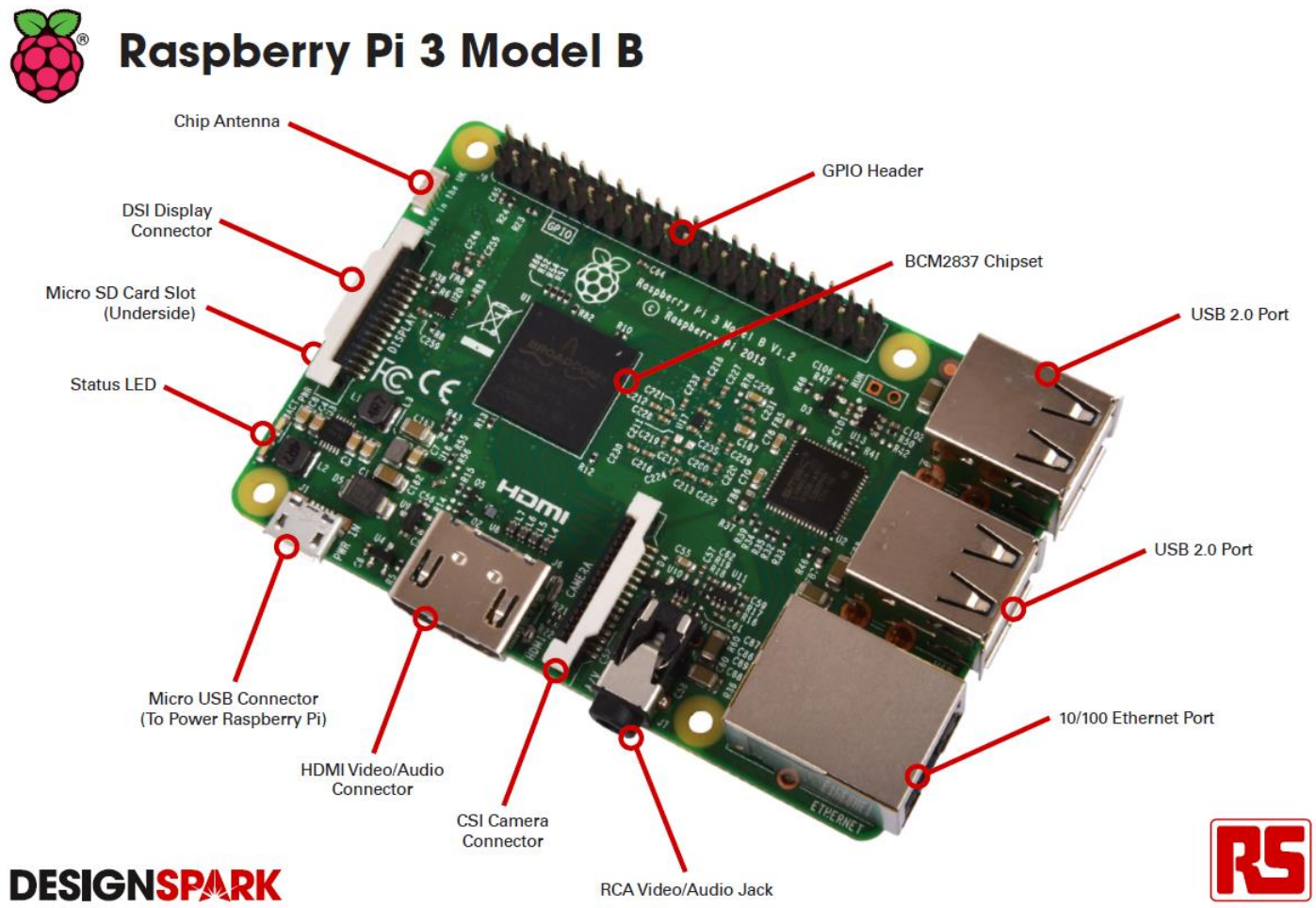
ECEN 5803- Mastering Embedded System Architecture

Practical Homework set 4

Due 2021/11/05

INTRODUCTION

RASPBERRY PI 3 MODEL B



What is a Raspberry Pi?

