JEPPIAAR INSTITUTE OFTECHNOLOGY

SELF BELIEF | SELF DISCIPLINE | SELF RESPECT

KUNNAM, SUNGUVARCHATRAM, SRIPERUMBUDUR, CHENNAI - 631 604

DEPARTMENT OF INFORMATION TECHNOLOGY

CSS3691– EMBEDDED AND IoT LABORATORY

NAME :

REG NO. :

YEAR :

SEMESTER :

BRANCH :

JEPPIAAR INSTITUTE OF TECHNOLOGY

SELF BELIEF | SELF DISCIPLINE | SELF RESPECT

KUNNAM, SUNGUVARCHATRAM, SRIPERUMBUDUR, CHENNAI - 631 604.

BONAFIDE CERTIFICATE

This is a certified Bonafide Record Work of Mr./Ms. _____

Register No._____ submitted for the Anna University Practical Examination held on_____ in **CCS3691 – EMBEDDED AND IoT LABORATORY** during the year 2023-2024.

Signature of the Lab In-charge

Head of the Department

Internal Examiner

External Examiner

Date _____

VISION OF THE INSTITUTION

Jeppiaar Institute of Technology aspires to provide technical education in futuristic technologies with the perspective of innovative, industrial and social application for the betterment of humanity.

MISSION OF THE INSTITUTION

- To produce competent and disciplined high-quality professionals with the practical skills necessary to excel as innovative professionals and entrepreneurs for the benefit of the society.
- To improve the quality of education through excellence in teaching and learning, research, leadership and by promoting the principles of scientific analysis, and creative thinking.
- To provide excellent infrastructure, serene and stimulating environment that is most conducive to learning.
- To strive for productive partnership between the Industry and the Institute for research and development inthe emerging fields and creating opportunities for employability.
- To serve the global community by instilling ethics, values and life skills among the students needed to enrich their lives.

VISION OF THE DEPARTMENT

The department will be an excellent centre to impart futuristic and innovative technological education to facilitate the evolution of problem-solving skills along with knowledge application in the field of Information Technology, understanding industrial and global requirements and societal needs for the benefit of humanity.

MISSION OF THE DEPARTMENT

M1: Produce competent and high-quality professional computing graduates in software development considering global requirements and societal needs thereby maximizing employability.

M2: Enhance evolution of professional skills and development of leadership traits among the students by providing favourable infrastructure and environment to grow into successful entrepreneurs.

M3: Training in multidisciplinary skills needed by Industries, higher educational institutions, research establishments and Entrepreneurship.

M4: Impart Human Values and Ethical Responsibilities in professional activities.

PEO's OF THE DEPARTMENT

- Provided with a fundamental knowledge in Science, mathematics and computing skills for creative and innovative application.
- Enabled students competent and employable by providing excellent Infrastructure to learn and contribute for the welfare of the society.
- To channelize the potentials of the students by offering state of the art amenities to undergo research and higher education.
- To evolve computing engineers with multi-disciplinary understanding and maximize Job Opportunities.
- To facilitate students, obtain profound understanding nature and social requirements and grow as professionals with values and integrity.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

- **Engineering knowledge:** Apply the knowledge of mathematics, science, Engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

- **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PROGRAM SPECIFIC OUTCOMES

- Students are able to analyse, design, implement and test any software with the programming and testingskills they have acquired.
- Students are able to design and develop algorithms for real time problems, scientific and businessapplications through analytical, logical and problems solving skills.
- Students are able to provide security solution for network components and data storage and management which will enable them to work efficiently in the industry.

TABLE OF CONTENTS

INTRODUCTION

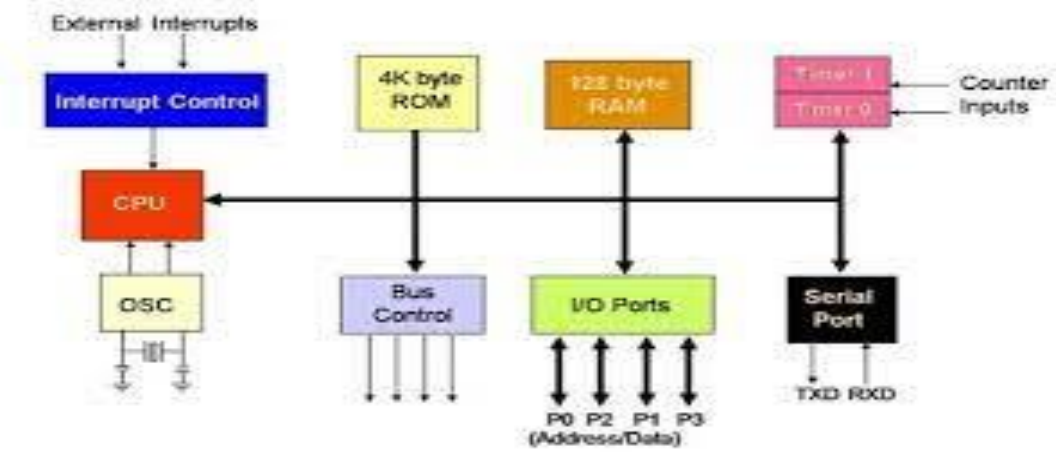
Earlier to Microcontrollers, Microprocessors were greatly used for each and every purpose. Microprocessors were containing ALU, general purpose register, stackpointer, program counter, clock counter and so many other features which the today's Microcontroller also possesses. But the difference between them exists with respect tothe number of instructions, access times, size, reliability, PCB size and so on. Microprocessor contains large instruction set called as CISC processor whereas Microcontroller contains less number of instructions and is called as RISC processor. The access time is less in case of microcontrollers compared to microprocessors and the PCB size reduces in case of microcontrollers.

There are many versions of microcontrollers 8051, 80528751, AT8951 from Atmel Corporation and many more. In this manual we will study about the 8051 architecture, its features, programming and interfacing.

MCS 8051 is an 8-bit single chip microcontroller with many built-in functions and is the core for all MCS-51 devices.

The main features of the 8051 core are:

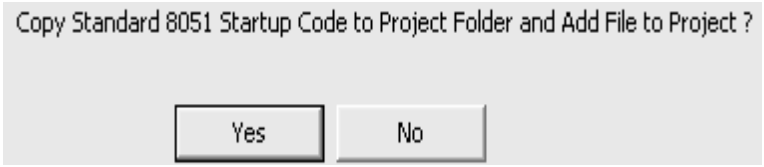
- Operates with single Power Supply +5V.
- 8-bit CPU optimized for control applications.
- 16-bit program counter (PC) and 16-bit data pointer (DPTR).
- 8-bit program status word (PSW).
- 8-bit stack pointer (SP).
- 4K Bytes of On-Chip Program Memory (Internal ROM or EPROM).
- 128 bytes of On-Chip Data Memory (Internal RAM):
  - Four Register Banks, each containing 8 registers (R0 to R7) [Total 32 reg]
  - 16-bytes of bit addressable memory.
  - 80 bytes of general-purpose data memory (Scratch Pad Area).
- Special Function Registers (SFR) to configure/operate microcontroller.
- 32 bit bi-directional I/O Lines (4 ports P0 to P3).
- Two 16-bit timers/counters (T0 and T1).
- Full duplex UART (Universal Asynchronous Receiver/Transmitter).
- On-Chip oscillator and clock circuitry.



STEPS TO CREATE AND COMPILE Keil µVision-3/4 PROJECT:

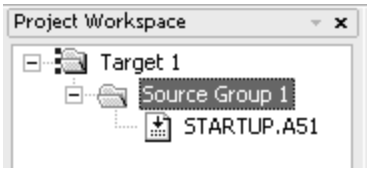
1. Double Click on the µ **Vision3/4** icon on the desktop. 

2. Close any previous projects that were opened using – **Project -> Close**.
3. Start **Project – New Project,** and select the CPU from the device database (Database-Atmel-AT89C51ED2 or AT89C51RD2 as per the board).On clicking **'OK'**, the following option is displayed. Choose **'No'**.



4. Create a source file (using **File->New**), type in the assembly or C program and save this (filename**.asm**/filename**.c**) and add this source file to the project using either one of the following two methods. (i) **Project->Manage->Components, Environment Books->addfiles->** browse to the required file **-> OK**

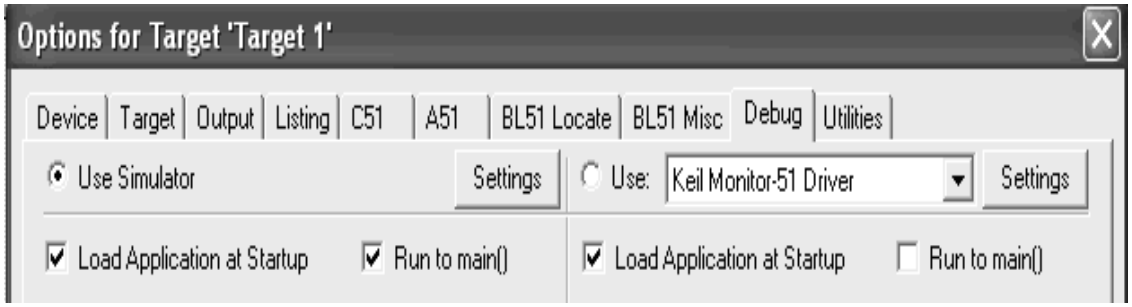
   "OR" ii) right click on the Source Group in the Project Window and the **Add Files to Group** option.



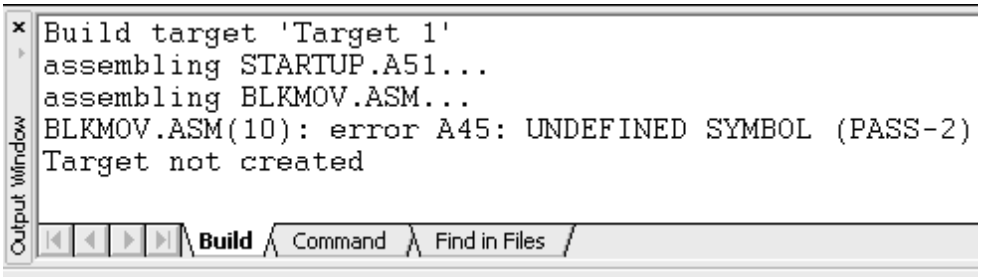
5. Set the Target options using -> **Project – Options for Target** opens the µ Vision2 **Options for Target – Target** configuration dialog. Set the **Xtal**(Crystal frequency) frequency

as 11.0592 MHz, and also the **Options for Target**

– Debug – use either Simulator / Keil Monitor- 51 driver.



6. If **Keil Monitor- 51 driver is used click on Settings** -> COM Port settings select the COM Port to which the board is connected and select the baud rate as 19200 or 9600 (recommended). Enable **Serial Interrupt** option if the user application is not using on-chip UART, to stop program execution.
7. Build the project; using **Project -> Build Project**. μ Vision translates all the user application and links. Any errors in the code are indicated by – "Target not created" in the Build window, along with the error line. Debug the errors. After anerror free, to build go to Debug mode.



8. Now user can enter into **Debug** mode with **Debug- Start / Stop Debug session** dialog. Or by clicking in the  icon.
9. The program is run using the **Debug-Run** command & halted using **Debug-Stop Running.** Also the  (reset, run, halt) icons can be used. Additional icons are  (step, step over, and step into, run till cursor).
10. If it is an interface program the outputs can be seen on the LCD, CRO, motor, led status, etc. If it is a part-A program, the appropriate memory window is opened using View -> memory window (for data RAM & XRAM locations), Watch window (for timer program), serial window, etc.

11. **Note:** To access data RAM area type address as D: 0020h. Similarly to access the DPTR region (XRAM-present on chip in AT89C51ED2) say 9000h location type in X: 09000H.

Ex no: **ARITHMETIC OPERATIONS USING SIMULATOR**

Date:

AIM:

To write a program for performing addition operations using 8051microcontroller using keil simulator.

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open the keil microvision 4 software
2. Select ne project and build the new project
3. Write the assembly program for addition operations
4. Debug the program

PROGRAM :

```
Mov r0, #34h
Mov r1, #12h
Mov r2, #odch
Mov r3, #ofeh
Clr c
Mov a, r0
Add a, r2
Mov 22h, a
Mov a, r1
Addc a, r3
Mov 21h, a
Mov ooh, c
end
```

RESULT :

Thus program for performing addition operations using 8051microcontroller using keil simulator is successfully completed.

Ex no: **DATA TRANSFER BETWEEN REGISTERS AND MEMORY**

Date:

AIM:

To Write an assembly language program to transfer the data from one location to another

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

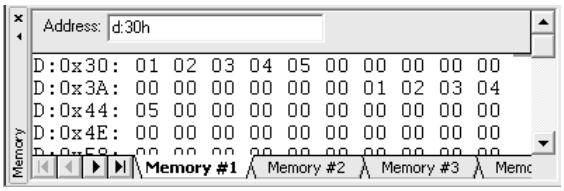
ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

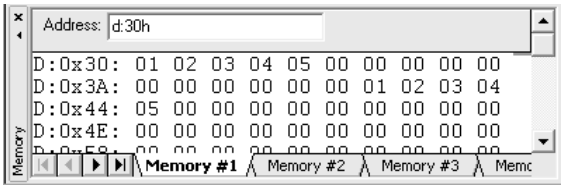
PROGRAM :

```
Org  000h
Mov r0, #30h
Mov r1, #50h
Mov r3, #05h
BACK : mov a , @r0
Mov @r1 , a
Inc r0inc r1
Djnz r3, BACK
end
```

Be.fore Execution:



After Execution:



.

Result:

Thus the program for data transfer is verified and executed successfully.

