# **LABORATORY 2: RASPBERRY PI OS AND INTRODUCTION TO LINUX BASICS**

**Objectives**

By the end of the laboratory, students will be able to

* Introduction to Basic Linux Command
* Configure Raspberry Pi OS on Monitor
* Familiarize with Raspberry Pi OS

**Activities**

* Flash Raspberry Pi OS into an SD card
* Connect Raspberry Pi to monitor
* Familiarize with basic linux Commands

**Equipment**

* Window OS laptop
* Raspberry Pi 4 Model B
* USB-C 5V Power Adapter
* Micro-HDMI to HDMI cable
* USB keyboard
* USB mouse
* 32 GB SD card

# **Introduction**

## **Raspberry Pi**

Raspberry Pi is a series of small [single-board computers](https://en.wikipedia.org/wiki/Single-board_computer) (SBCs) developed in the [United Kingdom](https://en.wikipedia.org/wiki/United_Kingdom) by the [Raspberry Pi Foundation](https://en.wikipedia.org/wiki/Raspberry_Pi_Foundation) in association with [Broadcom](https://en.wikipedia.org/wiki/Broadcom_Inc.). The Raspberry Pi project originally leaned towards the promotion of teaching basic [computer science](https://en.wikipedia.org/wiki/Computer_science) in schools.

It is a low-cost computer that runs Linux, but it also provides a set of GPIO (general purpose input/output) pins, allowing it to control electronic components for physical computing and explore the Internet of Things (IoT).

It is widely used in many areas, such as monitoring, programming skills education, hardware projects, home automation and edge computing.

# **Raspberry Pi 4 Model B**

* Silent, energy -efficient: The fan less, energy-efficient Raspberry Pi runs silently and uses far less power than other computers.
* USB3: RPI4B has upgraded USB capacity: along with two USB 2 ports and two USB3 ports, can transfer data 10 times faster.
* Fast networking: Raspberry Pi 4 comes with Gigabit Ethernet, along with onboard wireless networking and Bluetooth.

A close-up of a computer chip

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Figure 1: Raspberry Pi 4B

# **Raspberry Pi 4 Model B Operating Systems**

Raspberry Pi 4 Model B needs an operating system to work, an operating system is first flashed into a SD card and then the SD card is inserted into it. There is a list of operating systems suitable for the Raspberry Pi 4 Model B:

* Raspberry Pi OS (formerly Raspbian OS)
* OpenWrt OS
* Ubuntu OS
* Home Assistant OS

Raspberry Pi OS is the official supported operating system provided by the Raspberry Pi Foundation and is based on Debian distribution. Being an official operating system, it is the most compatible and easiest OS to use. OpenWrt is an open-source OS for embedded devices (e.g. router, access points) based on Linux kernel. It has a customizable and extensible platform for networking applications, a package management system for adding/removing features. It also supports VPN, NAT, firewall, QoS, and more. For the entirety of this module, only the Raspberry Pi OS is used.

# **Write Raspberry Pi OS into SD Card**

1. Download Raspberry Pi Imager from this link and click “Download for Windows”:  
   [Raspberry Pi OS – Raspberry Pi](https://www.raspberrypi.com/software/)
2. Insert the SD Card reader with an empty SD card to the laptop.

A white usb flash drive

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Figure 2: SD card reader with an empty SD card

1. Open Raspberry Pi imager, choose the following options:

A screenshot of a computer

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Figure 3: Raspberry Pi Imager

Choose **Device** > “Raspberry Pi 4”

Choose **OS** > “Raspberry Pi OS (Legacy, 32-bit)”

Choose **Storage** > “Generic Storage Device USB Device”

1. Click ‘Next’ and select “No”.

A screenshot of a computer

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1. Select “Yes” and wait for the writing to complete. **!!!Do not pull out the SD card while it is still writing!!!**

A screenshot of a computer error

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Ignore any errors that may pop out and click “OK”.

