**Assignment - 1**

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**Name: Paras Bhat Roll NO: 322048**

**Gr No: 21911029 Batch: TY-B7**

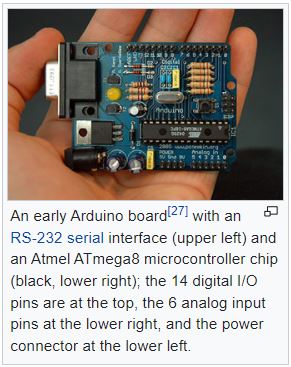
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**AIM:** Study of Arduino and Raspberry Pi.

**THEORY:**

1. **ARDUINO:**

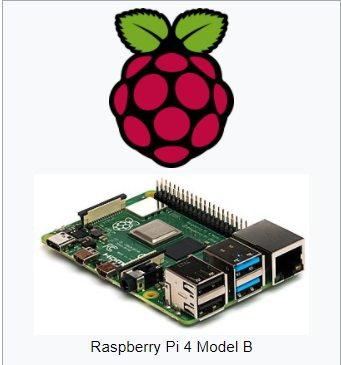


* 1. **History:** The Arduino project was started at the [Interaction Design Institute Ivrea](https://en.wikipedia.org/wiki/Interaction_Design_Institute_Ivrea) (IDII) in [Ivrea](https://en.wikipedia.org/wiki/Ivrea), Italy.[[2]](https://en.wikipedia.org/wiki/Arduino#cite_note-kushner-2) At that time, the students used a [BASIC Stamp](https://en.wikipedia.org/wiki/BASIC_Stamp) [microcontroller](https://en.wikipedia.org/wiki/Microcontroller) at a cost of $50. In 2003 [Hernando Barragán](https://en.wikipedia.org/w/index.php?title=Hernando_Barrag%C3%A1n&action=edit&redlink=1) created the development platform [*Wiring*](https://en.wikipedia.org/wiki/Wiring_(development_platform)) as a Master's thesis project at IDII, under the supervision of Massimo Banzi and [Casey Reas](https://en.wikipedia.org/wiki/Casey_Reas). Casey Reas is known for co-creating, with Ben Fry, the [Processing](https://en.wikipedia.org/wiki/Processing_(programming_language)) development platform. The project goal was to create simple, low cost tools for creating digital projects by non-engineers. The Wiring platform consisted of a [printed circuit board](https://en.wikipedia.org/wiki/Printed_circuit_board) (PCB) with an [ATmega](https://en.wikipedia.org/wiki/ATmega)128 microcontroller, an IDE based on Processing and library functions to easily program the microcontroller.[[4]](https://en.wikipedia.org/wiki/Arduino#cite_note-:0-4) In 2005, Massimo Banzi, with David Mellis, another IDII student, and David Cuartielles, extended Wiring by adding support for the cheaper ATmega8 microcontroller. The new project, forked from Wiring, was called *Arduino*.
  2. **Hardware:** Most Arduino boards consist of an [Atmel](https://en.wikipedia.org/wiki/Atmel) 8-bit [AVR microcontroller](https://en.wikipedia.org/wiki/AVR_microcontroller) (ATmega8,[[28]](https://en.wikipedia.org/wiki/Arduino#cite_note-28) ATmega168, [ATmega328](https://en.wikipedia.org/wiki/ATmega328), ATmega1280, or ATmega2560) with varying amounts of flash memory, pins, and features.[[29]](https://en.wikipedia.org/wiki/Arduino#cite_note-29) The 32-bit [Arduino Due](https://en.wikipedia.org/wiki/Arduino_Due), based on the Atmel [SAM3X8E](https://en.wikipedia.org/wiki/Atmel_ARM-based_processors#SAM_3) was introduced in 2012.[[30]](https://en.wikipedia.org/wiki/Arduino#cite_note-30) The boards use single or double-row pins or female headers that facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed *shields*. Multiple and possibly stacked shields may be individually addressable via an [I²C](https://en.wikipedia.org/wiki/I%C2%B2C) [serial bus](https://en.wikipedia.org/wiki/Serial_bus). Most boards include a 5 V [linear regulator](https://en.wikipedia.org/wiki/Linear_regulator) and a 16 MHz [crystal oscillator](https://en.wikipedia.org/wiki/Crystal_oscillator) or [ceramic resonator](https://en.wikipedia.org/wiki/Ceramic_resonator). Some designs, such as the LilyPad,[[31]](https://en.wikipedia.org/wiki/Arduino#cite_note-31) run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions.

