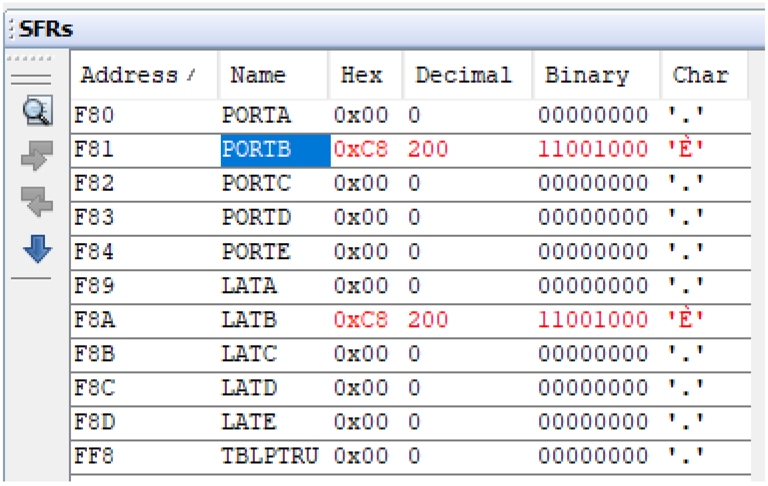
Assignment 1 : simple addition program

```
#include<PIC18F458.h>

#include<stdio.h>

void main(){

   int a,b,c;

   a=100;

   b=100;

   c=a+b;

   TRISB=0;

   PORTC=c;

}
```

Output:



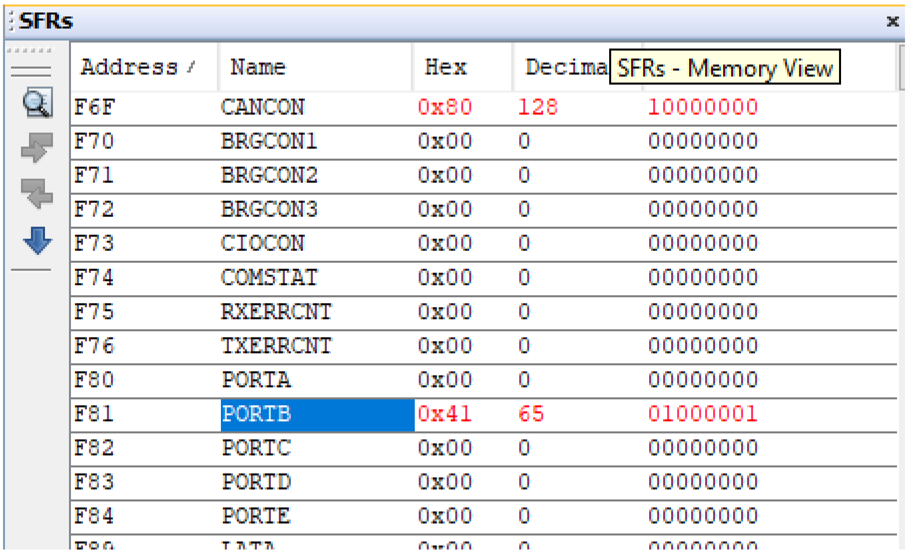
SFRs

Address	Name	Hex	Decimal	Binary	Char
F80	PORTA	0x00	0	00000000	'.'
F81	PORTB	0xC8	200	11001000	'È'
F82	PORTC	0x00	0	00000000	'.'
F83	PORTD	0x00	0	00000000	'.'
F84	PORTE	0x00	0	00000000	'.'
F89	LATA	0x00	0	00000000	'.'
F8A	LATB	0xC8	200	11001000	'È'
F8B	LATC	0x00	0	00000000	'.'
F8C	LATD	0x00	0	00000000	'.'
F8D	LATE	0x00	0	00000000	'.'
FF8	TBLPTRU	0x00	0	00000000	'.'