Created by the Raspberry Pi Foundation, the Raspberry Pi is an open-source, Linux based, credit card sized computer board. The Pi is an exciting and accessible means of improving computing and programming skills for people of all ages. By connecting to your TV or monitor and a keyboard, and with the right programming, the Pi can do many things that a desktop computer can do such as surf the internet and play video. The Pi is also great for those innovative projects that you want to try out - newer models are ideal for Internet of Things projects due to their processing power. With Pi 3, Wireless LAN and Bluetooth Low Energy are on-board too.

What is the user name and password for the Raspberry Pi?

The user name for Raspbian is **pi**
The password for Raspbian is **raspberry**

Operating Systems, Programming Languages & SD Cards

You will need an **operating system** to start using your Pi. An operating system is vital software that acts as a computer manager.
To download an operating system you will need an **SD card** between 8-32 GB. We have SD cards with New Out Of Box Software (NOOBS) pre-installed, so you don't have to do all of the work.
NOOBS helps you to set up your Pi and has six operating systems that you can download;
Of course, you don't have to use NOOBS. The Raspberry Pi Foundation regularly updates other available 'distros' in the downloads section of their website. Other available OSes include Raspbian (Linux), Fedora (Linux), Windows10 IoT, RISC OS, and Arch Linux. We will use the first 3 in this class.

Python is the recommended **programming language** — particularly if you are new to programming or want to refresh your programming knowledge.
Scratch is a great interactive programming language for children who want to learn to code through creating games, stories and animations.
Other programming languages you can get on your Pi include C, C++, Java and Ruby.

Specifications
Processor Broadcom BCM2387 chipset.
1.2GHz Quad-Core ARM Cortex-A53
802.11 b/g/n Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE)
GPU Dual Core VideoCore IV® Multimedia Co-Processor. Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode. Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure
Memory 1GB LPDDR2
Operating System Boots from Micro SD card, running a version of the Linux operating system or Windows 10 IoT
Dimensions 85 x 56 x 17mm
Power Micro USB socket 5V1, 2.5A
Connectors:
Ethernet 10/100 BaseT Ethernet socket
Video Output HDMI (rev 1.3 & 1.4
Composite RCA (PAL and NTSC)
Audio Output Audio Output 3.5mm jack, HDMI
USB 4 x USB 2.0 Connector
GPIO Connector 40-pin 2.54 mm (100 mil) expansion header: 2x20 strip
Providing 27 GPIO pins as well as +3.3 V, +5 V and GND supply lines
Camera Connector 15-pin MIPI Camera Serial Interface (CSI-2)
Display Connector Display Serial Interface (DSI) 15 way flat flex cable connector with two data lanes and a clock lane
Memory Card Slot Push/pull Micro SDIO
Key Benefits • Low cost • Consistent board format
• 10x faster processing • Added connectivity
Key Applications • Low cost PC/tablet/laptop • IoT applications
• Media center • Robotics
• Industrial/Home automation • Server/cloud server
• Print server • Security monitoring
• Web camera • Gaming
• Wireless access point
• Environmental sensing/monitoring (e.g. weather station)