ARITHMETIC OPERATIONS

Ex no:

Date:

AIM:

To Write an assembly language program to perform addition operation

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

INSTRUCTIONS	COMMANDS
MOV A, #33H	Move the immediate data of 33h into accumulator A
MOV B, #11H	Move the immediate data of 11h into B
ADD A ,B	Add the values of B with values in accumulator.
END	Halt the program

RESULT :

Thus , the program for addition operation is verified and executed successfully

ARITHMETIC OPERATIONS

Ex no:

Date:

AIM:

To Write an assembly language program to perform subtraction operation

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

INSTRUCTIONS	COMMANDS
MOV A, #22H	Move the immediate data of 22h into accumulator A
MOV B, #11H	Move the immediate data of 11h into B
SBB A ,B	Subtract the values of B with values in accumulator.
END	Halt the program

RESULT :

Thus , the program for subtraction operation is verified and executed successfully

ARITHMETIC OPERATIONS

Ex no:

Date:

AIM:

To Write an assembly language program to perform multiplication operation

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

INSTRUCTIONS	COMMANDS
MOV A, #22H	Move the immediate data of 22h into accumulator A
MOV B, #11H	Move the immediate data of 11h into B
MUL A ,B	Multiply the values of B with values in accumulator.
END	Halt the program

RESULT :

Thus , the program for multiplication operation is verified and executed successfully

ARITHMETIC OPERATIONS

Ex no:

Date:

AIM:

To Write an assembly language program to perform division operation

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

INSTRUCTIONS	COMMANDS
MOV A, #22H	Move the immediate data of 22h into accumulator A
MOV B, #11H	Move the immediate data of 11h into B
DIV A ,B	Multiply the values of B with values in accumulator.
END	Halt the program

RESULT :

Thus , the program for division operation is verified and executed successfully

LOGICAL OPERATIONS

Ex no:

Date:

AIM:

To Write an assembly language program to perform AND logical operation

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

INSTRUCTIONS	COMMANDS
MOV A, #22H	Move the immediate data of 22h into accumulator A
MOV B, #11H	Move the immediate data of 11h into B
ANL A ,B	AND the values of B with values in accumulator.
MOV 46,A	Move the values of A into memory location 46
END	Halt the program

RESULT :

Thus , the program for AND operation is verified and executed successfully

LOGICAL OPERATIONS

Ex no:

Date:

AIM:

To Write an assembly language program to perform OR logical operation

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

INSTRUCTIONS	COMMANDS
MOV A, #22H	Move the immediate data of 22h into accumulator A
MOV B, #11H	Move the immediate data of 11h into B
ORLL A ,B	OR the values of B with values in accumulator.
MOV 47,A	Move the values of A into memory location 47
END	Halt the program

RESULT :

Thus , the program for OR operation is verified and executed successfully

ARITHMETIC OPERATIONS USING EMBEDDED C

Ex no:

Date:

AIM:

To Write an assembly language program to perform addition operation using embedded c.

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

```
#include <reg51.h>
Void main (void)
{
Unsigned char x,y,z;
X=0x34;
Y=0x99;
P1 = 0x00;
Z=x+y;
P1 = z;
}
```

RESULT :

Thus , the program for addition operation using embedded c is verified and executed successfully

SUBTRACTION

Ex no:

Date:

AIM:

To Write an assembly language program to perform subtraction operation using embedded c.

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

```
#include <reg51.h>
Void main (void)
{
Unsigned char x,y,z;
X=0x34;
Y=0x99;
P1 = 0x00;
Z=x - y;
P1 = z;
}
```

RESULT :

Thus , the program for subtraction operation using embedded c is verified and executed successfully

DIVISION

Ex no:

Date:

AIM:

To Write an assembly language program to perform division operation using embedded c.

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

```
#include <reg51.h>
Void main (void)
{
Unsigned char x,y,z;
X=0x34;
Y=0x99;
P1 = 0x00;
Z=x/y;
P1 = z;
}
```

RESULT :

Thus , the program for division operation using embedded c is verified and executed successfully

MULTIPLICATION

Ex no:

Date:

AIM:

To Write an assembly language program to perform multiplication operation using embedded c.

APPARATUSREQUIRED:

1. Computer
2. Keil microvision software 3/4

ALGORITHM:

1. Open – keil microvision 5 – new microvision project – once open the project ,dialog box will be open – set the microcontroller AT89C51 and click ok – it ask whether STARTUP is ok – click yes – on a project window – target will be generated.
2. Once target is generated – goto new – file – design a name for it with extension .asm and click ok - right click on target – source group – right click –add existing files – ask file name – choose file name . asm – ok.
3. Do the program for data transfer in a work place. Once program is done – click save
4. GOTO – project – build target – on command window – error is acknowledged program is successfully compiler.

PROGRAM :

```
#include <reg51.h>
Void main (void)
{
Unsigned char x,y,z;
X=0x34;
Y=0x99;
P1 = 0x00;
Z=x*y;
P1 = z;
}
```

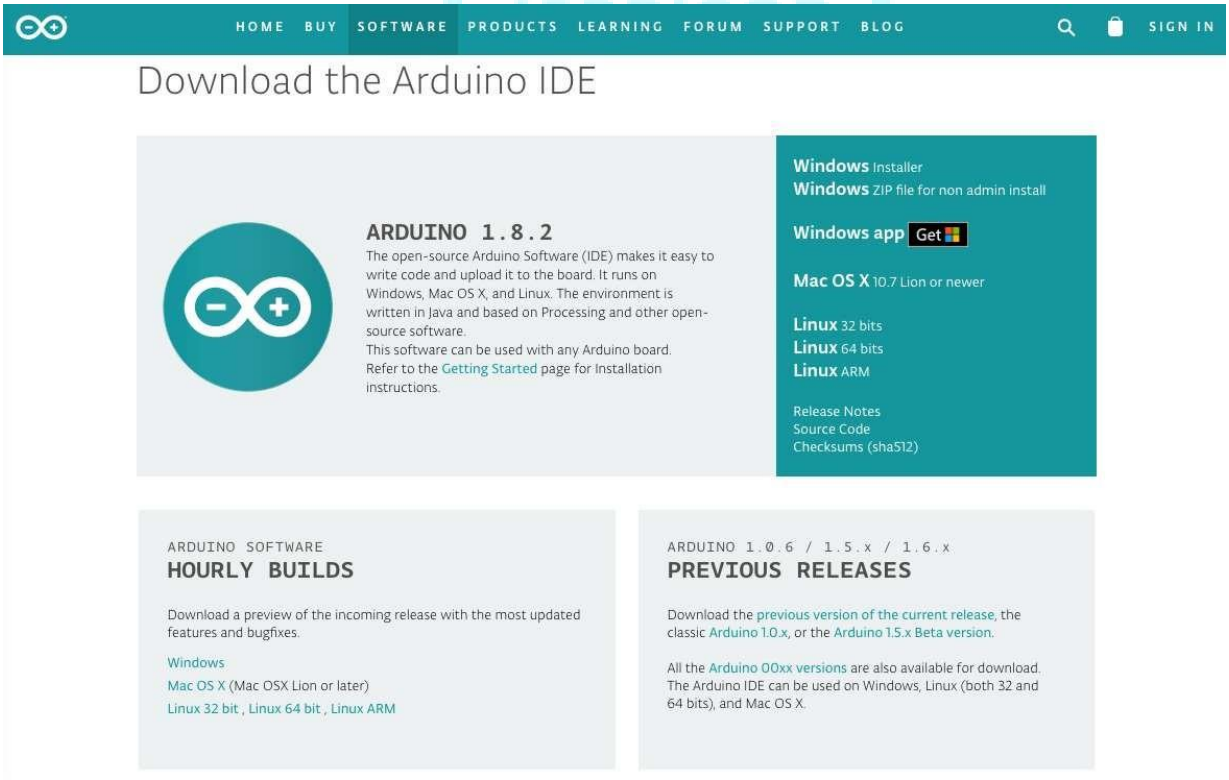
RESULT :

Thus , the program for multiplication operation using embedded c is verified and executed successfully

Ex No: **THE ARDUINO PROGRAMMING ENVIRONMENT (IDE)**

Date :

The Arduino Integrated Development Environment - or ArduinoSoftware (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.



Software-Installation

- Windows
  arduino.cc/windows
  Installation for: Windows 7, Vista, e XP
- Mac OS X

arduino.cc/mac
Installation for: OS X 10.7 or newer

- Linux
arduino.cc/linux

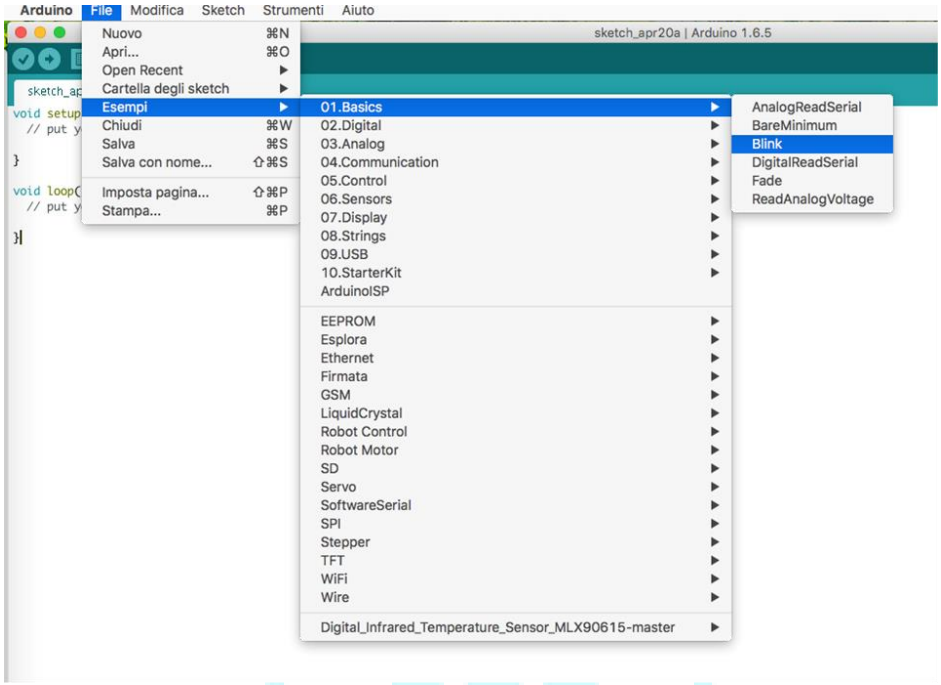
Communication with Arduino

- Launch the Arduino IDE (double clic

Arduino Program Development

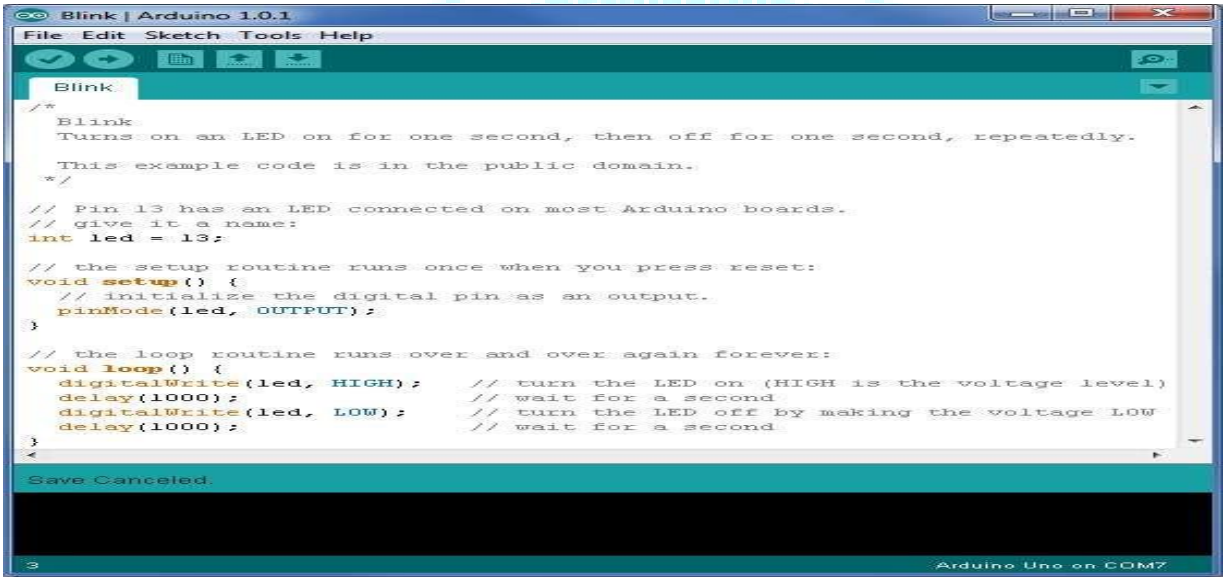
- Based on C++ without 80% of the instructions.
- A handful of new commands.
- Programs are called 'sketches'.
- Sketches need two functions:
  - void setup( )
  - void loop( )
- setup( ) runs first and once.
- loop( ) runs over and over, until power is lost or a newsketch is loaded.

