MES College of Engineering Pune-01

Department of Computer Engineering

Name of Student:	Class:
Semester/Year:	Roll No:
Date of Performance:	Date of Submission:
Examined By:	Experiment No: 01

ASSIGNMENT NO: 01

AIM: Study of Raspberry-Pi, Arduino with their operating systems. Understanding the process of OS installation on Raspberry-Pi /Arduino.

OBJECTIVES:

- To understand functionalities of single board embedded platforms fundamentals.
- To understand different sensory input.

**APPARATUS:** Raspberry-Pi, Arduino and Beagle board.

THEORY:

1) **Raspberry Pi:**

- Raspberry Pi is a series of small single-board computers developed in 2012 by the Raspberry Pi Foundation in the United Kingdom to promote the teaching of basic computer science in schools and developing countries.

- Its origins lie in the University of Cambridge computer lab in 2006. Computer scientists Eben Upton and Rob Mullins, Jack Lang and Alan Mycroft fear that incoming students can break away from the technical aspects of analysis. This is mainly because the school syllabus focuses on the use of computers rather than understanding them.

- Since then the group worked on developing a low priced and on-hand machine that would assist schools to train principles such as programming, for this reason bringing students closer to the appreciation of how computing works.

- Raspberry Pi is a very inexpensive computer that runs on Linux. However, it also offers a series of universal GPIO I/O that allows you to control electronic components for physical computers and explore the Internet of Things (IoT).

- Around the world, people use Raspberry Pis to learn programming skills, build hardware projects, run home automation, and even use them in industrial applications.
- **Different Models of RaspberryPi:**
  - ✓ Raspberry Pi 4 B → RAM — 1 GB, 2 GB, 4 GB — CPU Clock → 1.5 GHz
  - ✓ Raspberry Pi 3 B+ → RAM — 1 GB DDR2 — CPU Clock → 1.4 GHz
  - ✓ Raspberry Pi Zero → RAM — 512 MB — CPU Clock → 1 GHz
  - ✓ Raspberry Pi 2 → RAM — 1 GB — CPU Clock → 900 MHz
  - ✓ Raspberry Pi A+ → RAM — 256 MB — CPU Clock → 700 MHz
  - ✓ Raspberry Pi → RAM — 512 MB — CPU Clock → 700 MHz
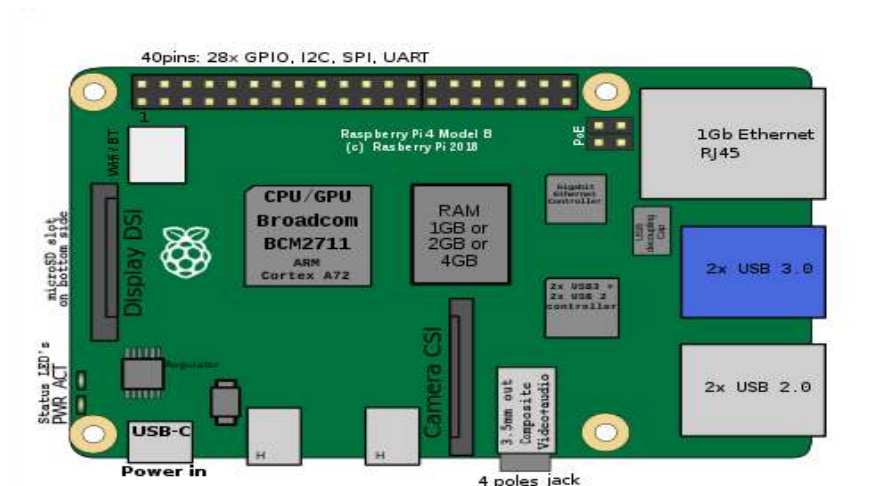
Raspberry Pi 400