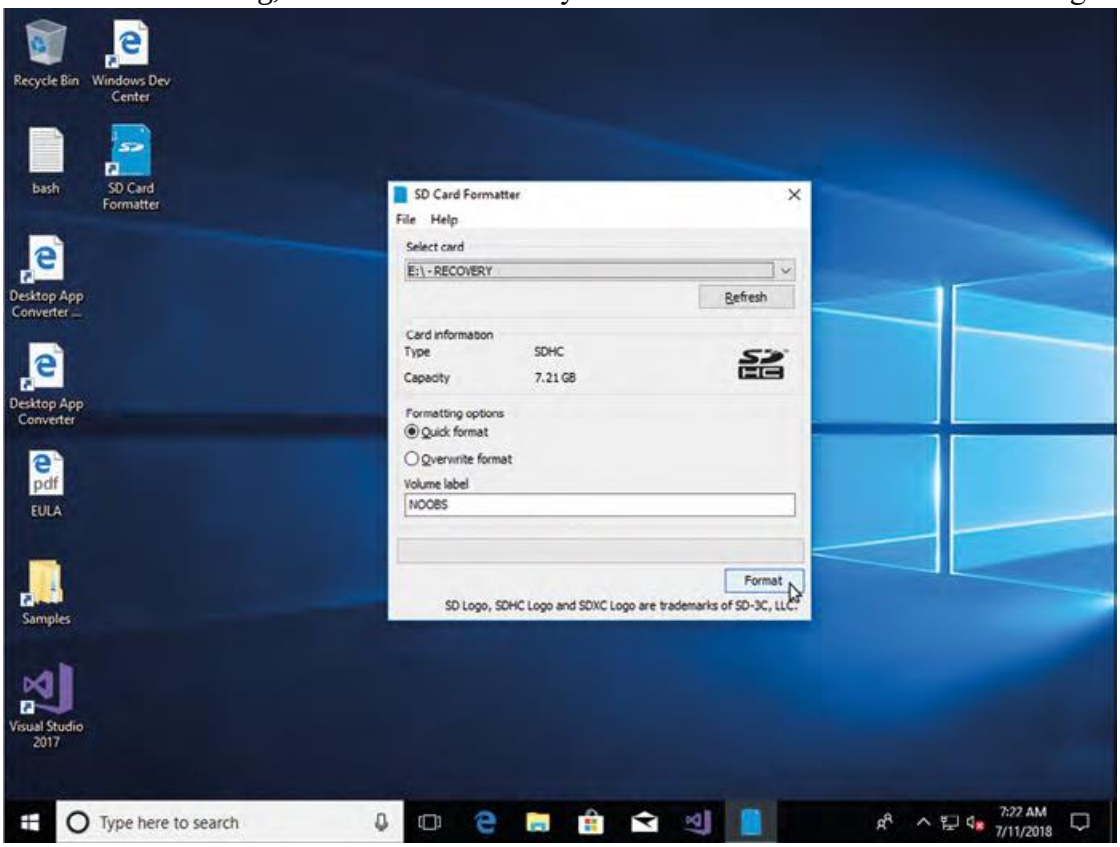
GETTING STARTED

This video shows how to get started with the Raspberry Pi 3 Model B:
https://www.youtube.com/watch?v=rLAblELXygA and https://www.youtube.com/watch?v=gbJB3387xUw
Also see "The Official Raspberry PI Beginner's Guide for more details on startup and also
https://projects.raspberrypi.org/en/projects/raspberry-pi-setting-up
NOTE: You will need an 8 GB microSD card to complete this lab

STEP 1: Gather necessary accessories and Write the SD Card

If you don't have the Raspberry Pi Starter Kit, then in addition to the Raspberry Pi 3 Model B you'll need:

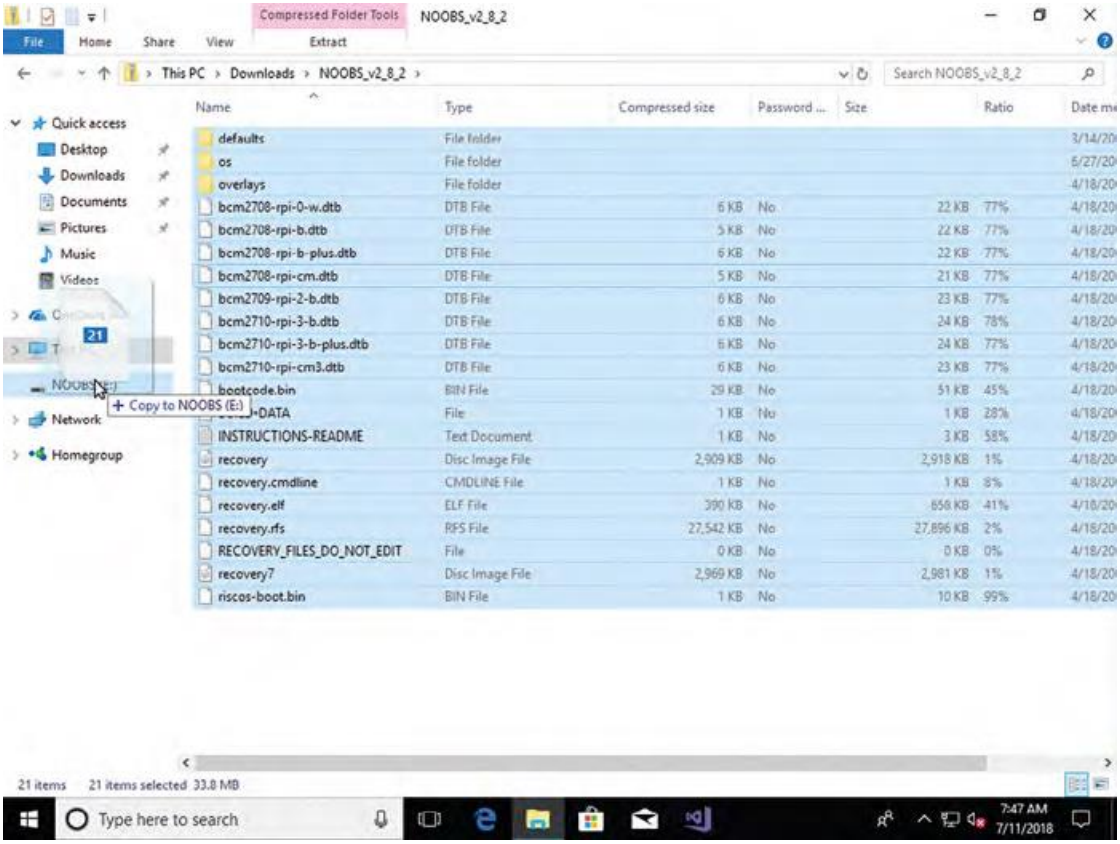
- USB power supply – A power supply rated at 2.5 amps (2.5A) or 12.5 watts (12.5W) and with a micro USB connector. The Official Raspberry Pi Power Supply is the recommended choice, as it can cope with the quickly switching power demands of the Raspberry Pi.
- microSD card with NOOBS – The microSD card acts as the Raspberry Pi's permanent storage; all the files you create and software you install, along with the operating system itself, are stored on the microSD card. An 8GB card will get you started, though a 16GB card offers more room to grow. Using a card with NOOBS, the New Out-Of-Box Software, pre-installed will save you some time; otherwise see below for instructions on installing NOOBS on a blank microSD card. NOOBS is available on the 5803Resources folder on the Google Drive, as is the SD Memory Card Formatter Tool. To format a previously used microSD card ready for NOOBS, Windows, and macOS users could download the SD Card Association SD Memory Card Formatter tool from **rpf.io/sdcard**, then double-click to install it; Linux users should use their distribution's disk management tool to delete any existing partitions on the disk, create a single partition, and format it as VFAT, then move onto the next section of this guide. Insert your microSD card into your card reader, if you haven't done so already, and load the SD Card Formatter tool. Look for your microSD card in the 'Select card' list; if you're reformatting a microSD card that has already been used with a Raspberry Pi, you may find it has more than one entry – just select any one of them. Double-check that you selected the correct drive by looking at the 'Card information' section: it should report the size and type of the microSD card you inserted. If the information is wrong, select a different entry from the 'Select card' list and check again.



When you're absolutely sure you've picked the correct microSD card, and you've backed up any files you want to keep if it's a used card, type 'NOOBS' into the 'Volume label' box, click the Format button, and confirm you want to overwrite the card. The default 'quick format' mode should only take a few seconds to complete, after which you can close the SD Card Formatter.