Open the sketch

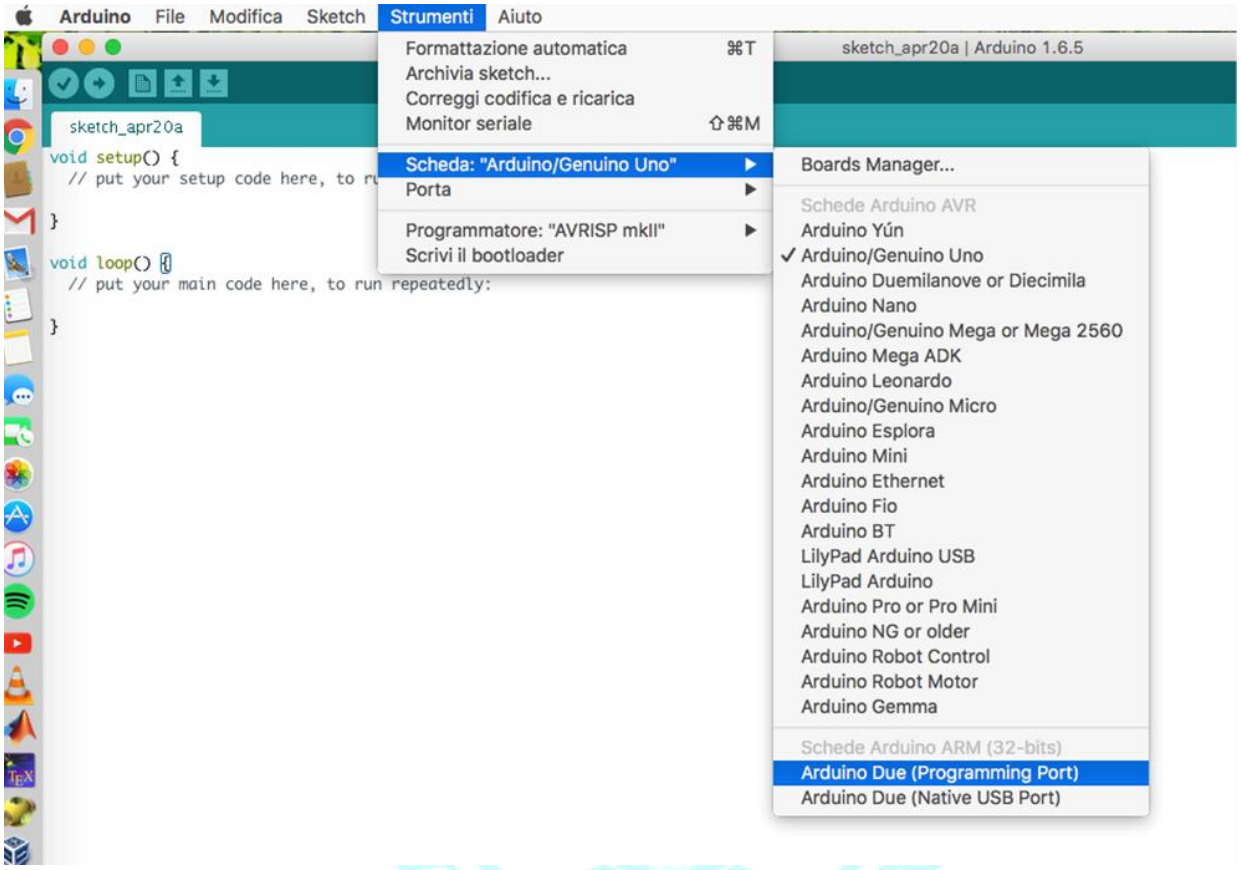


- Numerous sample sketches are includedin the compiler
- Located under File,Examples
- Once a sketch is written, it is uploadedby clicking on File, Upload, or by pressing <Ctrl> U

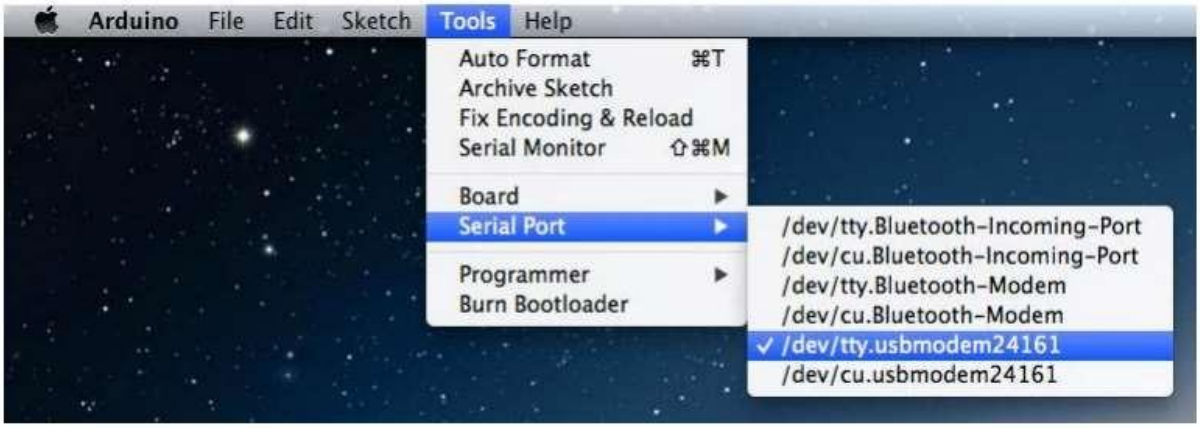
Open the Blink sketch



Select the Board



Select the Serial Port



- **Mac**:

  You can indifferently choose between

/dev/tty.usbmodemXXXXX or /dev/cu.usbmodemXXXXX

- **Windows:**
  - There are one or more COM ports:
  - choose the one with the higher number if it does not work try with theother proposals
  - The connection to the serial port is reported inthe code window in bottom right

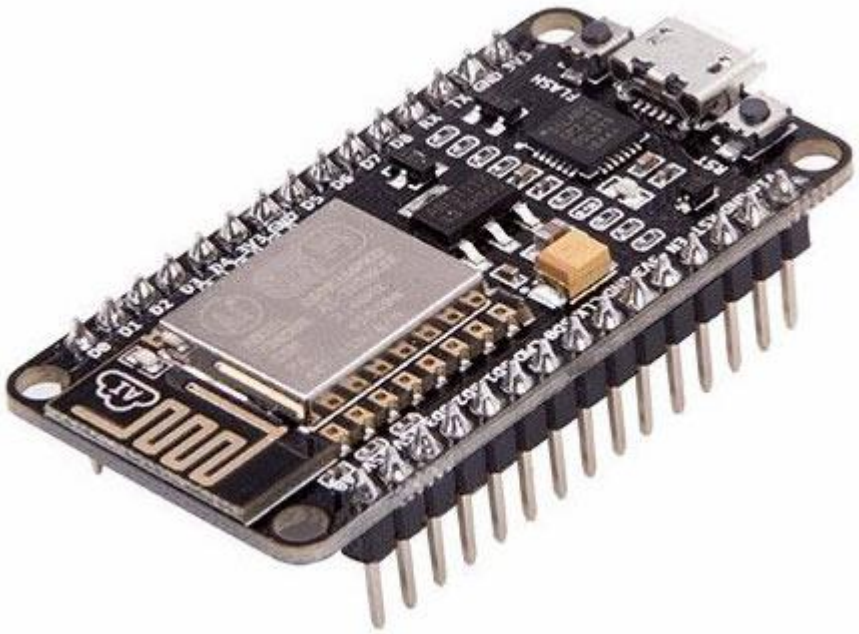
EX NO:

DATE :

EXPLORE DIFFERENT COMMUNICATION METHODS WITH IOT DEVICES (ZIGBEE, GSM, BLUETOOTH)

Wi-Fi

Wi-Fi (Wireless Fidelity) is the most popular **IOT communication protocols** for wireless local area network (WLAN) that utilizes the IEEE 802.11 standard through 2.4 GHz UHF and 5 GHz ISM frequencies. Wi-Fi provides Internet access to devices that are within the range of about 20 - 40 meters from the source. It has a data rate upto 600 Mbps maximum, depending on channel frequency used and the number of antennas. In embedded systems, ESP series controllers from Espressif are popular for building IoT based Applications. **ESP32** and **ESP8266** are the most commonly use wifi modules for embedded applications. You can find various projects based on ESP32 and ESP8266 by following the link.



In terms of using the Wi-Fi protocol for IOT, there are some pros & cons to be considered. The infrastructure or device cost for Wi-Fi is low & deployment is easy but the power consumption is high and the Wi-Fi range is quite moderate. So, the Wi-Fi may not be the best choice for all types of IOT applications but it can be used for applications like Home Automation.

There are many development boards available that allow people to build IOT applications using Wi-Fi. The most popular ones are the Raspberry Pi and Node MCU. These boards allow people to build IOT prototypes and also can be used for small real-time applications. Likewise is the Marvell Avastar 88W8997 SoC, which follows the Wi-Fi's IEEE 802.11n standard. The chip has applications like wearables, wireless audio & smart home.

Bluetooth

Bluetooth is a technology used for exchanging data wirelessly over short distances and preffered over vaouros **IOT network protocols**. It uses short-wavelength UHF radio waves of frequency ranging from 2.4 to 2.485 GHz in the ISM band. The Bluetooth technology has 3 different versions based on its applications:

- **Bluetooth:** The Bluetooth that is used in devices for communication has many applications in IOT/M2M devices nowadays. It is a technology using which two devices can communicate and share data wirelessly. It operates at 2.4GHz ISM band and the data is split in packets before sending and then is shared using any one of the designated 79 channels operating at 1 MHz of bandwidth.
- **BLE (Bluetooth 4.0, Bluetooth Low Energy):** The BLE has a single main difference from Bluetooth that it consumes low power. With that, it makes the product of low cost & more long-lasting than Bluetooth.
- **iBeacon:** It is a simplified communication technique used by Apple and is completely based on Bluetooth technology. The Bluetooth 4.0 transmits an ID called UUID for each user and makes it each to communicate between iPhone users.

Bluetooth has many applications, such as in telephones, tablets, media players, robotics systems, etc. The range of Bluetooth technology is between 50 – 150 meters and the data is being shared at a maximum data rate of 1 Mbps.

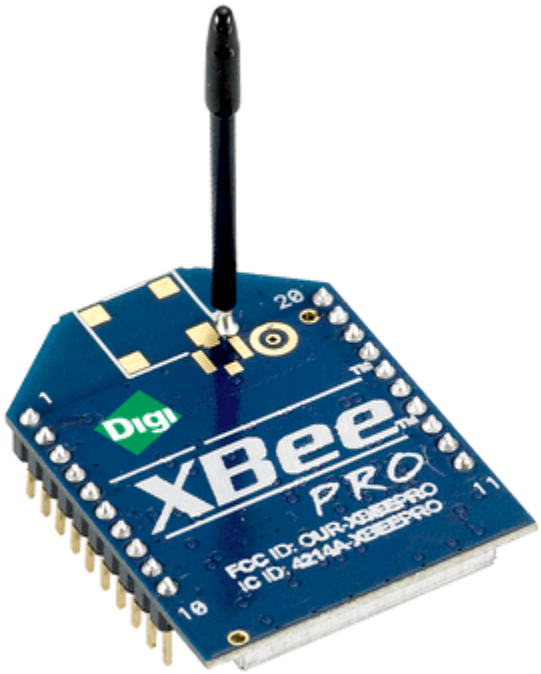
After launching the BLE protocol, there have been many new applications developed using Bluetooth in the field of IOT. They fall under the category of low-cost consumer products and Smart-Building applications. Like Wi-Fi, **Bluetooth also has a module Bluetooth HC-05 that can be interfaced with development boards like Arduino or Raspberry Pi to build DIY projects**. When it comes to Real-time applications, Marvell's Avastar 88W8977 comes with

Bluetooth v4.2 and has features like high speed, mesh networking for IOT. Another product, M5600 is a wireless pressure transducer with a Bluetooth v4.0 embedded in it.

Zigbee

ZigBee is another **iot wireless protocols** has features similar to the the Bluetooth technology. But it follows the IEEE 802.15.4 standard and is a high-level communication protocol. It has some advantages similar to Bluetooth i.e. low-power consumption, robustness, high security, and high scalability.

Zigbee offers a range of about 10 – 100 meters maximum and data rate to transfer data between communicated devices is around 250 Kbps. It has a large number of applications in technologies like M2M & IOT.



Having limitations in regards to data rate, range, and power consumption, Zigbee is only appropriate for Small-Scale Wireless applications. Though having some limitations**, it provides a 128-bit AES encryption and is giving a big hand in making secure communication for Home automation & small Industrial applications**. Zigbee too has its DIY module named **XBee** & **XBee Pro** which can be interfaced with Arduino or Raspberry Pi boards to make simple projects or application prototypes.

The company Develco has made products using Zigbee technologies like Sensors, gateways, meter interfaces, smart plugs, smart relays, etc which all work on the Zigbee wireless Mesh network, consuming low power and free from external interferences. Another company, Datanet has Zigbee based products which are used in real-time applications already, like the DNL910 & DNL920.

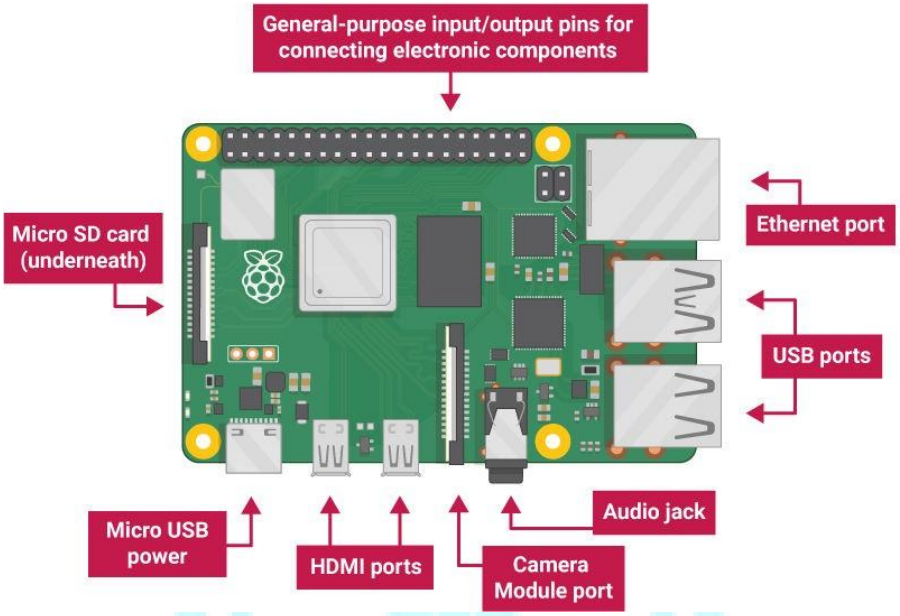
Ex no: **INTRODUCTION TO RASPBERRY PI PLATFORM AND PYTHON PROGRAMMING**

Date :

Raspberry Pi

You are going to take a first look at Raspberry Pi! You should have a Raspberry Pi computerin front of you for this. The computer shouldn't be connected to anything yet.

- Look at your Raspberry Pi. Can you find all the things labelled on the diagram?



- USB ports — these are used to connect a mouse and keyboard. You can also connect other components, such as a USB drive.
- SD card slot — you can slot the SD card in here. This is where the operating system software and your files are stored.
- Ethernet port — this is used to connect Raspberry Pi to a network with a cable. Raspberry Pi can also connect to a network via wireless LAN.
- Audio jack — you can connect headphones or speakers here.

- HDMI port — this is where you connect the monitor (or projector) that you are usingto display the output from the Raspberry Pi. If your monitor has speakers, you can alsouse them to hear sound.
- Micro USB power connector — this is where you connect a power supply. You should always do this last, after you have connected all your other components.
- GPIO ports — these allow you to connect electronic components such as LEDs and buttons

to Raspberry Pi.