Assignment 2 Addition of Array

```
#include<PIC18F458.h>
#include<stdio.h>
void main(){
   int i,sum;
   int n[]={11,12,13,14,15};
   sum=0;
   for(i=0;i<=4;i++){
      sum=sum+n[i];
   }
   TRISB=0;
   PORTB=sum;
   }
```

Output:

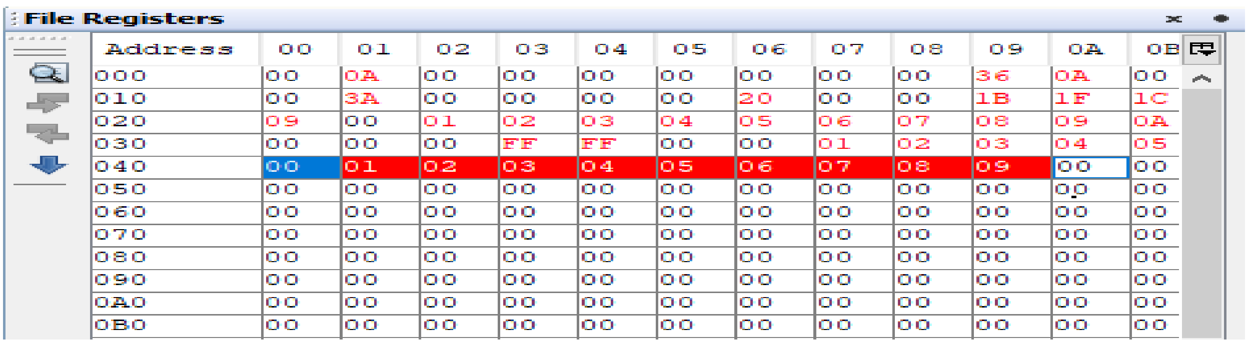


Address	Name	Hex	Decima	
F6F	CANCON	0x80	128	10000000
F70	BRGCON1	0x00	0	00000000
F71	BRGCON2	0x00	0	00000000
F72	BRGCON3	0x00	0	00000000
F73	CIOCON	0x00	0	00000000
F74	COMSTAT	0x00	0	00000000
F75	RXERRCNT	0x00	0	00000000
F76	TXERRCNT	0x00	0	00000000
F80	PORTA	0x00	0	00000000
F81	PORTB	0x41	65	01000001
F82	PORTC	0x00	0	00000000
F83	PORTD	0x00	0	00000000
F84	PORTE	0x00	0	00000000

Assignment 3 : Internal to internal memory transfer

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <PIC18F458.h>
#pragma config OSC=HS
#define SIZE 10
unsigned char data[SIZE];
unsigned char external_mem[SIZE];
void transfer_internal_to_internal(unsigned char *src,unsigned char *dest,int size)
{
 memcpy(dest, src, size);
}