Arduino microcontrollers are pre-programmed with a [boot loader](https://en.wikipedia.org/wiki/Boot_loader) that simplifies uploading of programs to the on-chip [flash memory](https://en.wikipedia.org/wiki/Flash_memory). The default bootloader of the Arduino Uno is the Optiboot bootloader.[[32]](https://en.wikipedia.org/wiki/Arduino#cite_note-32) Boards are loaded with program code via a serial connection to another computer. Some serial Arduino boards contain a level shifter circuit to convert between [RS-232](https://en.wikipedia.org/wiki/RS-232) logic levels and [transistor–transistor logic](https://en.wikipedia.org/wiki/Transistor%E2%80%93transistor_logic) (TTL) level signals. Current Arduino boards are programmed via [Universal Serial Bus](https://en.wikipedia.org/wiki/Universal_Serial_Bus) (USB), implemented using USB-to-serial adapter chips such as the [FTDI](https://en.wikipedia.org/wiki/FTDI) FT232. Some boards, such as later-model Uno boards, substitute the [FTDI](https://en.wikipedia.org/wiki/FTDI) chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own [ICSP](https://en.wikipedia.org/wiki/In-system_programming) header.

* 1. **Software**: A program for Arduino hardware may be written in any [programming language](https://en.wikipedia.org/wiki/Programming_language) with compilers that produce binary machine code for the target processor. Atmel provides a development environment for their 8-bit [AVR](https://en.wikipedia.org/wiki/Atmel_AVR) and 32-bit [ARM Cortex-M](https://en.wikipedia.org/wiki/ARM_Cortex-M) based microcontrollers: AVR Studio (older) and Atmel Studio (newer).
* **IDE:** The Arduino [integrated development environment](https://en.wikipedia.org/wiki/Integrated_development_environment) (IDE) is a [cross-platform](https://en.wikipedia.org/wiki/Cross-platform) application (for [Microsoft Windows](https://en.wikipedia.org/wiki/Microsoft_Windows), [macOS](https://en.wikipedia.org/wiki/MacOS), and [Linux](https://en.wikipedia.org/wiki/Linux)) that is written in the [Java](https://en.wikipedia.org/wiki/Java_(programming_language)) programming language. It originated from the IDE for the languages [*Processing*](https://en.wikipedia.org/wiki/Processing_(programming_language)) and [*Wiring*](https://en.wikipedia.org/wiki/Wiring_(development_platform)). It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, [brace matching](https://en.wikipedia.org/wiki/Brace_matching), and [syntax highlighting](https://en.wikipedia.org/wiki/Syntax_highlighting), and provides simple *one-click* mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus.
* **IDE 2.0:** On October 18, 2019, Arduino Pro IDE (alpha preview) was released. Later, on March 1, 2021, the beta preview was released, renamed IDE 2.0. The system still uses Arduino CLI (Command Line Interface), but improvements include a more professional development environment, autocompletion support, and Git integration.[[63]](https://en.wikipedia.org/wiki/Arduino#cite_note-66) The application frontend is based on the Eclipse Theia Open Source IDE. The main features available in the new release are:[[64]](https://en.wikipedia.org/wiki/Arduino#cite_note-67)
* Modern, fully featured development environment
* Dual Mode, Classic Mode (identical to the Classic Arduino IDE) and Pro Mode (File System view)
* New Board Manager
* New Library Manager
* Board List
* Basic Auto-Completion (Arm targets only)
* Git Integration
* Serial Monitor
* Dark Mode
  1. **Applications:** 
     1. [Arduboy](https://en.wikipedia.org/wiki/Arduboy), a [handheld game console](https://en.wikipedia.org/wiki/Handheld_game_console) based on Arduino
     2. [Arduinome](https://en.wikipedia.org/wiki/Arduinome), a [MIDI controller](https://en.wikipedia.org/wiki/MIDI_controller) device that mimics the [Monome](https://en.wikipedia.org/wiki/Monome)
     3. [Ardupilot](https://en.wikipedia.org/wiki/Ardupilot), drone software and hardware
     4. [ArduSat](https://en.wikipedia.org/wiki/ArduSat), a cubesat based on Arduino.
     5. [C-STEM Studio](https://en.wikipedia.org/wiki/C-STEM_Studio), a platform for hands-on integrated learning of computing, science, technology, engineering, and mathematics (C-STEM) with robotics.
     6. Data loggers for scientific research.[[75]](https://en.wikipedia.org/wiki/Arduino#cite_note-78)[[76]](https://en.wikipedia.org/wiki/Arduino#cite_note-79)[[77]](https://en.wikipedia.org/wiki/Arduino#cite_note-80)[[78]](https://en.wikipedia.org/wiki/Arduino#cite_note-81)
     7. [OBDuino](https://en.wikipedia.org/wiki/OBDuino), a [trip computer](https://en.wikipedia.org/wiki/Trip_computer) that uses the [on-board diagnostics](https://en.wikipedia.org/wiki/On-board_diagnostics) interface found in most modern cars
     8. [OpenEVSE](https://en.wikipedia.org/wiki/OpenEVSE) an open-source electric vehicle charger
     9. [XOD](https://en.wikipedia.org/wiki/XOD_(programming_language)), a visual programming language for Arduino
     10. [Tinkercad](https://en.wikipedia.org/wiki/Tinkercad), an analog and digital simulator supporting Arduino Simulation.