- Featuring a quad-core 64-bit processor, wireless networking, dual-display output and 4K video playback, Raspberry Pi 400 is a complete personal computer, built into a compact keyboard.
- Raspberry Pi 400 is ideal for surfing the web, creating and editing documents, watching videos, and learning to program using the Raspberry Pi OS desktop environment.
- Raspberry Pi 400 is available in a number of different regional variants and as either a computer kit, containing everything you need to get started (except for a TV or monitor), or a computer unit only.
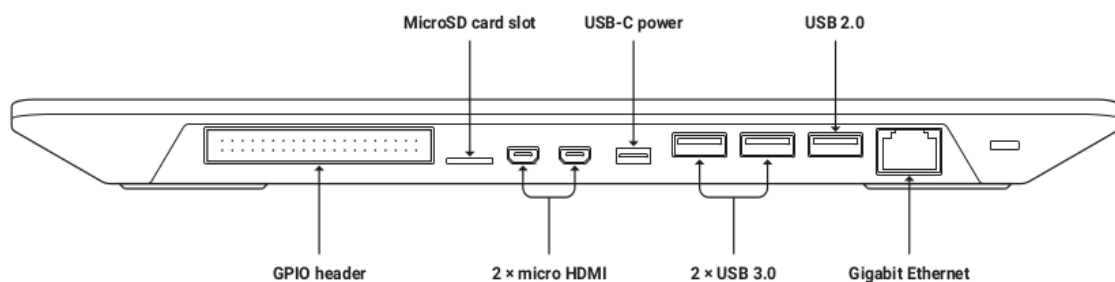
- **Specification of Pi 400**

Processor	Broadcom BCM2711 quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.8GHz
RAM	4GB LPDDR4-3200.
Connectivity	Dual-band (2.4GHz and 5.0GHz) IEEE 802.11b/g/n/ac wireless LAN, Bluetooth 5.0, BLE Gigabit Ethernet. 2 × USB 3.0 and 1 × USB 2.0 ports.
GPIO	Horizontal 40-pin GPIO header
Video & Sound	2 × micro HDMI ports (supports up to 4Kp60)
Multimedia	H.265 (4Kp60 decode); H.264 (1080p60 decode, 1080p30 encode); OpenGL ES 3.0 graphics
SD card support	MicroSD card slot for operating system and data storage
Keyboard	78- or 79-key compact keyboard (depending on regional variant)
Power	5V DC via USB connector
Operating Temperature	0°C to +50°C
Dimensions	286 mm × 122 mm × 23 mm (maximum)

2) BeagleBone Black

- BeagleBone Black is a low-cost, community-supported development platform for developers and hobbyists. Boot Linux in under 10 seconds and get started on development in less than 5 minutes with just a single USB cable.

- Explore the high-performance, low-power world with the tiny, affordable, open-source Beagles. Putting Android, Ubuntu and other Linux flavors at your fingertips, the Beagle family revs as high as 1GHz with flexible peripheral interfaces and a proven ecosystem of feature-rich "Cape" plug-in boards.
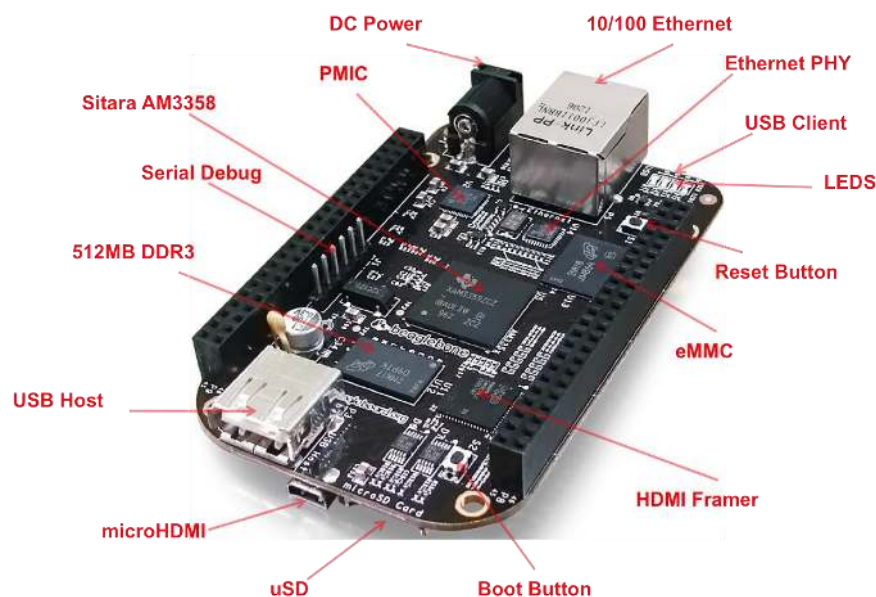
- **What can these boards do?**
  - ✓ The Beagles are tiny open-hardware (you could make one yourself), open-software computers that plug into whatever you have around the house.
  - ✓ Beagles mean big functionality in small packages because these little PCs can be used for all kinds of applications you've been tinkering with... and can handle many of the same tasks as your desktop PC.
  - ✓ The Beagle family is happiest when helping students to learn programming, hobbyists to push the boundaries of DIY and developers move to production quickly without excess noise, expense or bulk.