Set up your SD card

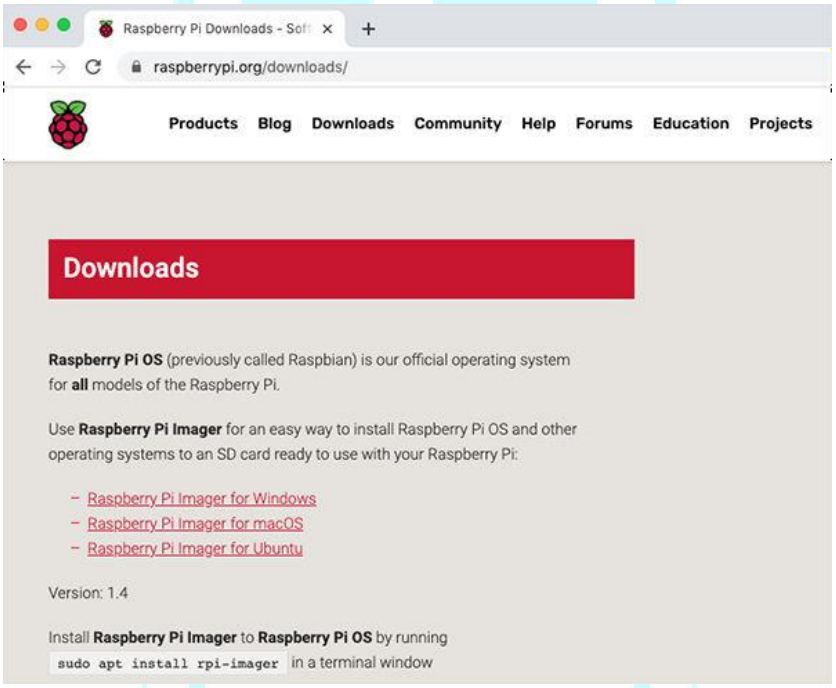
If you have an SD card that doesn't have the Raspberry Pi OS operating system on it yet, or ifyou want to reset your Raspberry Pi, you can easily install Raspberry Pi OS yourself. To do so, you need a computer that has an SD card port — most laptop and desktop computers haveone.

The Raspberry Pi OS operating system via the Raspberry Pi Imager

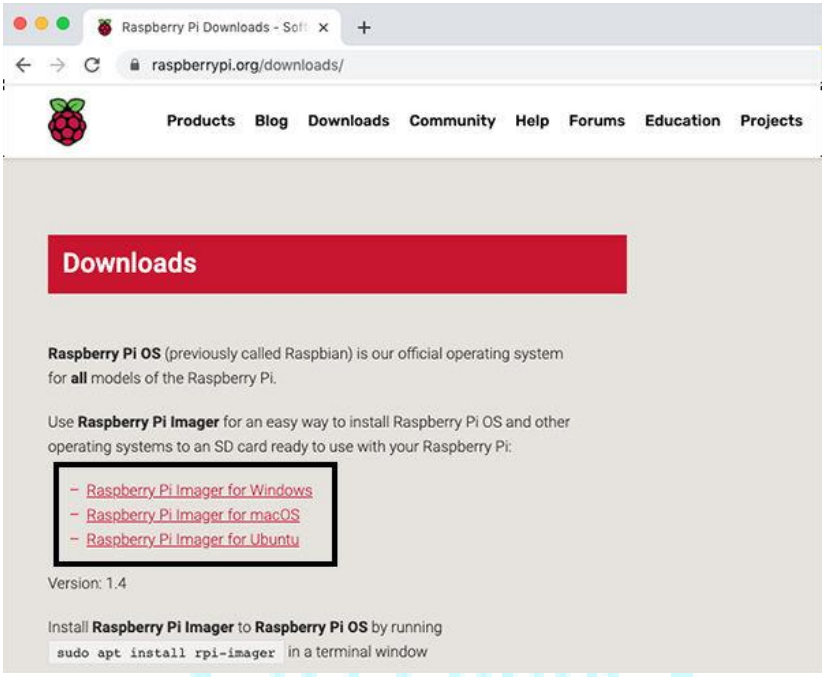
Using the Raspberry Pi Imager is the easiest way to install Raspberry Pi OS on your SD card.Note: More advanced users looking to install a particular operating system should use this guide to installing operating system images.

Download and launch the Raspberry Pi Imager

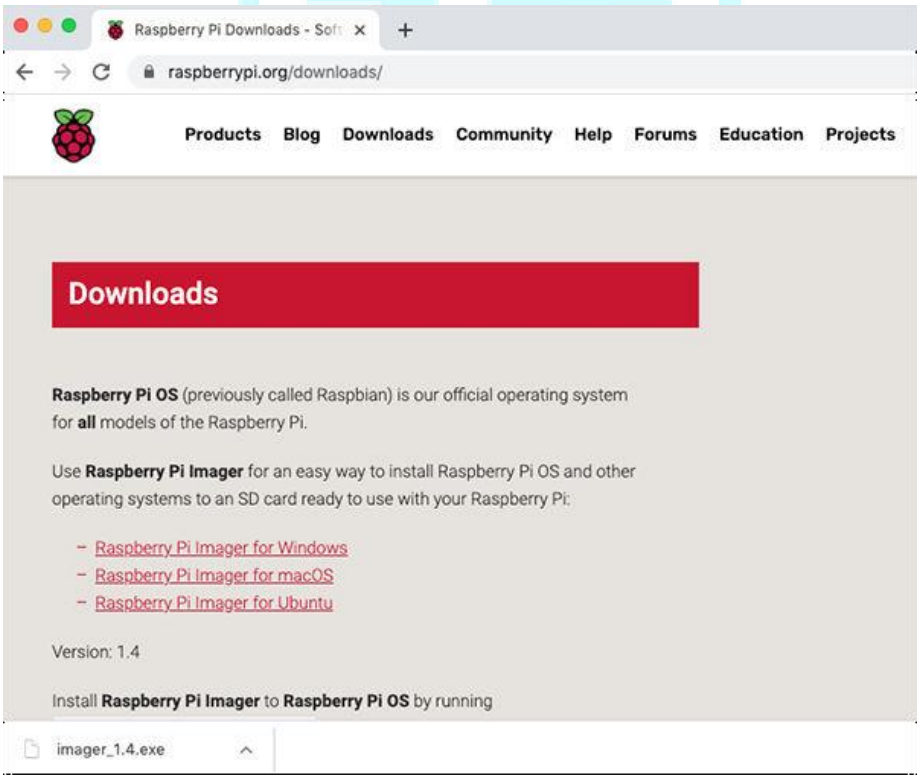
- Visit the Raspberry Pi downloads page



- Click on the link for the Raspberry Pi Imager that matches your operating system



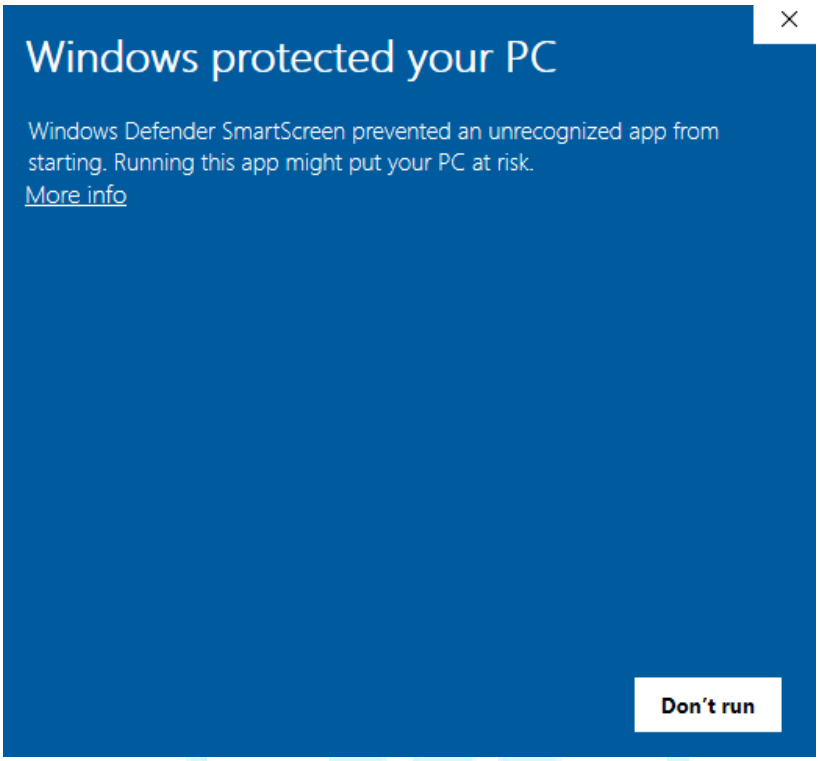
o When the download finishes, click it to launch the installer



Using the Raspberry Pi Imager

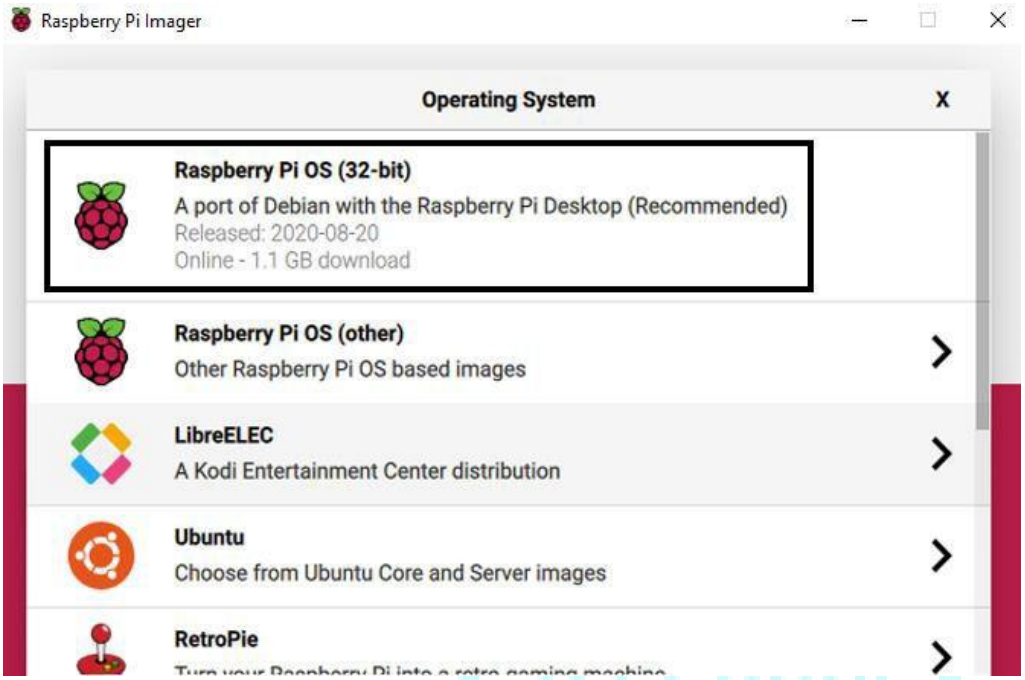
Anything that's stored on the SD card will be overwritten during formatting. If your SD card currently has any files on it, e.g. from an older version of Raspberry Pi OS, you may wish to back up these files first to prevent you from permanently losing them.

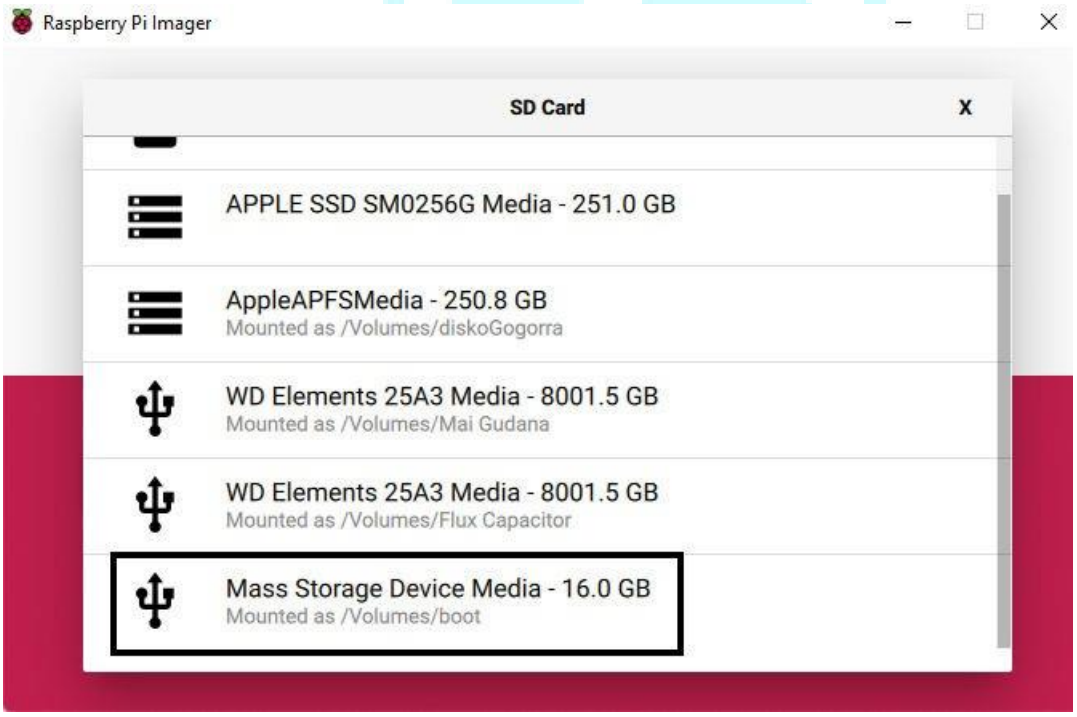
When you launch the installer, your operating system may try to block you from running it. For example, on Windows I receive the following message:



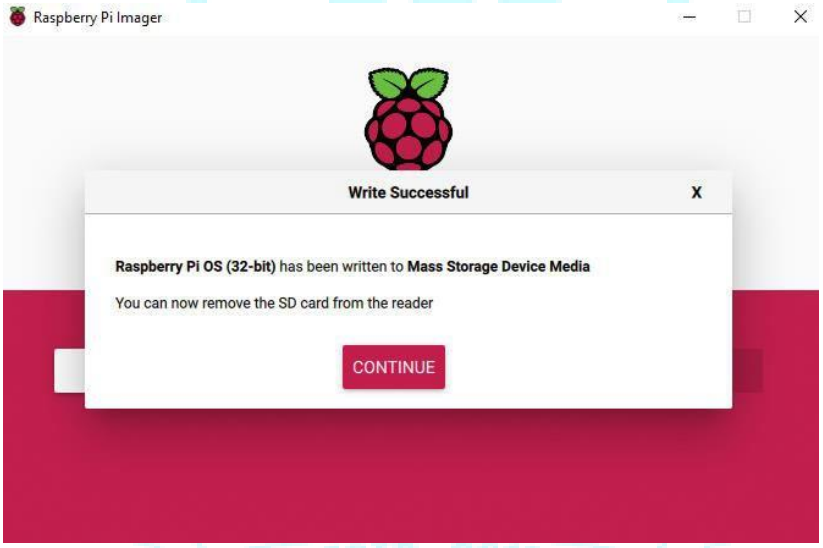
- If this pops up, click on More info and then Run anyway
- Follow the instructions to install and run the Raspberry Pi Imager
- Insert your SD card into the computer or laptop SD card slot
- In the Raspberry Pi Imager, select the OS that you want to install and the SD card you would like to install it on

Note: You will need to be connected to the internet the first time for the the Raspberry Pi Imager to download the OS that you choose. That OS will then be stored for future offline use. Being online for later uses means that the Raspberry Pi imager will always give you the latest version.


