**HOMEWORK 3**

**Question 1.**

**Describe how an embedded Linux device, such as the RPi, boots the Linux OS.**

**Ans:**

The Linux distribution has different versions available for users. The installation of any version of Linux have same process of booting the Raspberry Indifferent versions are used for different type of tasks and designing different programs. The most common Linux versions are Noobs, Ubuntu, Debian, Fedora, Raspbian (Buster, wheezy, stretch, jessie etc.). First of all, download the Image file of the operating system. You can find different Linux versions on the raspberry pi website in downloads section. The image file you download is either may be in zip format (compressed) or in unzip format (.img file)

After downloading the image file of the OS (Linux version), write this image file to the SD card of the raspberry pi by using Disk writing tools (e.g. Etcher).Before writing to the SD card, Format your raspberry pi SD card by using SD card formatter tools (SD card Formatter).The format of SD card erase all the data currently present in the SD card. After formatting write the image file of operating system to SD card. When writing of image file complete remove the SD card from your computer and Insert it into the raspberry pi SD card slot. When you boot the raspberry pi, the downloaded version of Linux start running and it can hold the processor of the raspberry pi board. Now you have to communicate with the microprocessor by using this installed version of Linux. The raspberry pi Linux boot completes when you do initial setting according to your current location, date&time and connection to the network.

**Question 2.**

**Describe important Linux concepts, such as kernel space, user space, and system initialization using systemd.**

**Ans:**

The Linux kernel includes system call interface, kernel services and device drivers and modules. The Linux kernel is running in the system memory so called kernel space. While the programs running in the area of system memory is called user space. There is a strong partition between these two types of spaces. The Linux kernel has full command on all type of spaces and programs so incorrect editing of any code in kernel space may collapse the whole system. The system kernel space is sometime automated like plug and play. When we connect mouse in the port, the kernel automatically finds its loadable kernel module and made able to use this device by running plug and play in the backend process. The kernel space includes the kernel files of devices called driver file to use that device with the computer. Sometime we can write kernel file by yourself in order to use some specific device.

The user space of Linux is its terminal window or where programs are running like web browsers etc. The user space includes user level codes, user level programs and some libraries to use deices. The user space involves the running of all the codes running outside of the kernel space. Most of the Linux versions have already installed programming languages, compilers, games, web browsers etc. these all applications are installed in user space. User space programs are linked with the kernel space in backend processes.

The system services initialize and stop the system by initializing and stopping the services like web servers, SSH etc.it depends on the raspberry pi state whether the raspberry pi is starting or shutting down. The system services manager consists of software bundles for login management of raspberry pi, device management and synchronization of date and time wit the locale and many more. The systemd prepares the user space and other Linux services to become operational state by starting all other system processes.

**Question 3.**

**Discuss the reliability of SD card file systems as described in the textbook. Also, discuss how to setup and use a RAM file system on your RPi.**

**Ans:**

The Multimedia card (MMC) of the raspberry pi has very less reliability. Actually, it is based on NAND-Based flash memory which is less in cost and have huge storage but these have less tendency to bear system changes and causes system errors. When we go to delete some data from raspberry pi SD card then the high voltage required to delete data disturb the nearby cells so the NAND flash memory erased the data in 1kb to 4kb blocks. There is single level cell (SLC) and Multi-level cell (MCL) in a SD card. The reliability of SLC is better then MLC because MLC use different charging levels to store more states data in a single cell while the SCL store data only in singe state. Further, High quality SD card must be used that have large lifetime. The use of large storage capacity SD card leaves more space empty in the card after booting the raspberry pi operating system which increase the life of SD card and increase performance of the card.

The use of RAM file system on raspberry pi and computer PC actually increase the performance of the system by reducing the number of read/write cycles. This RAM feature can be used when a file that is placed in the permanent storage (HDD,SD card or USB storage) is accessing many times in a process and system is spending more time to read/write from or on this file. This large time span can be reduced by making the copy of this file in the RAM storage (creating temporary file) and remove at the completion of process.so data read/written on the file can be done faster and save time. The permanent storage like SD card and USB storage can be used as RAM file system in your raspberry pi which store the file by creating its temporary folder and act like a RAM for processor to do processing and when process complete, the storage remove the temporary files or can automatically remove when system reboot.

**Question 4.**

**Describe and give an example of using the following Linux cli commands:**

* **I/O Redirection (>, >>, and <)**

**Ans:**

These Linux commands are used to redirect the output to a file by using the above-mentioned redirection symbols. The > symbol is used to send the output of the program to a new file. While the ≫ symbol is used to add text in the temporary files. The ≫ symbol appends to the file. The < symbol is used to take input to a file.

* **Pipe (|)**

**Ans:**

The pipe (|) command is used to enter the output of one command into the input of other command. For example, if you list the root directory of raspberry pi and send its output to the command which is arranging the root director in reverse order so the Linux command is ‘ls / | sort -r’.

* **Echo and cat**

**Ans:**

The echo command reverberations the string, command output and value to standard output.

For example, the echo command use:

echo “the date is: $(date)”

the date is: sun 14 june

The cat command is used to for concatenation purpose and concatenate different files.

For example, the echo command use:

$ echo "hi" > 1.txt

$ echo "how are you?" > 2.txt

$ cat 1.txt 2.txt > 3.txt

* **Ps**

**Ans:**

Ps is the abbreviation of ‘process status’. PS command in Linux is used to list the currently running process with their process Id’s.

For example, ‘$ ps -x’ command shows all the user running processes.

**Question 5.**

**Describe Linux foreground and background processes. Give commands to start and stop a foreground and background process.**

**Ans:**

Like windows, MAC and other operating systems, Linux have feature of multitasking and run both foreground and background process simultaneously. The example of this feature is this ‘the operating system continuously refreshing it thousands of time in every second and you are using other programs (like video player, compilers etc.) at the same time in parallel. So, some processes are running in the background that are not visible on the screen while some process are running foreground and that are showing on the screen.AT some stages we have option to make process either it backgrounds or foreground process according to our desire. Some processes take long time to complete so we can run these processes in the background so these processes can run with the foreground process without creating any error or hinderance in the flow of foreground process. The best example of background running process in Linux is bash that is running in the background of LINUX operating system. And foreground process is those we are using like web browsers, compilers, games, folders etc.

The terminal of Linux system can take single type of command at the same time. So if there is a case when we want to run dd command in the terminal and we know that it takes a lot of time to complete and we are unable to enter any other command in the terminal or run any other process when it is running so in order to avoid this complexity we run this process in background. To do that simply add an ampersand (&) to the command which run this process in the background.

To start a foreground process that is running in the background is firstly bring it to the foreground process by using command ‘fg’. Similarly, a foreground process can bring into the background process by using command ‘bg’. In order to permanently stop the process, use command ‘pkill’. It will kill the default running process either in background or foreground.