- **Product Comparison Table:**

Parameters	BeagleBoard.org BeagleBone Black	SeeedStudio BeagleBone Green	SanCloud BeagleBone Enhanced	BeagleBoard.org BeagleBone AI
Processor	AM3358 ARM Cortex-A8	AM3358 ARM Cortex-A8	AM3358 ARM Cortex-A8	AM5729 2x ARM Cortex-A15
Maximum Processor Speed	1GHz	1GHz	1GHz	1.5GHz
Co-processors	2x200-MHz PRUs, ARM Cortex-M3, SGX PowerVR	2x200-MHz PRUs, ARM Cortex-M3, SGX PowerVR	2x200-MHz PRUs, ARM Cortex-M3, SGX PowerVR	4x200-MHz PRUs, 2x ARM Cortex-M4, 2x SGX PowerVR, 2x HD video
Analog Pins	7 (1.8V)	7 (1.8V)	7 (1.8V)	7 (3.3V)
Digital Pins	65 (3.3V)	65 (3.3V)	65 (3.3V)	72 (3.3V) (7 shared with analog)
Memory	512MB DDR3 (800MHz x 16), 2GB (4GB on Rev C) on-board storage using eMMC, microSD card slot	512MB DDR3 (800MHz x 16), 4GB on-board storage using eMMC, microSD card slot	1GB DDR3 (800MHz x 16), 4GB on-board storage using eMMC, microSD card slot	1GB DDR3 (2x 512Mx16, dual-channel), 16GB on-board storage using eMMC, microSD card slot
USB	mini-AB USB 2.0 client port, Type-A USB 2.0 host port	micro-AB USB 2.0 client port, Type-A USB 2.0 host port	mini-AB USB 2.0 client port, 2x Type-A USB 2.0 host ports, 2x pin header USB 2.0 host ports	Type-C USB 3.0 5Gbps Host/Client port, Type-A USB 2.0 host port
Network	10/100 Ethernet	10/100 Ethernet	Gigabit Ethernet, 2.4GHz WiFi, Bluetooth, BLE	Gigabit Ethernet, 2.4/5GHz WiFi, Bluetooth, BLE
Video	microHDMI, cape add-ons	cape add-ons	microHDMI, cape add-ons	microHDMI, cape add-ons

|			microHDMI,	microHDMI,
Audio	microHDMI, cape add-ons	cape add-ons	Bluetooth, cape add-ons	Bluetooth, cape add-ons
Supported Interfaces	4x UART, 12x PWM/Timers, LCD, GPMC, MMC1, 2x SPI, 2x I2C, A/D Converter, 2x CAN Bus (w/o PHY)	4x UART, 12x PWM/Timers, LCD, GPMC, MMC1, 2x SPI, 2x I2C, A/D Converter, 2x CAN Bus (w/o PHY)2 Grove (I2C, UART)	4x UART, 12x PWM/Timers, LCD, GPMC, MMC1, 2x SPI, 2x I2C, A/D Converter, 2x CAN Bus (w/o PHY)	4x UART, 12x PWM/Timers, 2x SPI, 2x I2C, 7x A/D converter, CAN bus (w/o PHY), LCD, 3x quadrature encoder, SD/MMC
On-board Sensors	NA	NA	Barometer, Accelerometer, Gyro,Temperature	on-die temperature
MSRP	$49	$39	$69	$99

3) Arduino

- Arduino is an open-source electronics platform based on easy-to-use hardware and software.

- Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

- Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

- Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments.

- All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

- Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- ✓ Inexpensive
- ✓ Cross-platform
- ✓ Simple, clear programming environment
- ✓ Open source and extensible software
- ✓ Open source and extensible hardware

- **Arduino Products**
  - ✓ Entry Level: Arduino UNO, Arduino NANO, Arduino LEONARDO, Arduino MICRO etc.
  - ✓ Enhanced Features: Arduino NANO 33 BLE, Arduino NANO 33 BLE Sense, Arduino Due, Arduino MEGA 2560, Arduino Zero, etc.
  - ✓ IoT: Arduino NANO IOT, MKR FOX 1200, MRK WAN 1300, UNO Wifi REV2, etc.
  - ✓ Education: Engineering Kit Arduino fundamental bundle, Arduino Science kit Physics Lab, Arduino CTC Go!, etc .
  - ✓ Retired: Arduino ESPORA, Arduino Industrial 101m Arduino YUN MINI, etc.

- The Arduino UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.
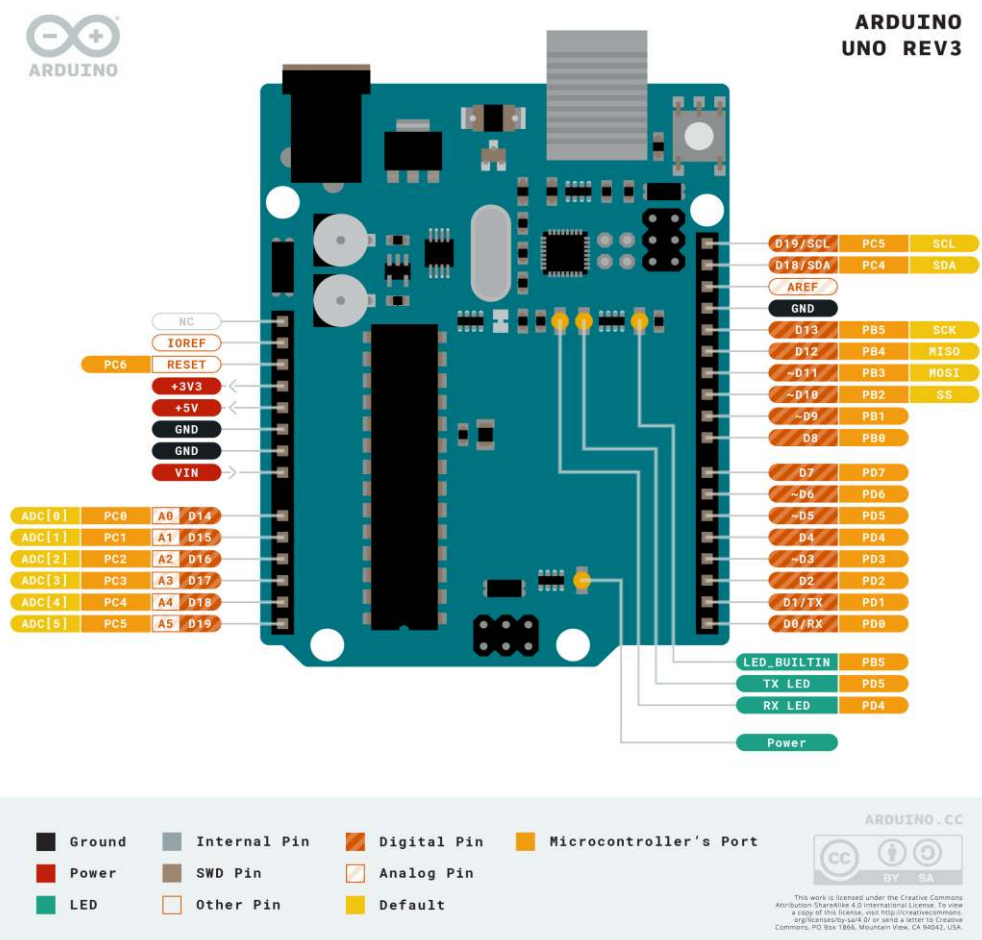
Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Installing operating system images:

✓ Raspberry Pi have developed a graphical SD card writing tool that works on Mac OS, Ubuntu 18.04 and Windows, and is the easiest option for most users as it will download the image and install it automatically to the SD card.