1. **Raspberry Pi:**



1. **Introduction**:

* Raspberry Pi ([/paɪ/](https://en.wikipedia.org/wiki/Help:IPA/English)) 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.).[[14]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-14) The Raspberry Pi project originally leaned towards the promotion of teaching basic [computer science](https://en.wikipedia.org/wiki/Computer_science) in schools and in [developing countries](https://en.wikipedia.org/wiki/Developing_countries).[[15]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-15)[[16]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-16)[[17]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-17) The original model became more popular than anticipated,[[18]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-1000x-18) selling outside its [target market](https://en.wikipedia.org/wiki/Target_market) for uses such as [robotics](https://en.wikipedia.org/wiki/Robotics). It is widely used in many areas, such as for [weather monitoring](https://en.wikipedia.org/wiki/Automatic_weather_station),[[19]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-19) because of its low cost, modularity, and open design. It is typically used by computer and electronic hobbyists, due to its adoption of HDMI and USB devices.

After the release of the second board type, the Raspberry Pi Foundation set up a new entity, named Raspberry Pi Trading, and installed [Eben Upton](https://en.wikipedia.org/wiki/Eben_Upton" \o "Eben Upton) as [CEO](https://en.wikipedia.org/wiki/Chief_executive_officer), with the responsibility of developing technology.[[20]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-20) The Foundation was rededicated as an educational charity for promoting the teaching of basic computer science in schools and developing countries.