void transfer_internal_to_external(unsigned char *src,unsigned char *dest,int size)
{
 memcpy(dest, src, size);
}
void main(void)
{
 for( int i = 0; i<SIZE; i++)
 {
 data[i]=i;
 }
 unsigned char internal_data[SIZE];
 transfer_internal_to_internal(data,internal_data,SIZE );
 transfer_internal_to_external(data,external_mem,SIZE );
 printf("Data in internal Memory : \n");
for (int i =0; i<SIZE; i++ ){
 printf("%d",internal_data[i]);
 }
 printf("\n");
 printf("Data in external Memory : \n");
 for (int i =0; i<SIZE; i++ ){
 printf("%d",external_mem[i]);
 }
 printf("\n");
 while(1);
}
```

Output:



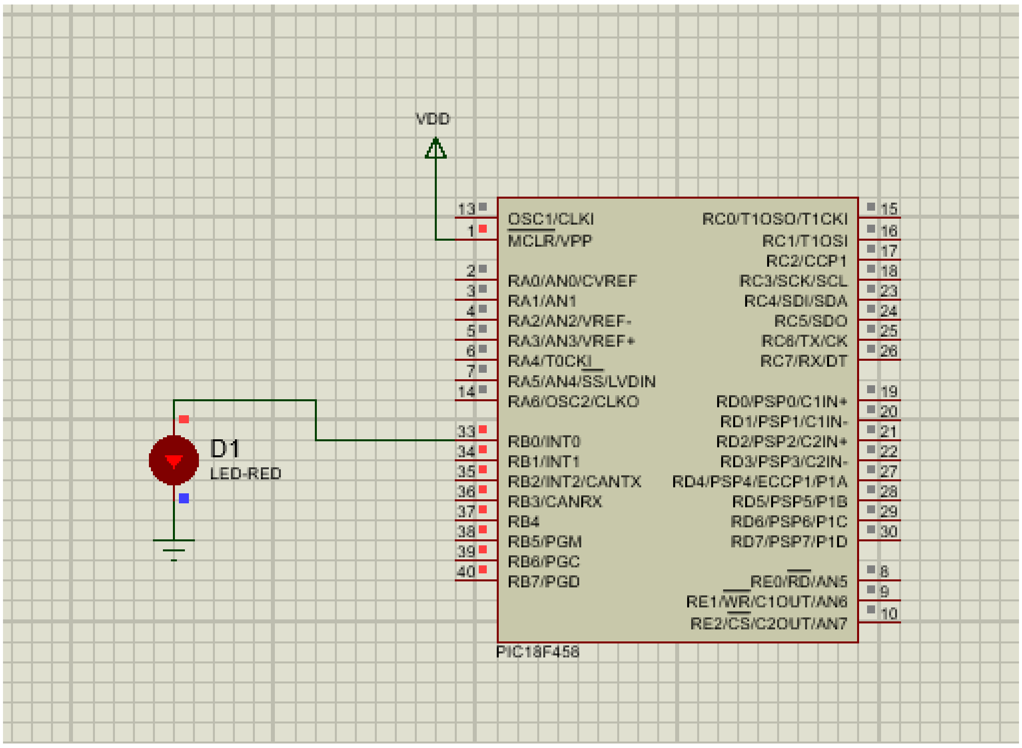
File Registers

Address	00	01	02	03	04	05	06	07	08	09	0A	0B
000	00	0A	00	00	00	00	00	00	00	36	0A	00
010	00	3A	00	00	00	00	20	00	00	1B	1F	1C
020	09	00	01	02	03	04	05	06	07	08	09	0A
030	00	00	00	FF	FF	00	00	01	02	03	04	05
040	00	01	02	03	04	05	06	07	08	09	00	00
050	00	00	00	00	00	00	00	00	00	00	00	00
060	00	00	00	00	00	00	00	00	00	00	00	00
070	00	00	00	00	00	00	00	00	00	00	00	00
080	00	00	00	00	00	00	00	00	00	00	00	00