Installing NOOBS is as simple as drag-and-drop. Start by finding the NOOBS file, which should be in your Downloads folder. This file is known as an *archive*, a single file containing copies of lots of individual files which have been *compressed* to save space and make them quicker and easier to download.

Double-click on the archive to open it, then press **CTRL+A** on your keyboard – ⌘**+A** on macOS – to select all the files in the archive. Click on one of the files with the left mousebutton, and drag them to the removable drive representing your microSD card. Let go of the mouse button to drop the files, and wait for them to copy to the microSD; this can take a few minutes.



When the files have successfully copied, eject the microSD card from the computer and insert it into your Raspberry Pi. The next time the Raspberry Pi is switched on, NOOBS will load and ask you to choose your operating system.

- USB keyboard and mouse – The keyboard and mouse allow you to control the Raspberry Pi. Almost any wired or wireless keyboard and mouse with a USB connector will work with the Raspberry Pi, though some 'gaming' style keyboards with colorful lights may draw too much power to be used reliably.
- HDMI Cable – The HDMI cable carries sound and pictures from the Raspberry Pi to your TV or monitor. There's no need to spend a lot of money on an HDMI cable. If you are using a computer monitor without an HDMI socket, you can buy HDMI to DVI-D, DisplayPort, or VGA adapters; if you want to connect your Raspberry Pi to an older TV which uses composite video or has a SCART socket, use a 3.5 mm tip-ring-ringsleeve (TRRS) audio/video cable.

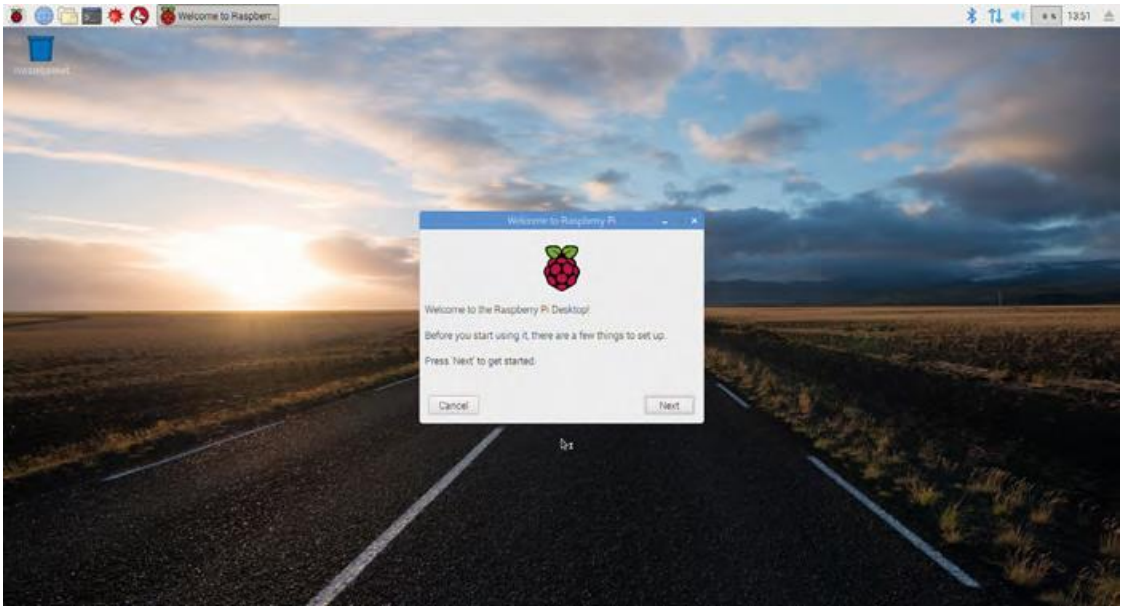
STEP 2: Install the SD Card, and Turn on the Raspberry Pi

To install the microSD card, which is the Raspberry Pi's storage, turn the Raspberry Pi over and slide the card into the microSD slot with the label facing away from the Pi. It can only go in one way, and should slide home without too much pressure. Next connect the USB keyboard and mouse (not supplied). Then connect the

display (you can use ones in the lab) using an HDMI Cable. Lastly, connect the power supply and the computer should boot.