Raspberry Pi Imager
Operating System
X
Raspberry Pi OS (32-bit)
A port of Debian with the Raspberry Pi Desktop (Recommended)
Released: 2020-08-20
Online - 1.1 GB download
Raspberry Pi OS (other)
Other Raspberry Pi OS based images
LibreELEC
A Kodi Entertainment Center distribution
Ubuntu
Choose from Ubuntu Core and Server images
RetroPie


Raspberry Pi Imager
SD Card
X
APPLE SSD SM0256G Media - 251.0 GB
AppleAPFSMedia - 250.8 GB
Mounted as /Volumes/diskoGogorra
WD Elements 25A3 Media - 8001.5 GB
Mounted as /Volumes/Mai Gudana
WD Elements 25A3 Media - 8001.5 GB
Mounted as /Volumes/Flux Capacitor
Mass Storage Device Media - 16.0 GB
Mounted as /Volumes/boot

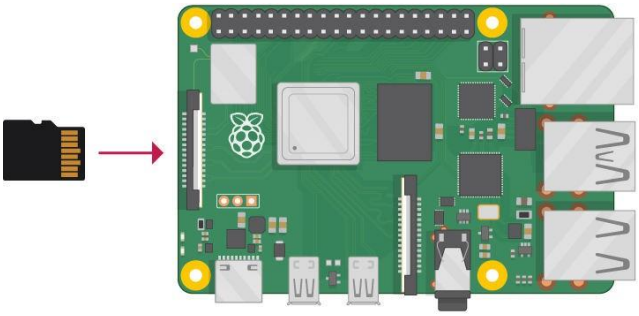
- Then simply click the WRITE button
- Wait for the Raspberry Pi Imager to finish writing
- Once you get the following message, you can eject your SD card



Connect your Raspberry Pi

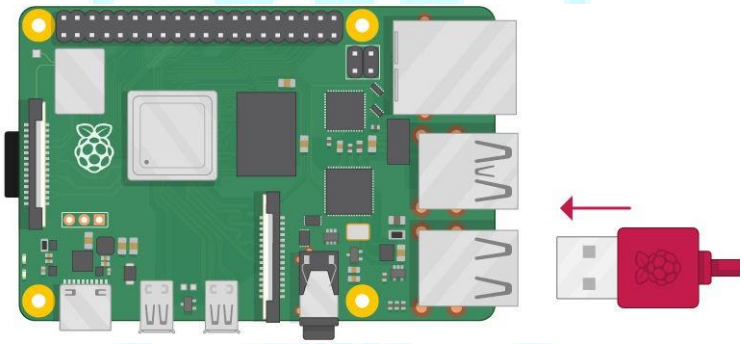
Let's connect up your Raspberry Pi and get it running.

o Check the slot on the underside of your Raspberry Pi to see whether an SD card is inside.If no SD card is there, then insert an SD card with Raspbian installed (via NOOBS).

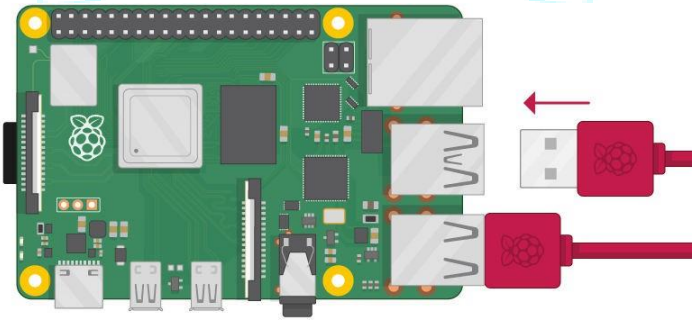


Note: Many microSD cards come inside a larger adapter — you can slide the smaller card out using the lip at the bottom.

- Find the USB connector end of your mouse's cable, and connect the mouse to a USB port on your Raspberry Pi (it doesn't matter which port you use).



- Connect the keyboard in the same way.

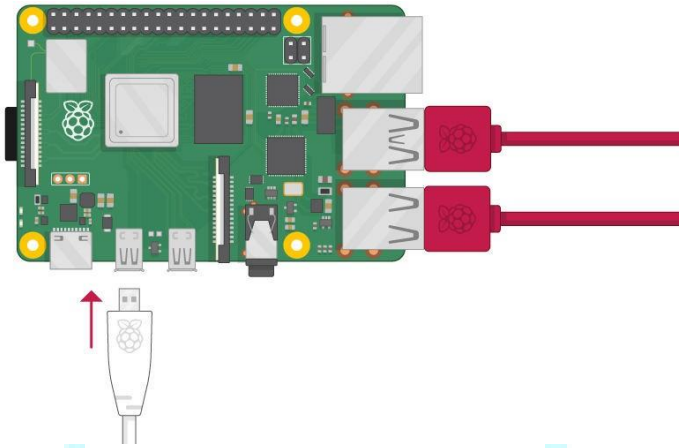


- Make sure your screen is plugged into a wall socket and switched on.
- Look at the HDMI port(s) on your Raspberry Pi — notice that they have a flat side on top.

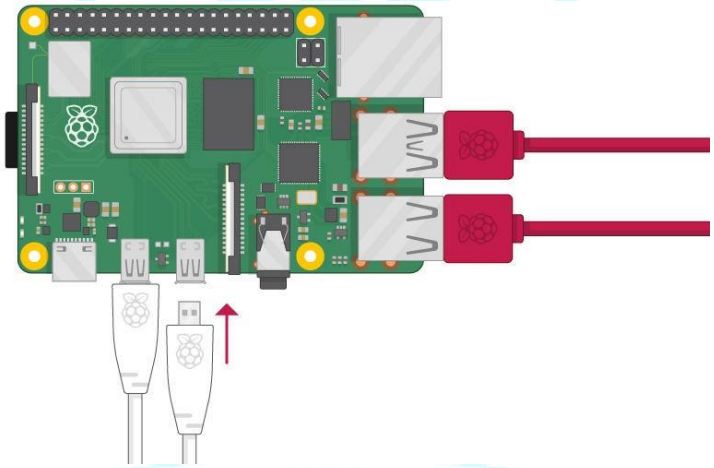
- Use a cable to connect the screen to the Raspberry Pi's HDMI port — use an adapter if necessary.

  Raspberry Pi 4

  Connect your screen to the first of Raspberry Pi 4's HDMI ports, labelled HDMI0.

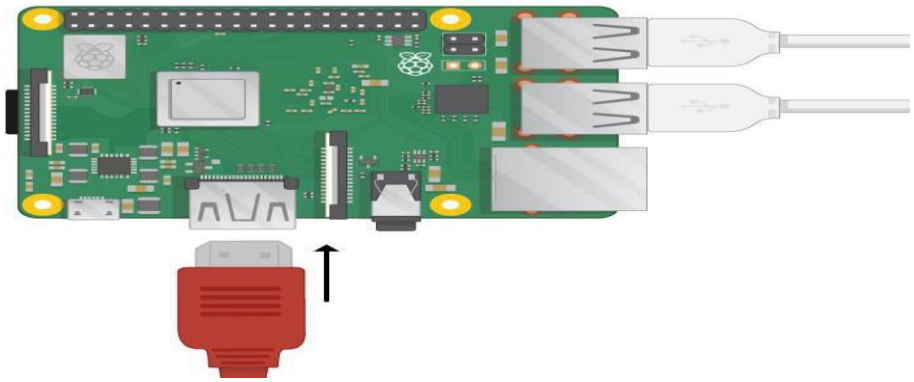


  You could connect an optional second screen in the same way.



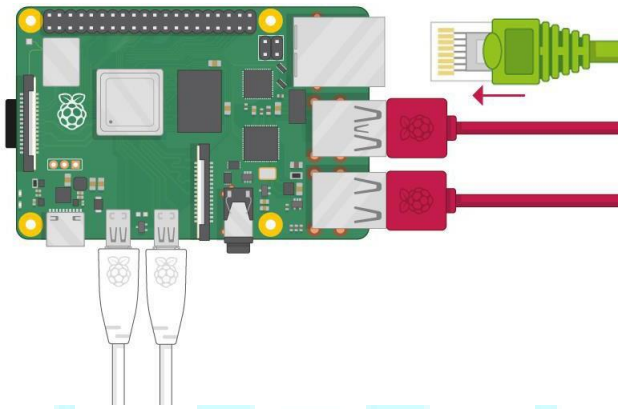
  Raspberry Pi 1, 2, 3

  Connect your screen to the single HDMI port.

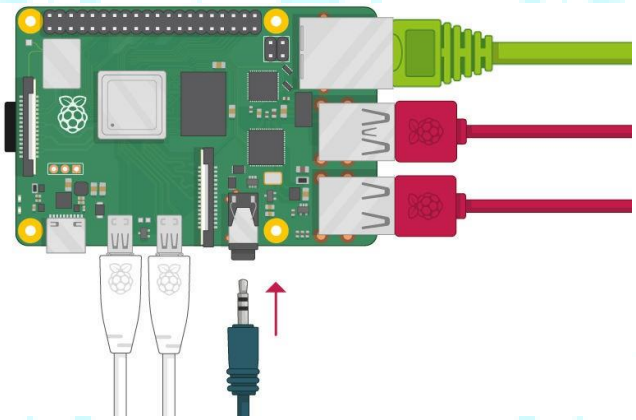


Note: nothing will display on the screen, because the Raspberry Pi is not running yet.

- If you want to connect the Pi to the internet via Ethernet, use an Ethernet cable to connect the Ethernet port on the Raspberry Pi to an Ethernet socket on the wall or on your internet router. You don't need to do this if you want to use wireless connectivity, or if you don't want to connect to the internet.



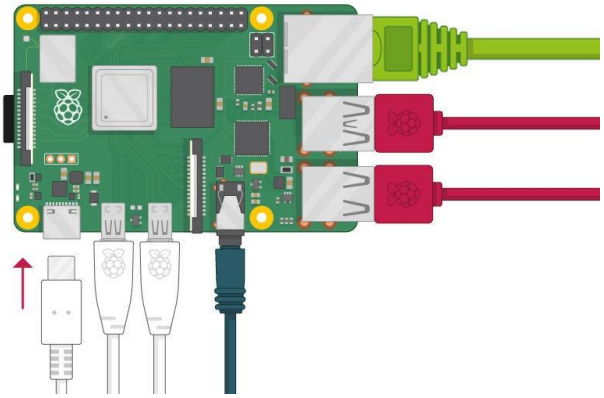
- If your screen has speakers, your Raspberry Pi can play sound through these. Or you could connect headphones or speakers to the audio port.



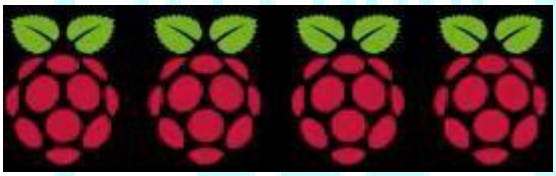
Start up your Raspberry Pi

Your Raspberry Pi doesn't have a power switch. As soon as you connect it to a power outlet, it will turn on.

- Plug the power supply into a socket and connect it to your Raspberry Pi's power port.



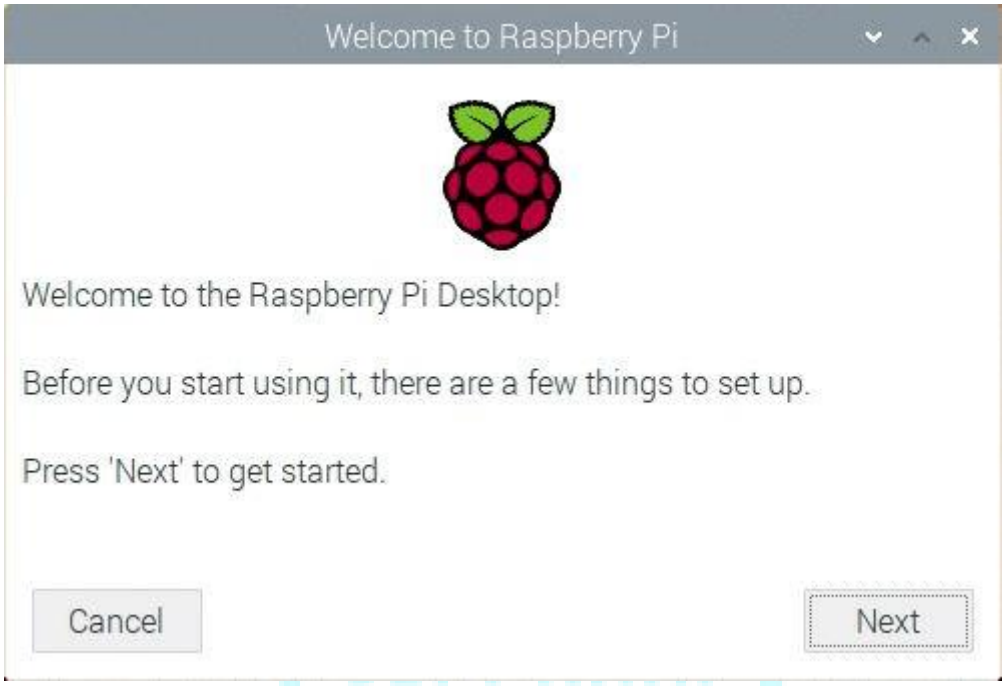
You should see a red LED light up on the Raspberry Pi, which indicates that Raspberry Pi is connected to power. As it starts up (this is also called booting), you will see raspberries appear in the top left-hand corner of your screen.