090	00	00	00	00	00	00	00	00	00	00	00	00
0A0	00	00	00	00	00	00	00	00	00	00	00	00
0B0	00	00	00	00	00	00	00	00	00	00	00	00

Assignment 4: LED Interfacing

```
#include <PIC18F458.h>
// Define the delay in milliseconds
void delay();
void main(void) {
 // Set the TRISB register to output mode for the LED
 TRISB = 0x00;
 // Loop forever
 // Turn the LED on
while(1)
{
 PORTB = 0xFF;
 delay();
 PORTB = 0x00;
 delay();
 }
}
 void delay()
 {
 for(int i=0;i<=10000;i++)
 {

 }
 }
```

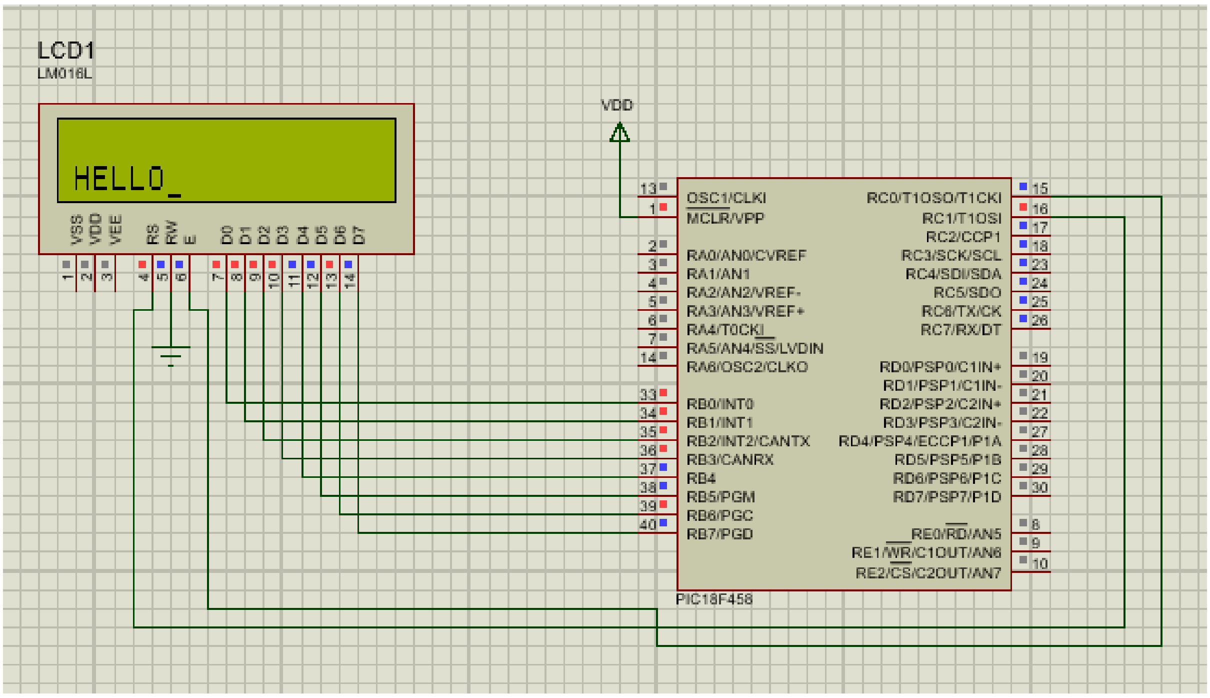
Output:



Assignment 5: LCD Interfacing

```
#include <PIC18F458.h>
#define ldata PORTB //define name ldata to PORTB
#define rs PORTCbits.RC1 //definne name rs(egister select) for RC0 pin of PORTC
#define en PORTCbits.RC0 //definne name en(enable) for RC1 pin of PORTC
void delay();
void lcdcmd(unsigned char);
void lcdval(unsigned char);
void main()
{
unsigned char xc;
 TRISB=0; //make PORTB as output
 TRISC=0; //make PORTC as output
 lcdcmd(0x38); //command to initialise LCD.