✓ Download the latest version of Raspberry Pi Imager from and install it.

https://www.raspberrypi.org/software/

▪ If you want to use Raspberry Pi Imager on the Raspberry Pi itself, you can install it from a terminal using **sudo apt install rpi-imager.**

✓ Connect an SD card reader with the SD card inside.

✓ Open Raspberry Pi Imager and choose the required OS from the list presented.

✓ Choose the SD card you wish to write your image to.

✓ Review your selections and click 'WRITE' to begin writing data to the SD card.

Installing operating system images using Windows:

Raspberry Pi Imager is our recommended option for most users to write images to SD cards, so it is a good place to start. If you're looking for an alternative on Windows, you can use balenaEtcher, Win32DiskImager or imgFlasher.

Win32DiskImager:

1. Insert the SD card into your SD card reader. You can use the SD card slot if you have one, or an SD adapter in a USB port. Note the drive letter assigned to the SD card. You can see the drive letter in the left hand column of Windows Explorer, for example **G:**

2. Download the Win32DiskImager utility from the Sourceforge Project page as an installer file, and run it to install the software.

3. Run the Win32DiskImager utility from your desktop or menu.

4. Select the image file you extracted earlier.

5. In the device box, select the drive letter of the SD card. Be careful to select the correct drive: if you choose the wrong drive you could destroy the data on your computer's hard disk! If you are using an SD card slot in your computer, and can't see the drive in the Win32DiskImager window, try using an external SD adapter.

6. Click 'Write' and wait for the write to complete.

7. Exit the imager and eject the SD card.

How to get NOOBS:

New out of Box Software (NOOBS) is an easy operating system installation manager for the Raspberry Pi.

✓ Buy a pre-installed SD card: SD cards with NOOBS preinstalled are available from many of our distributors and independent retailers, including Pimoroni, Adafruit, and Pi Hut.

✓ Download: Alternatively, NOOBS is available for download on the Raspberry Pi website: raspberrypi.org/downloads

How to install NOOBS on an SD card

✓ Once you've downloaded the NOOBS zip file, you'll need to copy the contents to a formatted SD card on your computer.

✓ To set up a blank SD card with NOOBS:

▪ Format an SD card as FAT. See the instructions given below.

  o Your SD card will need to be at least 16GB for Full Raspberry Pi OS, or at least 8GB for all other installs.

▪ Download and extract the files from the NOOBS zip file.

▪ Copy the extracted files onto the SD card that you just formatted, so that these files are at the root directory of the SD card. Please note that in some cases it may extract the files into a folder; if this is the case, then please copy across the files from inside the folder rather than the folder itself.

▪ On first boot, the "RECOVERY" FAT partition will be automatically resized to a minimum, and a list of OSes that are available to install will be displayed.

CONCLUSION:

QUESTIONS:

1. Differentiate between Raspberry-Pi, Beagle Bone and Arduino?
2. Enlist various features of different Raspberry Pi?
3. What are silent feature of BeagleBone AI and Raspberry-Pi 400?
4. Want key factors should be considered when choosing a microprocessor/microcontroller is design particular application?
5. List down different application of Raspberry-Pi, Beagle Bone and Arduino?
6. List Different operating systems that can run on the Raspberry-Pi.
7. Explain process of OS installation on Raspberry-Pi on Linux or Windows platform.
8. How to Configuring Raspberry Pi OS.
9. How to update and upgrade Raspberry Pi OS.
10. How to find your Raspberry Pi's IP address in order to connect to it