After a few seconds the Raspberry Pi OS desktop will appear.

Finish the setup

When you start your Raspberry Pi for the first time, the Welcome to Raspberry Pi application will pop up and guide you through the initial setup.



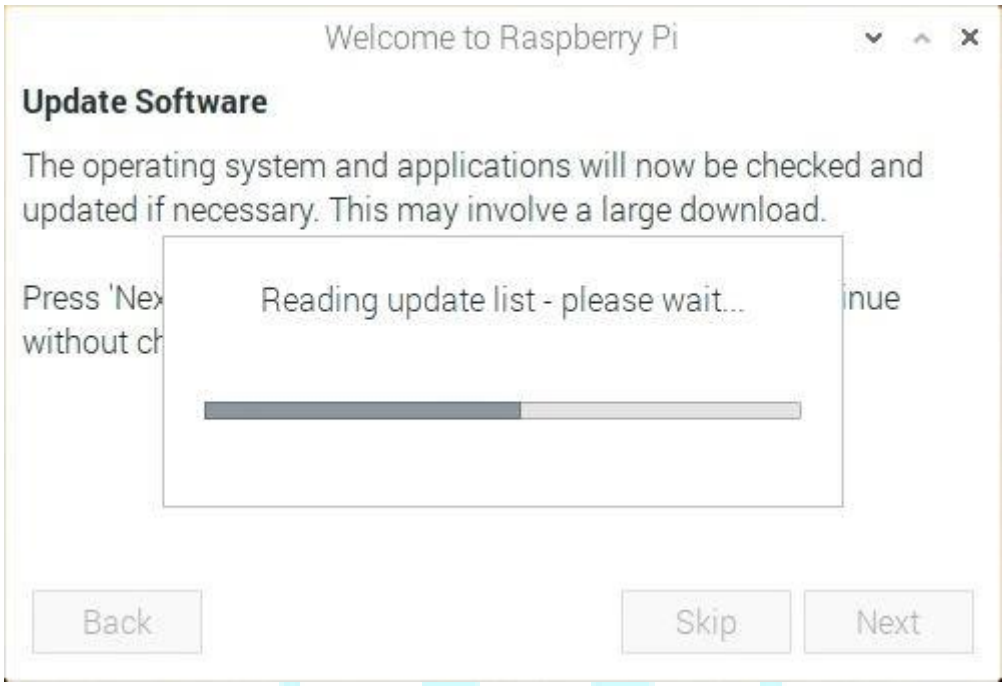
- Click Next to start the setup.
- Set your Country, Language, and Timezone, then click Next again.

- Enter a new password for your Raspberry Pi and click Next.

o Connect to your WiFi network by selecting its name, entering the password, and clicking Next.

Note: if your Raspberry Pi model doesn't have wireless connectivity, you won't see this screen.

- Click Next let the wizard check for updates to Raspbian and install them (this might take a little while).



- Click Done or Reboot to finish the setup.

Note: you will only need to reboot if that's necessary to complete an update.

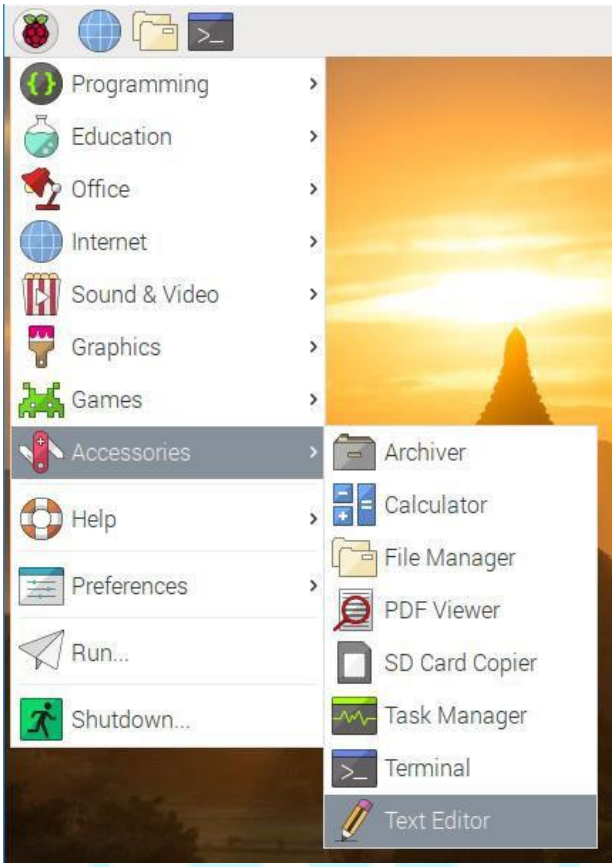
A tour of Raspberry Pi

Now it's time to take a tour of your Raspberry Pi.

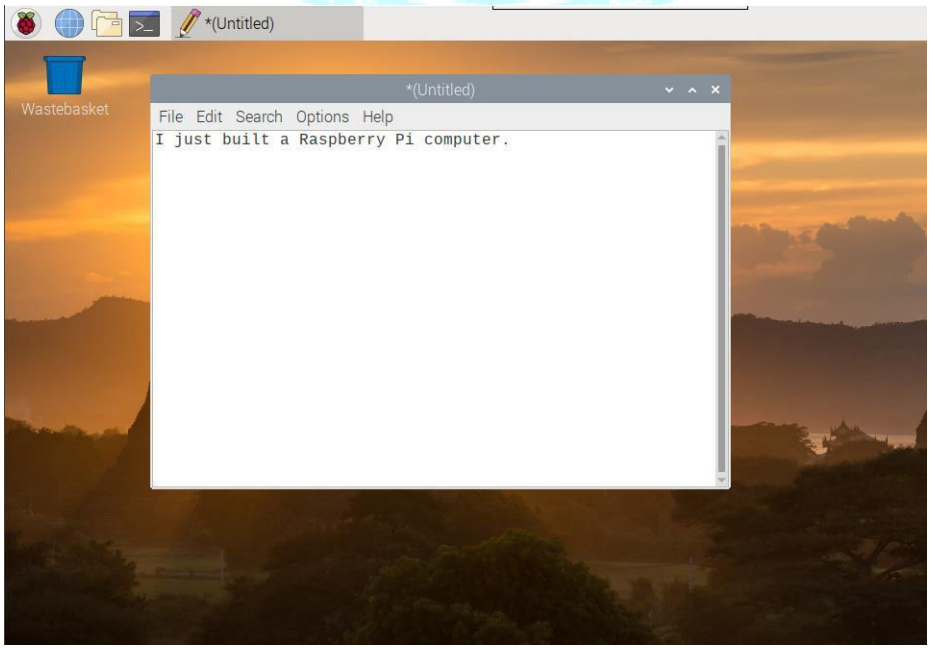
- Do you see the raspberry symbol in the top left-hand corner? That's where you access the

menu: click on it to find lots of applications.

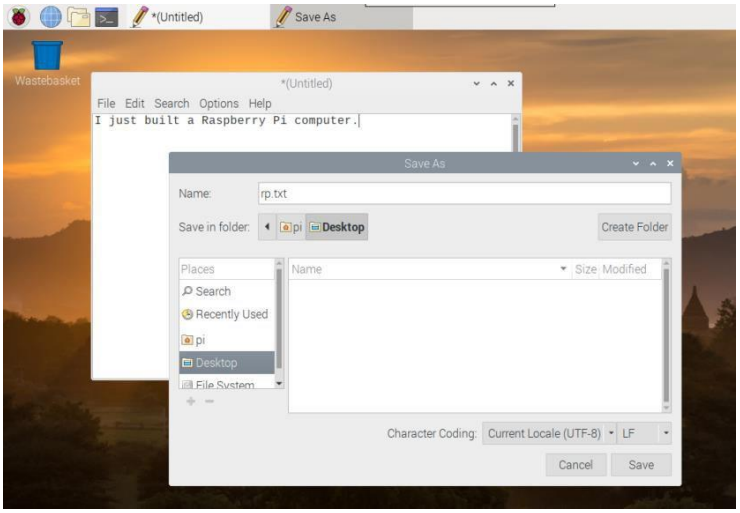
- Click on Accessories, and then click on Text Editor.



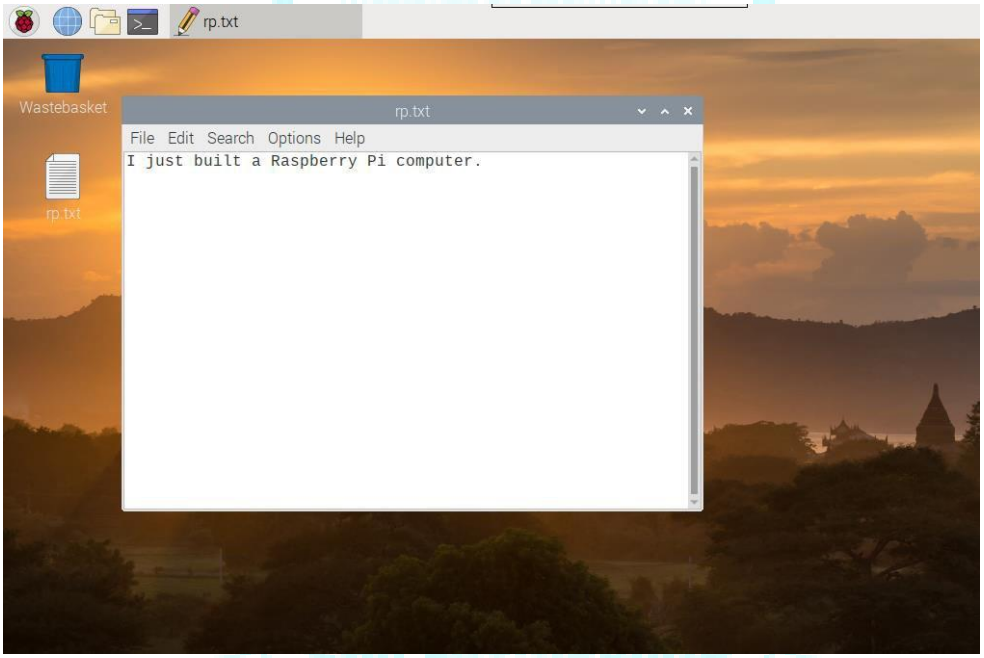
- Type I just built a Raspberry Pi computer in the window that appears.



- Click on File, then choose Save, and then click on Desktop and save the file as .

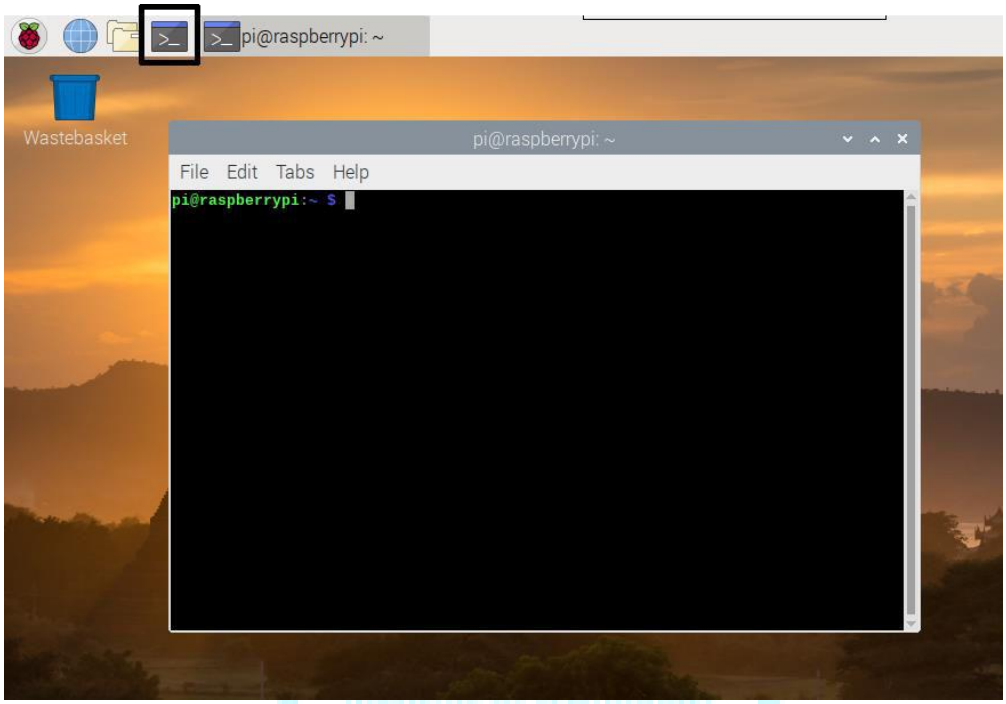


- You should see an icon named rp.txt appear on the desktop.



Your file has been saved to your Raspberry Pi's SD card.

- Close the text editor by clicking the X in the top right-hand corner of the window.
- Return to the menu, click on Shutdown, and then click on Reboot.
- When Raspberry Pi has rebooted, your text file should still be there on the desktop.
- Raspberry Pi runs a version of an operating system called Linux (Windows andmacOS are other operating systems). This operating system allows you to make things happen by typing in commands instead of clicking on menu options. To try this out, click on the Terminal symbol at the top of the screen:



- In the window that appears, type:

```
ls
```

and then press Enter on the keyboard.

You can now see a list of the files and folders in your directory.

- Now type this command to change directory to the Desktop:

```
cd Desktop
```

You have to press the Enter key after every command.

Then type:

```
ls
```

Can you see the text file you created?

- Close the terminal window by clicking on the X.
- Now drag to the Wastebasket on the desktop so the Raspberry Pi will be tidy for the next person using it.

Browsing the web

You might want to connect your Raspberry Pi to the internet. If you didn't plug in an ethernet cable or connect to a WiFi network during the setup, then you can connect now.