 lcdcmd(0x0E); //command to make Display on cursor blinking
 lcdcmd(0x01); //command to clear display screen
 lcdcmd(0x06); //command to increment cursor
 lcdcmd(0xC0); //command to set cursor at 1st line 6th position
 lcdval('H');
 lcdval('E');
 lcdval('L');
 lcdval('L');
 lcdval('O');
 while(1);
}
void lcdcmd(unsigned char y)
{
 rs=0;
 ldata=y;
 en=1;
 delay();
 en=0;
 delay();
}
// lcdval fuction used to select DATA REGISTER of LCD by making,
// rs=1 and en=1 to 0 edge AND sends 8 bit command to PORTB
void lcdval(unsigned char y)
{
 rs=1;
 ldata=y;
 en=1;
 delay();
 en=0;
 delay();
}void delay(){
 for(int i=0;i<=2000;i++)
{}
 }
```

Output:

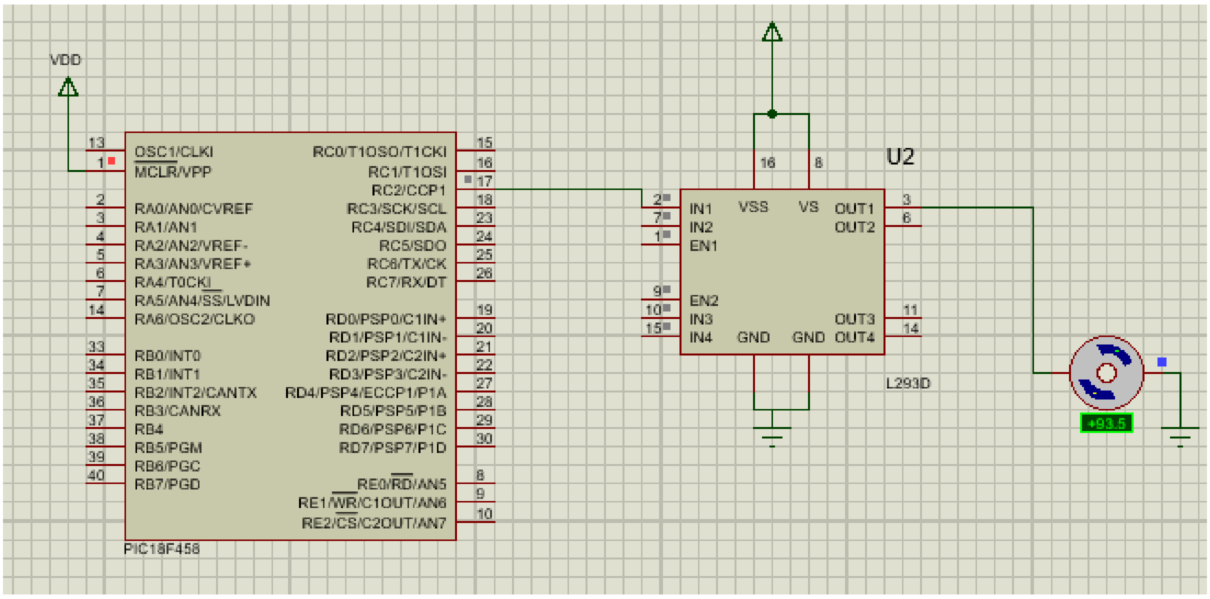


LCD1
LM016L
HELLO_
VSS
VDD
VEE
RS
RW
E
D0
D1
D2
D3
D4
D5
D6
D7
VDD
OSC1/CLKI
MCLR/VPP
RA0/AN0/CVREF
RA1/AN1
RA2/AN2/VREF-
RA3/AN3/VREF+
RA4/T0CKI
RA5/AN4/SS/LVDIN
RA6/OSC2/CLKO
RB0/INT0
RB1/INT1
RB2/INT2/CANTX
RB3/CANRX
RB4
RB5/PGM
RB6/PGC
RB7/PGD
RC0/T1OSO/T1CKI
RC1/T1OSI
RC2/CCP1
RC3/SCK/SCL
RC4/SDI/SDA
RC5/SDO
RC6/TX/CK
RC7/RX/DT
RD0/PSP0/C1IN+
RD1/PSP1/C1IN-
RD2/PSP2/C2IN+
RD3/PSP3/C2IN-
RD4/PSP4/ECCP1/P1A
RD5/PSP5/P1B
RD6/PSP6/P1C
RD7/PSP7/P1D
RE0/RD/AN5
RE1/WR/C1OUT/AN6
RE2/CS/C2OUT/AN7
PIC18F458

Assignment 6 :DC Motor Interfacing

```
#include<pic18f458.h>
void main(void)
{
TRISCbits.RC2 = 0; // 00101100 to Select PWM mode; Duty cycle LSB
CCP1CONbits.CCP1M = 0b1100; //CCP1CON<4:5> = <1:1>