A screenshot of a computer

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1. Once done, take out the SD Card and insert into Raspberry Pi 4 Model B.

A screenshot of a computer

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Figure 4: Raspberry Pi OS successfully flashed into SD card

A hand holding a black device

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Figure 5: Insert SD card into the Raspberry Pi

**!!!VERY IMPORTANT!!!**

**DO NOT REMOVE THE SD CARD WHILE THE RASPBERRY PI IS STILL POWERED ON OR ELSE THE SD CARD WILL CORRUPT (DATA GONE)**

# **Set up Raspberry Pi OS on the monitor**

Make sure you have all these items:

A collage of different electronic devices

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## Power on the monitor.

## Connect the power supply to the Raspberry Pi and power on.

* 1. Connect the Raspberry Pi to the monitor via the micro-hdmi port.
  2. Connect the keyboard and mouse to the USB 2.0 ports of the Raspberry Pi.

A close-up of a computer

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Figure 7: Raspberry Pi ports

* 1. When you first start up a fresh Raspberry Pi OS, you will need to set country and create a user. Configure the following and click “Next”.

A computer screen with a white screen

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Figure 9: Set country

* 1. Create a user with following username “**pi**” and password “**raspberry**”, then click “Next”. Then reboot the Raspberry Pi.

A computer screen with a white screen

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Figure 10: Create a user

* 1. After rebooting, Raspberry Pi Desktop will appear on the monitor. Explore the Raspberry Pi OS!

A computer monitor with a picture of a fire

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# **Basic Linux Commands**

The Raspberry Pi OS running on the Raspberry Pi is a Linux based OS, becoming familiar with Linux commands can help to develop applications on the Raspberry Pi.

All Linux commands will be executed on the monitor which is connected to your Raspberry Pi.

The following are some common Linux commands that are useful:

|  |  |
| --- | --- |
| **Linux Command** | **Description** |
| ls | Lists all the files and folders in the current  directory |
| pwd | Displays the current directory path |
| cd | Navigate through directories |
| mkdir | Create directories |
| mv | Move or rename files |
| cp | Similar usage as mv but for copying files |
| rm | Delete files or directories |
| sudo | Changes the user permissions level to the root user (In Windows, administrator mode) |
| touch | Create a new empty file |
| rmdir | Removes the directory specified by directory parameter |
| man | Display user manual of any linux command |

**Table 1**

The following are some of the best practices for Linux file names:

|  |  |
| --- | --- |
| **Linux considerations** | **Description** |
| All file names are case sensitive | sample and SAMPLE are 2 different files |
| Instead of using a space, use an underscore or a dash | Might cause problems |
| Special characters can be significant | Don’t use symbols like “%”, “$”, and so forth. |
| Linux can have file names up to 255 characters.  You may have to type it out! | Keep the file names short and descriptive. |

**Table 2**

**Exercise 1**

1. Open a terminal, enter a Linux command to create the directory **/home/pi/ET0743/Lab2**

Key Linux commands: **mkdir, cd**

Write down the steps you used below.

|  |
| --- |
| **mkdir ET0743**  **cd ET0743**  **mkdir Lab2** |

1. Change to directory that you created **/home/pi/ET0743/Lab2** and show current driectory.

Key Linux commands: **cd, pwd**

Write down the steps you used below.

|  |
| --- |
| **cd Lab2**  **pwd** |

1. In the directory **/home/pi/ET0743/Lab2**, create a total of 3 empty practice files with names **NumberX**. Replace X with the numbers 1 to 3 and list all 3 files.