- Click the icon with red crosses in the top right-hand corner of the screen, and select your network from the drop-down menu. You may need to ask an adult which network you should choose.

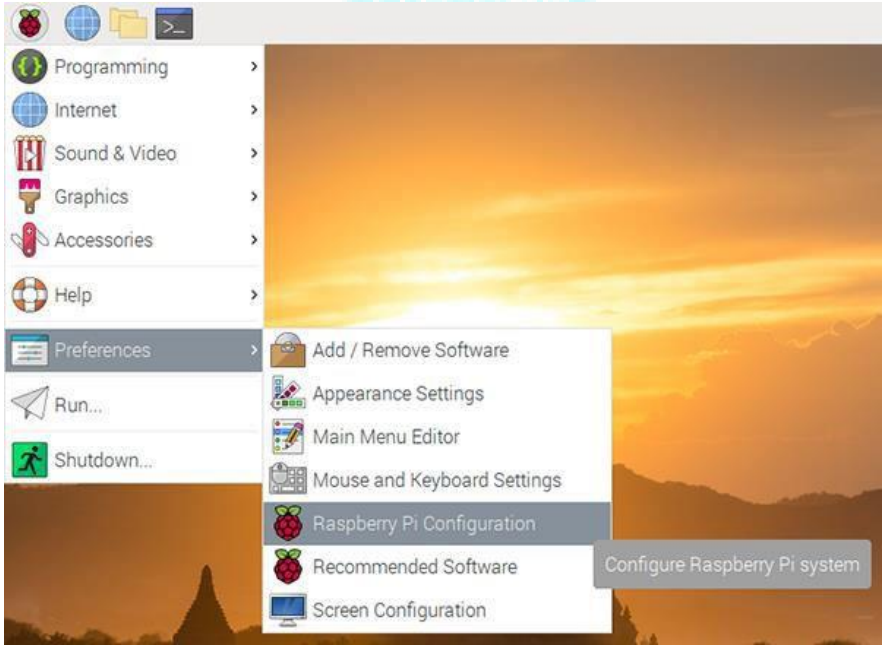
- Type in the password for your wireless network, or ask an adult to type it for you, then click OK.

- When your Pi is connected to the internet, you will see a wireless LAN symbol instead of the red crosses.

o Click the web browser icon and search for .

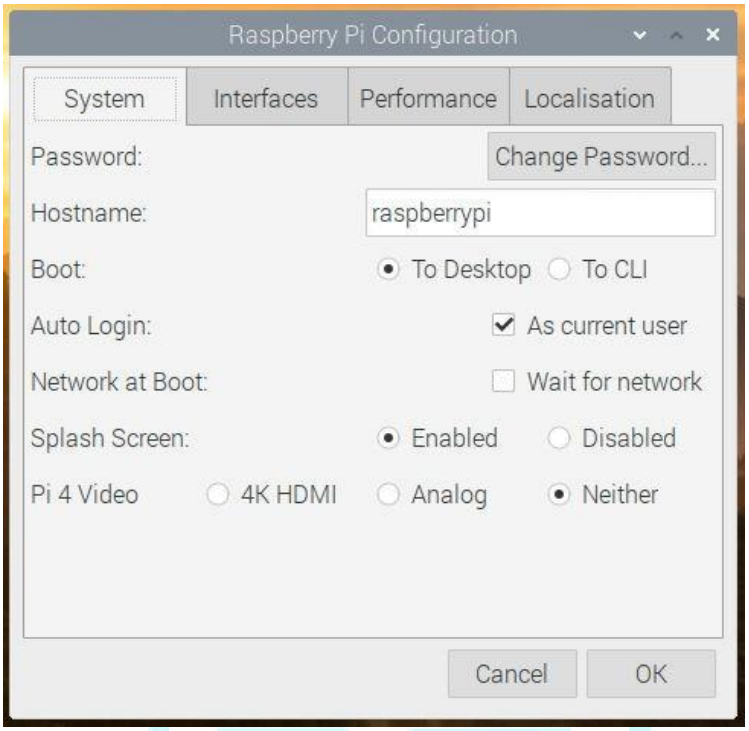
Configuring your Raspberry Pi

You can control most of your Raspberry Pi's settings, such as the password, through the Raspberry Pi Configuration application found in Preferences on the menu.



 System

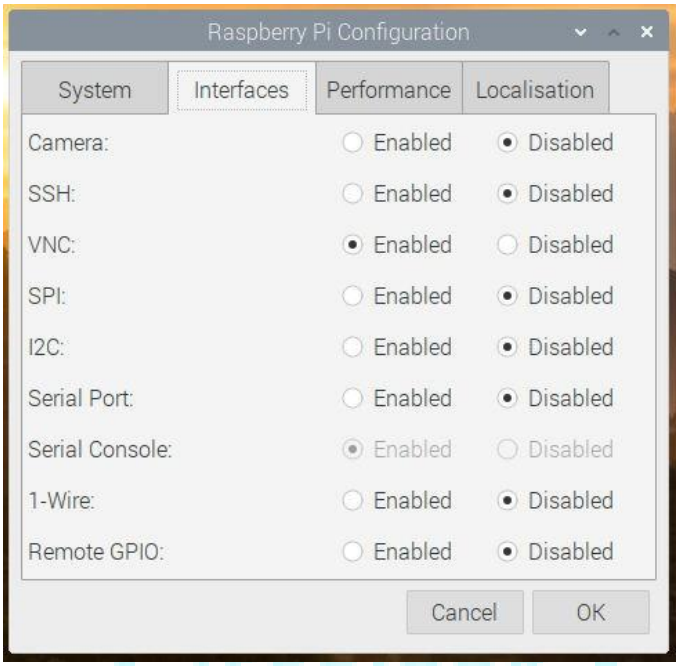
In this tab you can change basic system settings of your Raspberry Pi.



- Password — set the password of the pi user (it is a good idea to change the password from the factory default 'raspberry')
- Boot — select to show the Desktop or CLI (command line interface) when your Raspberry Pi starts
- Auto Login — enabling this option will make the Raspberry Pi automatically log in whenever it starts

- Network at Boot — selecting this option will cause your Raspberry Pi to wait until a network connection is available before starting
- Splash Screen — choose whether or not to show the splash (startup) screen when your Raspberry Pi boots
- Interfaces

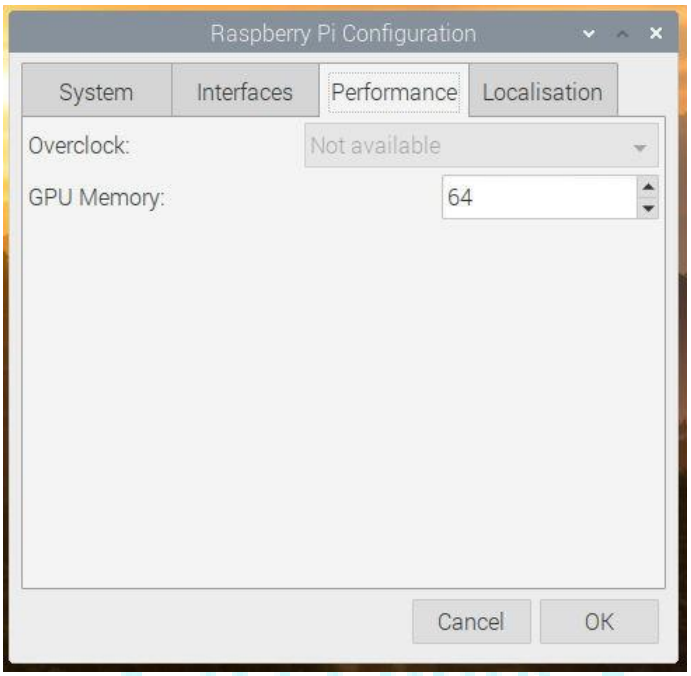
You can link devices and components to your Raspberry Pi using a lot of different types of connections. The Interfaces tab is where you turn these different connections on or off, so that your Raspberry Pi recognises that you've linked something to it via a particular type of connection.



- Camera — enable the Raspberry Pi Camera Module
- SSH — allow remote access to your Raspberry Pi from another computer using SSH
- VNC — allow remote access to the Raspberry Pi Desktop from another computer using VNC
- SPI — enable the SPI GPIO pins
- I2C — enable the I2C GPIO pins
- Serial — enable the Serial (Rx, Tx) GPIO pins
- 1-Wire — enable the 1-Wire GPIO pin.
- Remote GPIO — allow access to your Raspberry Pi's GPIO pins from another computer
- Performance

If you need to do so for a particular project you want to work on, you can change the performance settings of your Raspberry Pi in this tab.

Warning: Changing your Raspberry Pi's performance settings may result in it behaving erratically or not working.



- Overclock — change the CPU speed and voltage to increase performance

- **GPU Memory** — change the allocation of memory given to the GPU
- Localisation

This tab allows you to change your Raspberry Pi settings to be specific to a country or location.

- Locale — set the language, country, and character set used by your Raspberry Pi
- Timezone — set the time zone
- Keyboard — change your keyboard layout
- WiFi Country — set the WiFi country code

Ex no : **INTERFACING OF LED**

Date :

Aim :

write a program to blink LED using Arduino

Apparatus required :

1. Computer
2. Arduino software

Procedure:

1. Connect the Arduino UNO board to the system make sure all the connections . and install the Arduino IDE 2.11 in the system
2. Open Arduino IDE 2.11 - tools-board- Arduino UNO
3. Go to file –new program – save – compile –run
4. Now,view the LED blinking in the Arduino UNO board ,it shows LED on for one second and off for one second

Program :

```
Void setup ()
{
Pinmode(LED _BUILTIN,OUTPUT);
}
Void loop()
{
Digitalwrite(LED _BUILTIN, HIGH);
Delay(1000)
Digitalwrite(LED _BUILTIN, LOW);
Delay(1000)
}
```

Result :

Thus the interfacing LED is successfully completed.

Ex no: **WIRELESS COMMUNICATION USING AURDINO**
Date :

Aim :

Write a program to using wireless communication medium in Arduino

Apparatus required :

1. Computer
2. Arduino software

Procedure:

1. Connect the Arduino UNO board to the system make sure all the connections . and install the Arduino IDE 2.11 in the system
2. Open Arduino IDE 2.11 - tools-board- Arduino UNO
3. Go to file –new program – save – compile –run
4. Now, view the wireless medium bluetooth using Arduino board

Program

```
Void setup()
{
Pinmode(12,OUTPUT);
Serial.begin(9400);

}

Void loop
{
Char inchar = (char)serial.read();
If (inchar ==’A’)
{
Digitalwrite (12, HIGH);
Serial printin (inchar);
}
elseif(inchar ==’D’)
Digitalwrite (12,LOW);
Serial printin (inchar);
}
```

Result :

Thus the wireless communication using Arduino is successfully completed.

Ex no : SETUP A CLOUD PLATFORM TO LOG THE DATA
Date :

Aim:

Building and hosting a simple website(static/dynamic) on the device and make it accessible online. There is a need to install server(eg: Apache) and thereby host the website.

Setting up an Apache Web Server on a Raspberry Pi

Apache is a popular web server application you can install on the Raspberry Pi to allow it to serve web pages.

On its own, Apache can serve HTML files over HTTP, and with additional modules can serve dynamic web pages using scripting languages such as PHP.

Install Apache

First, update the available packages by typing the following command into the Terminal:

```
sudo apt update
```

Then, install the apache2 package with this command:

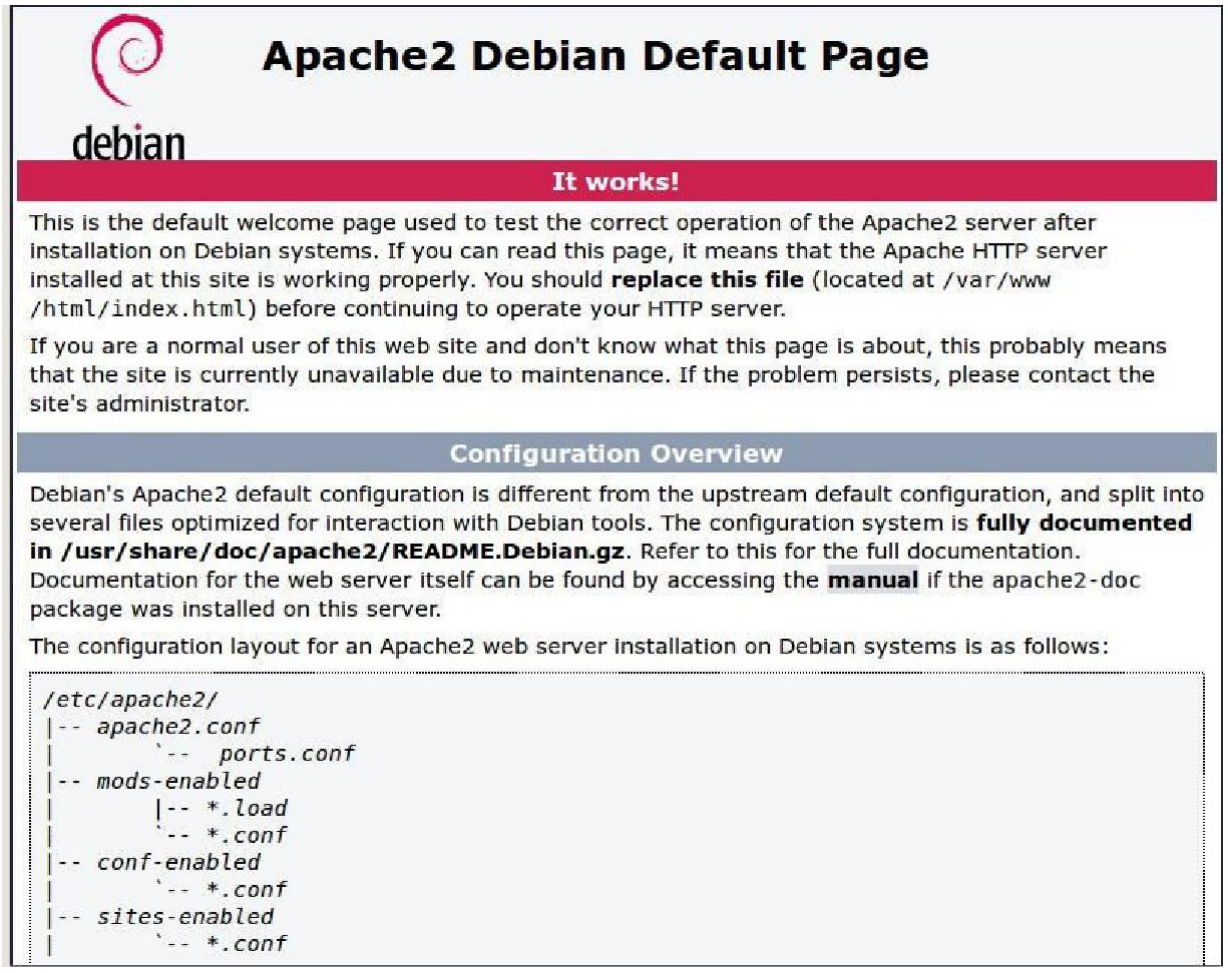
```
sudo apt install apache2 -y
```

Test the web server

By default, Apache puts a test HTML file in the web folder. This default web page is served when you browse to `http://localhost/` on the Pi itself, or `http://192.168.1.10` (whatever the

Pi's IP address is) from another computer on the network. To find the Pi's IP address, type `hostname -I` at the command line (or read more about finding your IP address).

