/161 release 1.99.06, compiled Aug 23 2013 10:23:34

OS/161 base system version 1.99.05
Copyright (c) 2000, 2001, 2002, 2003, 2004, 2005, 2008, 2009
President and Fellows of Harvard College.  All rights reserved.

Put-your-group-name-here's system version 0 (ASST0 #1)

316k physical memory available
Device probe...
lamebus0 (system main bus)
emu0 at lamebus0
ltrace0 at lamebus0
ltimer0 at lamebus0
beep0 at ltimer0
rtclock0 at ltimer0
lrandom0 at lamebus0
random0 at lrandom0
lhd0 at lamebus0
lhd1 at lamebus0
lser0 at lamebus0
con0 at lser0

cpu0: MIPS r3000
OS/161 kernel [? for menu]:
```

The last line is a command prompt from the OS/161 kernel. For now, just enter the command **q** to shut down the simulation and return to your shell. After logging out, to get back again into OS/161 just follow **STEP 12**.

Verified by

Staff In-charge Sign :	**Date :**