TMR2ON = 0;
while(1)
{
PR2 = 74;
CCPR1L = 18;
TMR2ON = 1;
}
}
```

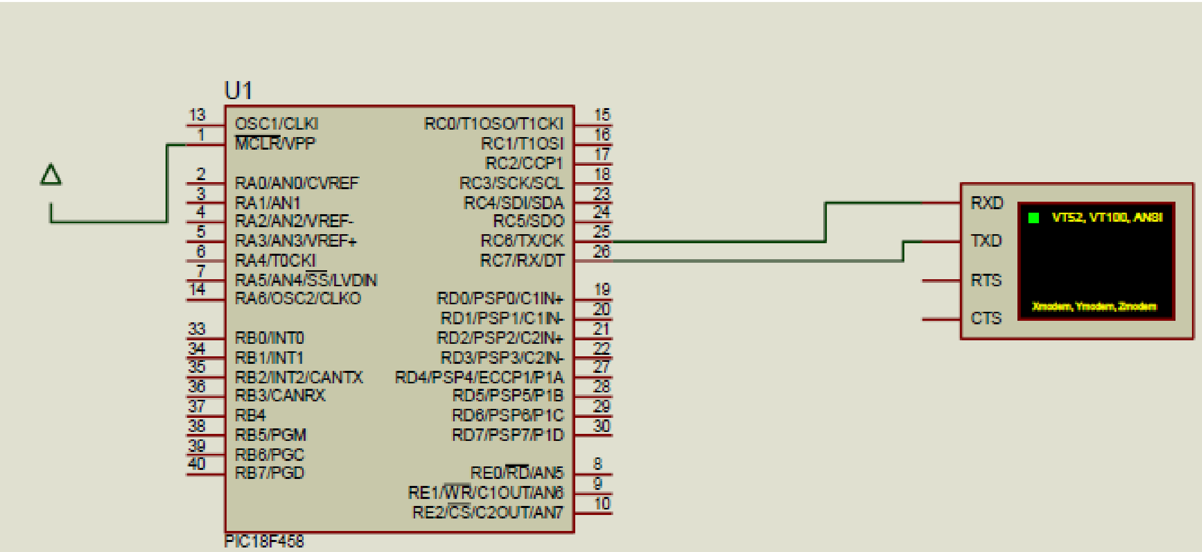
Output:



Assignment – 07 PC TO PC Serial Communication using UART

```
#include <PIC18F458.h>
void main()
{
unsigned char a[]="WELCOME"; ///character array to transmit
int i;
TRISB=0;
TRISCbits.RC6=0;
TRISCbits.RC7=1;
SPBRG=0X4D;//to set baud rate
RCSTAbits.SPEN = 1; // Enable USART module
TXSTAbits.TXEN = 1;//receive status and control register
for(i=0;i<=6;i++)
{
while(PIR1bits.TXIF==0); //check whether data is transmitted or not
TXREG=a[i];
PIR1bits.TXIF=0;
}
while(1);
}
```

Output:



Assignment No. 8: Study of Arduino, Raspberry-Pi

Aim: Study of Arduino, Raspberry-Pi, Beagle board.

Theory:

A) **Arduino Uno Board**

Arduino Uno is a microcontroller board developed by Arduino.cc which is an open-source electronics platform mainly based on AVR microcontroller Atmega328.

First Arduino project was started in Interaction Design Institute Ivrea in 2003 by David Cuartielles and Massimo Banzi with the intention of providing a cheap and flexible way to students and professional for controlling a number of devices in the real world.

It allows the designers to control and sense the external electronic devices in the real world.

There are many versions of Uno boards available, however, Arduino Nano V3 and Arduino Uno arethe most official versions.