When the Pi is first switched on, or booted, with a fresh installation of NOOBS on its microSD card, you'll see a screen with the Raspberry Pi logo on it and a small progress window at the upper-left. After a short pause, which can take up to a minute the first time you use the NOOBS microSD card, you'll see the NOOBS menu screen. Two operating systems are included with NOOBS as standard: Raspbian, a version of the Debian Linux operating system tailored specifically for the Raspberry Pi; and LibreELEC, a version of the Kodi entertainment Centre software. To begin installing an operating system, use the mouse to put a cross in the box to the left of Raspbian Full: point the cursor at the white box and click once with the left mouse button. When you've done so, you'll see that the 'Install (i)' menu icon is no longer greyed-out; this lets you know that your operating system is ready to install. The installation process can take anything from 10 to 30 minutes, depending on the speed of your microSD card. As the operating system is installed, progress is shown in a bar along the bottom of the window, you'll see a slide show highlighting some of its key features.

When the installation has finished, a window will pop up with an 'OK' button; click this and the Pi will restart into its freshly installed operating system. You will see boot messages scrolling on the screen, and then the Raspbian desktop GUI screen will appear.



HARDWARE DOCUMENTATION

See the schematic and hardware documents in the 5803Resources folder on the Google Drive.

Questions:
Note: Submit Screenshots to validate your output for each of problem requirements given below.

Q1: BOOT AND RUN RASPBIAN LINUX

1. Using the Getting Started instructions above, boot into Raspbian Linux.
2. How much memory is used by the code? (What is the image size?) Think about how you might determine this.
3. Capture a screen shot of the Raspbian Desktop.
4. Capture a screen shot of a Linux terminal window.
5. Blink the LEDs from the command shell.

Q2: CREATE AN FEDORA LINUX IMAGE

1. Watch these helpful videos: https://www.youtube.com/watch?v=z_59NjrouO8
2. Download the image from https://fedoraproject.org/wiki/Architectures/ARM/Raspberry_Pi#aarch64_supported_images_for_Raspberry_Pi_3 . A working image is also available on the ECEN5803Resources drive at https://drive.google.com/open?id=1enLLbtM1mF34IyFR3lEFsnk-yK64z-4j .
3. Extract the .raw file from the Fedora ARM image using file-decompression software (such as 7zip). For example:

   > "C:\Program Files\7-Zip\7z.exe" x -y "C:\Users\admin\Downloads\Fedora-Server-armhfp-31-1.1-sda.raw.xz"

4. Follow the instructions provided by the Raspberry Pi foundation for writing an image to a microSD card from Microsoft Windows: Raspberry Pi Foundation: Installing operating system images using Windows.
5. Insert your SD/SDHC card into the card reader, and attach to the computer if necessary. Follow the instructions above in #4.
6. Remove the card.
7. Connect the HDMI output to a monitor using an HDMI Cable and adapter if necessary.
8. Insert the card in to the Raspberry Pi 3 and apply power to the board. You should see the Fedora booting messages.
9. How much memory is used by the code? (What is the image size?)
10. Capture a screen shot of a Linux terminal window.
11. Blink an LED from the command shell. In order to control GPIO pins in Fedora, you may need to install the libgpiod library, which can be used from a Python script. See https://github.com/brgl/libgpiod
12. Connect the HDMI output to a monitor using an HDMI Cable and adapter if necessary. Reboot the system – what do you see?
13. Record your observations. How is the Fedora image different from the Raspbian image?

Grading Rubric

Q1) - [5 points] 1 point each

Q2) - [6 points] 1 point each