Browse to the default web page either on the Pi or from another computer on the network and you should see the following:



This means you have Apache working!

Changing the default web page

This default web page is just an HTML file on the filesystem. It is located at `/var/www/html/index.html`.

Navigate to this directory in a terminal window and have a look at what's inside:

```
cd
/var/www/htmlls
```

This will show you:

```
total 12
drwxr-xr-x  2 root root 4096 Jan  8 01:29 .
drwxr-xr-x 12 root root 4096 Jan  8 01:28 ..
-rw-r--r--  1 root root  177 Jan  8 01:29 index.html
```

Additional - install PHP

To allow your Apache server to process PHP files, you'll need to install the latest version of PHP and the PHP module for Apache. Type the following command to install these:

```
sudo apt install php libapache2-mod-php -y
```

Now remove the `index.html` file:

```
sudo rm index.html
```

and create the file `index.php` :

```
sudo nano index.php
```

Put some PHP content in it:

```
<?php echo "hello world"; ?>
```

Now save and refresh your browser. You should see "hello world". This is not dynamic but still served by PHP. Try something dynamic:

```
<?php echo date('Y-m-d H:i:s'); ?>
```

or show your PHP info:

```
<?php phpinfo(); ?>
```

Result :

Thus the setting the cloud platform to logout the data is completed successfully.

Ex no: **LOG DATA USING RASPBERRY PI AND UPLOAD TO THE CLOUD PLATFORM**

Date :

Aim :

Interfacing the regular usb webcam with the device and turn it into fully functional IPwebcam & test the functionality.

Using a standard USB webcam

Rather than using the Raspberry Pi camera module, you can use a standard USBwebcam to take pictures and video on the Raspberry Pi.

Note that the quality and configurability of the camera module is highly superior toa standard USB webcam.

Install fswebcam

First, install the `fswebcam` package:

```
sudo apt install fswebcam
```

Add your user to `video` group

If you are not using the default `pi` user account, you need to add your username to the `video` group, otherwise you will see 'permission denied' errors.

```
sudo usermod -a -G video <username>
```

To check that the user has been added to the group correctly, use the `groups` command.

Basic usage

Enter the command `fswebcam` followed by a filename and a picture will be

taken using the webcam, and saved to the filename specified:

```
fswebcam image.jpg
```

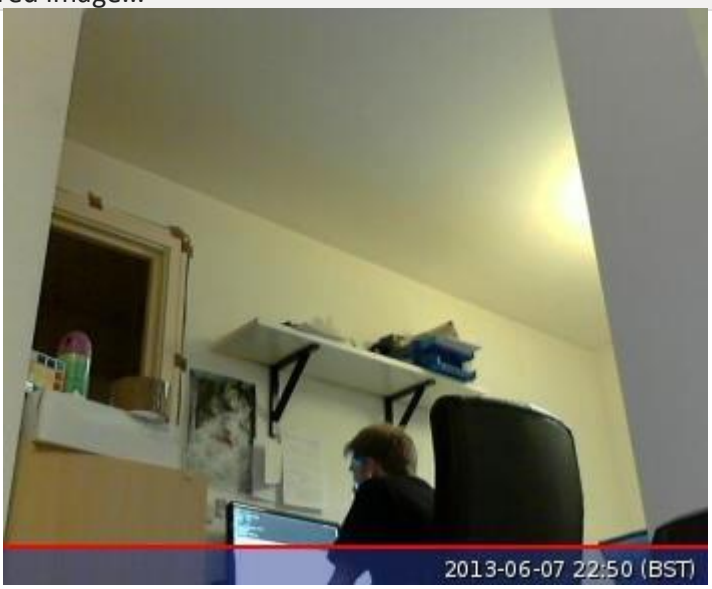
This command will show the following information:

```
--- Opening /dev/video0...
Trying source module v4l2...

/dev/video0 opened.
No input was specified, using the first.
Adjusting resolution from 384x288 to 352x288.

--- Capturing frame...
Corrupt JPEG data: 2 extraneous bytes before marker
0xd4Captured frame in 0.00 seconds.

--- Processing captured image...
```



Note the small default resolution used, and the presence of a banner showing the timestamp.

Specify resolution

The webcam used in this example has a resolution of `1280 x 720` so to specify the

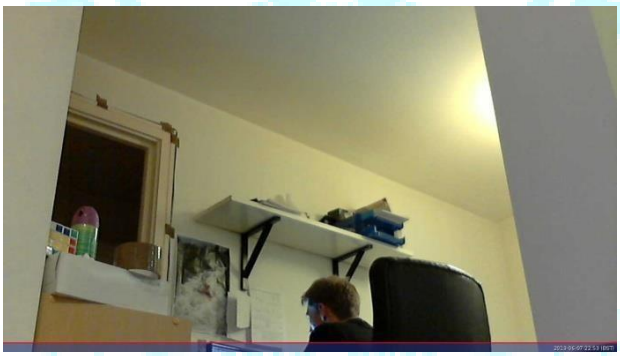
resolution I want the image to be taken at, use the `-r` flag:

```
fswebcam -r 1280x720 image2.jpg
```

This command will show the following information:

```
--- Opening /dev/video0...
```

```
Trying source module v4l2...
/dev/video0 opened.
No input was specified, using the first.
--- Capturing frame...
Corrupt JPEG data: 1 extraneous bytes before marker
0xd5Captured frame in 0.00 seconds.
--- Processing captured image...
```



Picture now taken at the full resolution of the webcam, with the banner present.

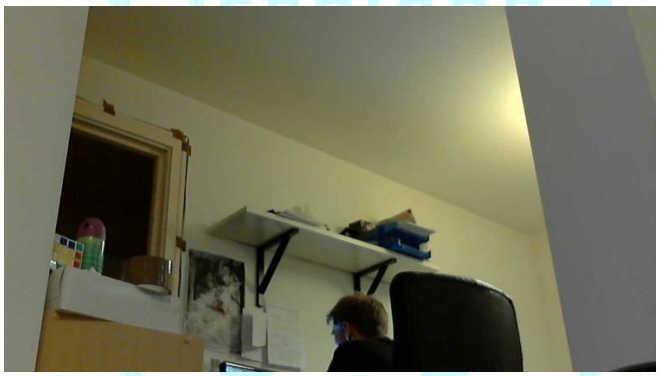
Specify no banner

Now add the `--no-banner` flag:

```
fswebcam -r 1280x720 --no-banner image3.jpg
```

which shows the following information:

```
--- Opening /dev/video0...
Trying source module v4l2...
/dev/video0 opened.
No input was specified, using the first.
--- Capturing frame...
Corrupt JPEG data: 2 extraneous bytes before marker
0xd6Captured frame in 0.00 seconds.
--- Processing captured
image...Disabling banner.
```



Now the picture is taken at full resolution with no banner.

Bad Pictures

You may experience poor quality pictures with a USB webcam, such as thisaccidentally artistic piece:

Some webcams are more reliable than others, but this sort of issue may occur with poor quality webcams. If the problem persists, ensure your system is up to date. Also try other webcams, but you'll get the best performance from the RaspberryPi camera module.

Bash script

You can write a Bash script which takes a picture with the webcam. The script below saves the images in the `/home/pi/webca` directory, so create the `webcam` subdirectory first with:

```
mkdir webcam
```

To create a script, open up your editor of choice and write the following example code:

```
#!/bin/bash
DATE=$(date +"%Y-%m-%d_%H%M")
fswebcam -r 1280x720 --no-banner /home/pi/webcam/$DATE.jpg
```

This script will take a picture and name the file with a timestamp. Say we saved it as `webcam.sh`, we would first make the file executable:

```
chmod +x webcam.sh
```

Then run with:

```
./webcam.sh
```

Which would run the commands in the file and give the usual output:

```
--- Opening /dev/video0...
Trying source module v4l2...
/dev/video0 opened.
No input was specified, using the first.
--- Capturing frame...
Corrupt JPEG data: 2 extraneous bytes before marker
0xd6Captured frame in 0.00 seconds.
```

```
Disabling banner.
Writing JPEG image to '/home/pi/webcam/2013-06-07_2338.jpg'.
```

Time-lapse using cron

You can use `cron` to schedule taking a picture at a given interval, such as every minute to capture a time-lapse.

First open the cron table for editing:

```
crontab -e
```

This will either ask which editor you would like to use, or open in your default editor. Once you have the file open in an editor, add the following line to schedule taking a picture every minute (referring to the Bash script from above):

```
* * * * * /home/pi/webcam.sh 2>&1
```

Save and exit and you should see the message:

```
crontab: installing new crontab
```

Ensure your script does not save each picture taken with the same filename. This will overwrite the picture each time.

Result :

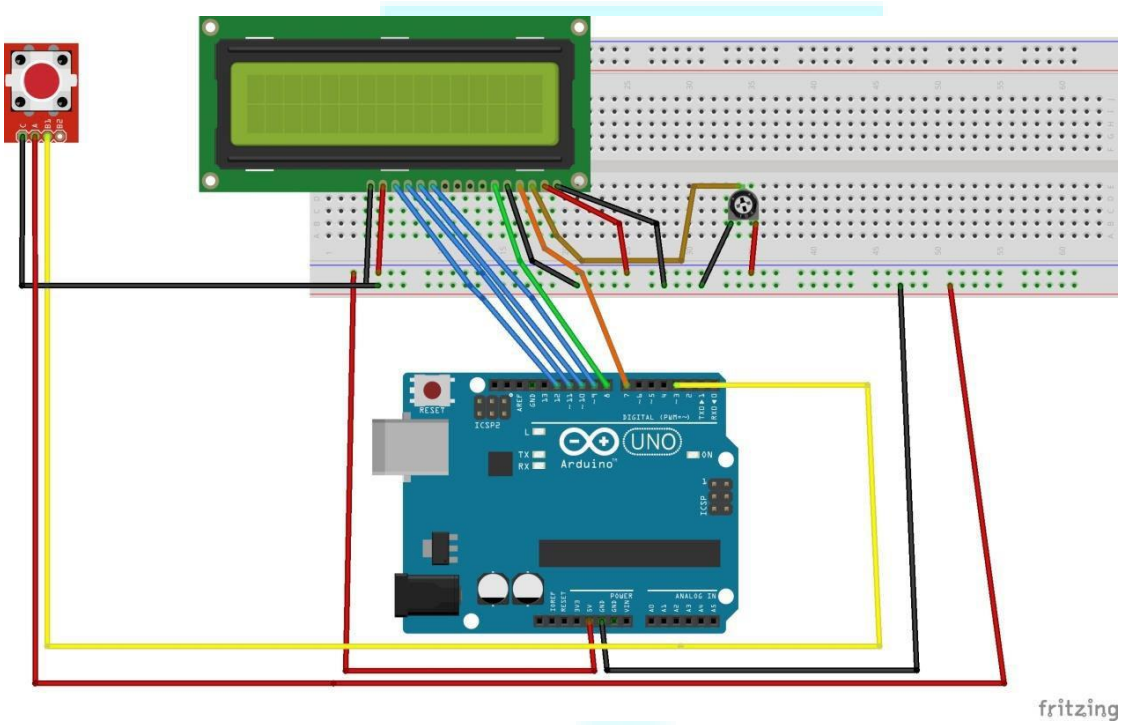
Thus the Log Data using Raspberry PI and upload to the cloud platform is completed successfully.

Ex no : **DESIGN AN IoT SYSTEMS**

Date :

Aim:

Instead of using the conventional dice, generate a random value similar to dice value and display the same using a 16X2 LCD. A possible extension could be to provide the user with option of selecting single or double dice game.




```
#include <LiquidCrystal.h>
long randNumber;
int Led = 13; //define LED port
int Shock = 2; //define shock port
int val;//define digital variable val
// initialize the library with the numbers of the interface pins
LiquidCrystal lcd(7, 8, 9, 10, 11, 12 );
byte customChar[] = {
  B00000,
  B00000,
  B11111,
  B11001,
```

```
  B10101,
  B10011,

  B11111,
  B00000
};
void  setup()
{

  lcd.begin(16, 2);
  lcd.createChar(0, customChar);
  lcd.home();
  pinMode(Led, OUTPUT); //define LED as a output port
  randomSeed(analogRead(0));
  pinMode(Shock, INPUT); //define shock sensor as a output port
  lcd.write(byte( 0));
  lcd.print("Digital dice");
  lcd.write(byte( 0));
  delay(1000);
}

void loop()
{

  val = digitalRead(Shock); //read the value of the digital interface 3 assigned to val
  if (val == LOW) //when the shock sensor have signal do the following
  {
     lcd.clear();
     lcd.print("Rolling dice...");
     delay(4000);
     lcd.clear();
     lcd.setCursor(0, 0);
     randNumber = random(1,7);
     lcd.print("Dice 1 = ");
     lcd.print(randNumber);

lcd.setCursor(0, 1); randNumber = random(1,7);
```

```
    lcd.print("Dice 2 = ");
    lcd.print(randNumber);


  }

 delay(150);
}
```

Result :

Thus the IoT based diecing systems is designed successfullhy.