When nature and functionality of the task go complex, Mirco SD card can be added in the boards to make them store more information.

Processor:

1. 8-bit AVR microcontroller Atmega328
2. 2KB SRAM and 1KB of EEPROM.
3. 13KB of flash memory.

Features of Arduino Uno Board

1. Arduino Uno comes with USB interface i.e. USB port is added on the board to develop serial communication with the computer. Apart from USB, battery or AC to DC adopter can also be used to power the board. It is an open source platform where anyone can modify and optimize the board based on the number of instructions and task they want to achieve.
2. This board comes with a built-in regulation feature which keeps the voltage under control when the device is connected to the external device.
3. There are 14 I/O digital and 6 analog pins incorporated in the board that allows the external connection with any circuit with the board. These pins provide the flexibility and ease of use to the external devices that can be connected through these pins.
4. The 6 analog pins are marked as A0 to A5 and come with a resolution of 10bits. These pins measure from 0 to 5V, however, they can be configured to the high range using analog Reference() function and AREF pin.
5. 13KB of flash memory is used to store the number of instructions in the form of code.
6. Only 5 V is required to turn the board on, which can be achieved directly using USB port or external adopter, however, it can support external power source up to 12 V which can be regulated and limit to 5 V or 3.3 V based on the requirement of the project.

Pin Description

I/O digital and analog pins placed on the board which operates at 5V. These pins come with standard operating ratings ranging between 20mA to 40mA. Internal pull-up resistors are used in theboard that limits the current exceeding from the given operating conditions. However, too much increase in current makes these resisters useless and damages the device.

LED: Arduino Uno comes with built-in LED which is connected through pin 13. Providing HIGH value to the pin will turn it ON and LOW will turn it OFF.

Vin: It is the input voltage provided to the Arduino Board. Vin and Power Jack support a voltage ranges between 7V to 20V. This pin is used to supply voltage. If a voltage is provided through power jack, it can be accessed through this pin.

5V: This board comes with the ability to provide voltage regulation. 5V pin is used to provide output regulated voltage. The board is powered up using three ways i.e. USB, Vin pin of the board or DC power jack.

GND: These are ground pins. More than one ground pins are provided on the board which can be used as per requirement.

RESET: This pin is incorporated on the board which resets the program running on the board. Instead of physical reset on the board, IDE comes with a feature of resetting the board through programming.

IOREF: This pin is very useful for providing voltage reference to the board. A shield is used toread the voltage across this pin which then selects the proper power source.

PWM: PWM is provided by 3, 5, 6, 9, 10, 11 pins. These pins are configured to provide 8- bit output PWM.

SPI: It is known as Serial Peripheral Interface. Four pins 10(SS), 11(MOSI), 12(MISO), 13(SCK) provide SPI communication with the help of SPI library.

AREF: It is called Analog Reference. This pin is used for providing a reference voltage to the analog inputs.

TWI: It is called Two-wire Interface. TWI communication is accessed through Wire Library. A4 and A5 pins are used for this purpose.

Serial Communication: The Atmega328 placed on the board provides serial communication using pins like Rx and Tx. It is carried out through these pins called Pin 0 (Rx) and Pin 1 (Tx).

Rx pin is used to receive data while Tx pin is used to transmit data.

External Interrupts: Pin 2 and 3 are used for providing external interrupts. An interrupt is called by providing LOW or changing value.

(B) Raspberry Pi Board

Raspberry Pi is a credit card sized bargain micro-Linux machine. The goal behind creating Raspberry Pi was to create a low cost device that would improve programming skills and hardware understanding for students.Raspberry Pi is open hardware with the exception of its primary chip, theBroadcomm SoC which runs the main components of the board – CPU, graphics, memory, USB controller etc.

Processor:

1. The Model A+ is the low-cost variant of the Raspberry Pi. It has 256MB RAM, one USB port,40 GPIO pins and no Ethernet port.