* The first generation (**Raspberry Pi Model B**) was released in February 2012, followed by the simpler and cheaper **Model A**.
* In 2014, the Foundation released a board with an improved design, **Raspberry Pi Model B+**. These first generation boards feature [ARM11 processors](https://en.wikipedia.org/wiki/ARM11), are approximately credit-card sized and represent the standard *mainline* form-factor. Improved A+ and B+ models were released a year later.[[*clarification needed*](https://en.wikipedia.org/wiki/Wikipedia:Please_clarify)] A ["Compute Module"](https://en.wikipedia.org/wiki/Raspberry_Pi#Compute_module) was released in April 2014 for [embedded applications](https://en.wikipedia.org/wiki/Embedded_system).
* The **Raspberry Pi 2** was released in February 2015 and initially featured a 900 MHz 32-bit quad-core [ARM Cortex-A7](https://en.wikipedia.org/wiki/ARM_Cortex-A7) processor with 1 GB RAM. Revision 1.2 featured a 900 MHz [64-bit](https://en.wikipedia.org/wiki/64-bit_computing) quad-core [ARM Cortex-A53](https://en.wikipedia.org/wiki/ARM_Cortex-A53) processor (the same as that in the Raspberry Pi 3 Model B, but underclocked to 900 MHz).[[26]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-:0-26)
* **Raspberry Pi 3 Model B** was released in February 2016 with a 1.2 GHz 64-bit [quad core](https://en.wikipedia.org/wiki/Multi-core_processor) [ARM Cortex-A53](https://en.wikipedia.org/wiki/ARM_Cortex-A53) processor, on-board [802.11n](https://en.wikipedia.org/wiki/802.11n) [Wi-Fi](https://en.wikipedia.org/wiki/Wi-Fi), [Bluetooth](https://en.wikipedia.org/wiki/Bluetooth) and USB boot capabilities.[[27]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-27)
* On [Pi Day](https://en.wikipedia.org/wiki/Pi_Day) 2018, the **Raspberry Pi 3 Model B+** was launched with a faster 1.4 GHz processor, a three-times faster [gigabit Ethernet](https://en.wikipedia.org/wiki/Gigabit_Ethernet) (throughput limited to ca. 300 [Mbit/s](https://en.wikipedia.org/wiki/Mbit/s) by the internal USB 2.0 connection), and 2.4 / 5 GHz [dual-band](https://en.wikipedia.org/wiki/Dual-band) [802.11ac](https://en.wikipedia.org/wiki/802.11ac) Wi-Fi (100 Mbit/s).[[28]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-RapsberryPi3B+Release-28) Other features are [Power over Ethernet](https://en.wikipedia.org/wiki/Power_over_Ethernet) (PoE) (with the add-on PoE [HAT](https://en.wikipedia.org/wiki/Raspberry_Pi#Accessories)), [USB boot](https://en.wikipedia.org/wiki/USB-bootable_Linux_distribution) and [network boot](https://en.wikipedia.org/wiki/Network_booting) (an [SD card](https://en.wikipedia.org/wiki/SD_card) is no longer required).
* **Raspberry Pi 4 Model B** was released in June 2019[[1]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-Pi4OnSale-1) with a 1.5 GHz 64-bit quad core [ARM Cortex-A72](https://en.wikipedia.org/wiki/ARM_Cortex-A72) processor, on-board 802.11ac [Wi-Fi](https://en.wikipedia.org/wiki/Wi-Fi), [Bluetooth 5](https://en.wikipedia.org/wiki/Bluetooth_5), full [gigabit Ethernet](https://en.wikipedia.org/wiki/Gigabit_Ethernet) (throughput not limited), two [USB 2.0](https://en.wikipedia.org/wiki/USB_2.0) ports, two [USB 3.0](https://en.wikipedia.org/wiki/USB_3.0) ports, 2-8 GB of RAM, and dual-monitor support via a pair of micro HDMI ([HDMI Type D](https://en.wikipedia.org/wiki/HDMI#Connectors)) ports for up to [4K resolution](https://en.wikipedia.org/wiki/4K_resolution). The version with 1 GB RAM has been abandoned and the prices of the 2 GB version have been reduced. The 8 GB version has a revised circuit board. The Pi 4 is also powered via a [USB-C](https://en.wikipedia.org/wiki/USB-C) port, enabling additional power to be provided to downstream peripherals, when used with an appropriate PSU. But the Pi can only be operated with 5 volts and not 9 or 12 volts like other mini computers of this class. The initial Raspberry Pi 4 board has a design flaw where third-party [e-marked](https://en.wikipedia.org/wiki/USB-C#Cables) USB cables, such as those used on Apple MacBooks, incorrectly identify it and refuse to provide power.[[29]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-29)[[30]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-30) [Tom's Hardware](https://en.wikipedia.org/wiki/Tom%27s_Hardware) tested 14 different cables and found that 11 of them turned on and powered the Pi without issue.[[31]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-31) The design flaw was fixed in revision 1.2 of the board, released in late 2019.[[32]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-32) In mid-2021, Pi 4 B models appeared with the improved Broadcom BCM2711**C0**. The manufacturer is now using this chip for the Pi 4 B and Pi 400. However, the tack frequency of the Pi 4 B was not increased in the factory.

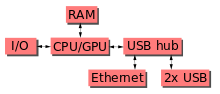
[](https://en.wikipedia.org/wiki/File:Raspberry_Pi_400_(50586757772).jpg)

Raspberry Pi 400 Kit

* **Raspberry Pi 400** was released in November 2020. It features a custom board that is derived from the existing Raspberry Pi 4, specifically remodelled with a keyboard attached. The case was derived from that of the Raspberry Pi Keyboard.[[33]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-33) A robust cooling solution (i.e. a broad metal plate) and an upgraded switched-mode power supply[[34]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-1.8Ghz-34) allow the Raspberry Pi 400's Broadcom BCM2711C0 processor to be clocked at 1.8 GHz, which is slightly higher than the Raspberry Pi 4 it's based on.[[35]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-35) The keyboard-computer features 4 GB of LPDDR4 RAM.

1. **Hardware:**

The Raspberry Pi hardware has evolved through several versions that feature variations in the type of the central processing unit, amount of [memory](https://en.wikipedia.org/wiki/Computer_memory) capacity, networking support, and peripheral-device support.