Key Linux commands: **touch , ls**

Write down the steps you used below.

|  |
| --- |
| **touch Number1 Number2 Number3**  **ls** |

**Exercise 2**

1. In the directory /home/pi/ET0743, delete the Lab2 folder that you created previously using **rmdir**.

Write down the error message displayed below.

|  |
| --- |
| **rmdir: failed to remove 'Lab2': Directory not empty** |

1. Based on the above example, delete the Lab2 and then ET0743 folder using the correct command.

Write down the steps you used below.

|  |
| --- |
| **cd /home/pi/ET0743/Lab2**  **rm Number1 Number2 Number3**  **cd**  **cd ET0743**  **rmdir Lab2**  **rmdir ET0743** |

To find out on why **rmdir** command did not work, there is a command to use to learn more about the command which is the man command which is used to display the user manual of any command that we can run on the terminal.

1. In the terminal PuTTY, type man followed by the Linux command name which man page you want to see, i.e., **man rmdir**

Write down the meaning of the command under NAME in the man page below.

|  |
| --- |
| **rmdir - remove empty directories** |

# **Appendix**

Configuring the Raspberry Pi in “headless” mode means that login to the raspberry pi without a monitor, keyboard or mouse. First, you must enable SSH and VNC in the raspberry pi by typing sudo raspi-config.

After enabling “headless” mode, there are many ways to login to the Raspberry Pi like using PuTTY or VNC viewer etc.

# **PuTTY**

PuTTY is an SSH and telnet client for the Windows platform.

PuTTY is open-source software that is available with source code and is developed and supported by a group of volunteers.

Now, we will connect to the Raspberry Pi using the PuTTY tool and remotely run Linux commands from our laptop via the SSH protocol.

1. Download PuTTY tool for Windows from <https://www.putty.org/>
2. Choose 64-bit x86 under MSI (‘Windows Installer’)

A screenshot of a computer

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1. Run Putty and Connect to the Raspberry Pi using the **IP address of eth0 obtained from Part B step 13.**

A computer screen shot of a computer

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1. For the first time connecting to the Raspberry pi via PuTTY, there will be a prompt window “PuTTY Security Alert” informing you the remote server's host key is not cached. Click “Accept”.

A screenshot of a computer security alert

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1. Enter the **Username as “pi” and the Password as “raspberry”** to start the SSH connection to Raspberry Pi.

A screenshot of a computer screen

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1. You are now able to navigate the PuTTY remote terminal via Linux commands.

# **VNC Viewer**

PuTTY is used only to establish a secure connection first. We will now install VNC Viewer to remotely control the Raspberry Pi using your laptop.

1. Download VNC Viewer for windows from the link below:

<https://www.realvnc.com/en/connect/download/viewer/windows/>

1. After installing, connect by entering the Raspberry Pi IP address of eth0 obtained from part B step 10.

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1. Enter the raspberry username “**pi**” and password “**raspberry**” to start the remote connection.

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1. You should see the **Raspberry Pi desktop** below the same as you would see on your monitor. You can disconnect Raspberry Pi from the monitor but keep it connected to your laptop.

A red and orange clouds over water

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Figure 12: Same Raspberry PI Desktop on monitor and VNC Viewer

## **Configuring Raspberry Pi to use WLAN (Optional)**

You can allow multiple users to connect to the Raspberry Pi using wireless connection.

1. Click on the arrow icon on your top right and select “Turn on Wireless LAN”. Select any Wi-Fi network and enter the password.

You will see an IP address when you hover your mouse to the Wireless LAN symbol, or you can check by clicking the VNC symbol.

1. Under the other ways to connect you can see that there are 2 IP addresses **192.168.0.209** (Ethernet) and **192.168.114.236** (WLAN). Repeat step 3.2 but instead of using **192.168.0.209**, use the new WLAN IP address that appears on your Raspberry Pi desktop. If you failed to connect to Raspberry Pi, check that your **laptop** is connected to the **same WLAN** as your Raspberry Pi.

A screenshot of a computer

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Figure 13: All these IP addresses can be used to login into the raspberry pi via SSH

**\*\*It is not recommended to SSH into the Raspberry Pi over Wi-Fi as the connection is unstable as compared to using ethernet connection, so only use Wi-Fi when there are multiple wireless devices**