[](https://en.wikipedia.org/wiki/File:Raspberrypi_block_function_v01.svg)

This block diagram[[*which?*](https://en.wikipedia.org/wiki/Wikipedia:Avoid_weasel_words)] describes models B, B+, A and A+. The Pi Zero models are similar, but lack the [Ethernet](https://en.wikipedia.org/wiki/Ethernet) and [USB](https://en.wikipedia.org/wiki/USB) hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the [system on a chip](https://en.wikipedia.org/wiki/System_on_a_chip) (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-port USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a [micro USB](https://en.wikipedia.org/wiki/Micro_USB) (OTG) port. Unlike all other Pi models, the 40 pin GPIO connector is omitted on the Pi Zero, with solderable through-holes only in the pin locations. The Pi Zero WH remedies this.

Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+ or 1.5 GHz for the Pi 4; on-board memory ranges from 256 [MB](https://en.wikipedia.org/wiki/Megabyte) to 8 [GB](https://en.wikipedia.org/wiki/Gigabyte) [random-access memory](https://en.wikipedia.org/wiki/Random-access_memory) (RAM), with only the Raspberry Pi 4 having more than 1 GB. [Secure Digital](https://en.wikipedia.org/wiki/Secure_Digital) (SD) cards in MicroSDHC form factor (SDHC on early models) are used to store the operating system and program memory, however some models also come with onboard eMMC storage[[50]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-53) and the Raspberry Pi 4 can also make use of USB-attached SSD storage for its operating system.[[51]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-54) The boards have one to five [USB](https://en.wikipedia.org/wiki/USB) ports. For video output, [HDMI](https://en.wikipedia.org/wiki/HDMI) and [composite video](https://en.wikipedia.org/wiki/Composite_video) are supported, with a standard 3.5 mm [tip-ring-sleeve](https://en.wikipedia.org/wiki/Phone_connector_(audio)) jack for audio output. Lower-level output is provided by a number of [GPIO](https://en.wikipedia.org/wiki/General-purpose_input/output) pins, which support common protocols like [I²C](https://en.wikipedia.org/wiki/I%C2%B2C). The B-models have an [8P8C](https://en.wikipedia.org/wiki/8P8C) [Ethernet](https://en.wikipedia.org/wiki/Ethernet) port and the Pi 3, Pi 4 and Pi Zero W have on-board [Wi-Fi](https://en.wikipedia.org/wiki/Wi-Fi) [802.11n](https://en.wikipedia.org/wiki/802.11n) and [Bluetooth](https://en.wikipedia.org/wiki/Bluetooth).

1. **Driver API:** Raspberry Pi can use a [VideoCore](https://en.wikipedia.org/wiki/VideoCore) IV GPU via a [binary blob](https://en.wikipedia.org/wiki/Binary_blob), which is loaded into the GPU at boot time from the [SD-card](https://en.wikipedia.org/wiki/Secure_Digital), and additional software, that initially was [closed source](https://en.wikipedia.org/wiki/Closed_source_software).[[193]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-h-online_2011-206) This part of the driver code was later released.[[194]](https://en.wikipedia.org/wiki/Raspberry_Pi#cite_note-ARMuserland-207) However, much of the actual driver work is done using the closed source GPU code. Application software makes calls to closed source run-time libraries ([OpenMax](https://en.wikipedia.org/wiki/OpenMax), [OpenGL ES](https://en.wikipedia.org/wiki/OpenGL_ES) or [OpenVG](https://en.wikipedia.org/wiki/OpenVG)), which in turn call an open source driver inside the Linux kernel, which then calls the closed source VideoCore IV GPU driver code. The [API](https://en.wikipedia.org/wiki/Application_programming_interface) of the kernel driver is specific for these closed libraries. Video applications use [OpenMAX](https://en.wikipedia.org/wiki/OpenMAX), [3D applications](https://en.wikipedia.org/wiki/3D_computer_graphics) use [OpenGL ES](https://en.wikipedia.org/wiki/OpenGL_ES) and [2D applications](https://en.wikipedia.org/wiki/2D_computer_graphics) use [OpenVG](https://en.wikipedia.org/wiki/OpenVG), which both in turn use [EGL](https://en.wikipedia.org/wiki/EGL_(OpenGL)). OpenMAX and EGL use the open source kernel driver in turn.
2. **Applications:** Following are the applications of Raspberry Pi.
   * 1. Education
     2. Home Automation
     3. Industrial Automation
     4. Commercial Products
     5. Automation For Pandemics