2. The Model B+ is the final revision of the original Raspberry Pi. It has 512MB RAM, four USB ports, 40 GPIO pins, and an Ethernet port.
3. The Pi 2 uses a 900MHz quad-core ARM Cortex-A7 CPU and has 1GB RAM.
4. The Pi 3 Model B was launched in February 2016; it uses a 1.2GHz 64-bit quad-core ARMCortex-A53 CPU, has 1GB RAM, integrated 802.11n wireless LAN, and Bluetooth 4.1.
5. Pi Zero is half the size of a Model A+, with a 1Ghz single-core CPU and 512MB RAM, andmini-HDMI and USB On-The-Go ports.
6. Operating Systems: Raspbian RaspBMC, Arch Linux, Rise OS, OpenELEC Pidora
7. Video Output: HDMI Composite RCA
8. Supported Resolutions: 640x350 to 1920x1200, including 1080p, PAL & NTSC standards
9. Power Source: Micro USB

Hardware required to setup your Raspberry Pi

1. A Raspberry Pi
2. An HDMI or composite video capable television or monitor
3. An HDMI or composite video cable
4. An SD card that is compatible with your Raspberry Pi - http://elinux.org/Raspberry Pi_SD_cards has
   a list of SD cards you should use
5. A USB keyboard and mouse (Bluetooth keyboard/mouse work for latest model but with minor connectivity issues)
6. Standard Ethernet cable
7. Micro USB power supply (that can provide at least 700mA at 5V)
8. A 3.5 mm stereo audio cable if your project requires Raspberry Pi to be connected to external speakers.

Steps to setup Raspberry Pi

Each of the following steps is detailed in the subsequent slides.

Step 1 : SD Card Setup

Step 2 : Raspberry Pi cabling

Step 3 : Booting your Raspberry Pi for the first time

Step 4 : Load GUI environment to your Raspberry Pi

Sep 5 : Setup a network connection

Step 6: After completing this setup, you will have your device powered up and working as full-fledged

Linux box running Debian.

Raspberry Pi cabling

1. Push SD card into the SD card slot.
2. Plug the HDMI cable into the HDMI output of the Raspberry Pi and connect to the

TV/monitor.

3. Turn on monitor and switch to the HDMI port.
4. Insert the network cable and connect to the router.
5. Connect the keyboard and mouse via USB ports.
6. Plug the power supply into the micro USB.
7. The device is now ready for the next steps.

Voltages

Two 5V pins and two 3V3 pins are present on the board, as well as a number of ground pins (0V),which are not configurable.

Outputs

A GPIO pin designated as an output pin can be set to high (3V3) or low (0V).

Inputs

A GPIO pin designated as an input pin can be read as high (3V3) or low (0V). This is made easier with the use of internal pull-up or pull-down resistors. Pins GPIO2 and GPIO3 have fixed pull-up resistors, but for other pins this can be configured in software. The GPIO pins can be used with a variety of alternative functions; some are available on all pins, others on specific pins such as

1. PWM (pulse-width modulation)
2. Software PWM available on all pins
3. Hardware PWM available on GPIO12, GPIO13, GPIO18, GPIO19
4. SPI
5. SPI0: MOSI (GPIO10); MISO (GPIO9); SCLK (GPIO11); CE0 (GPIO8), CE1 (GPIO7)
6. SPI1: MOSI (GPIO20); MISO (GPIO19); SCLK (GPIO21); CE0 (GPIO18); CE1 (GPIO17);CE2 (GPIO16)
7. I2C
8. Data: (GPIO2); Clock (GPIO3)
9. EEPROM Data: (GPIO0); EEPROM Clock (GPIO1)
10. Serial
11. TX (GPIO14); RX (GPIO15)

Difference between Arduino and Raspberry Pi

Sr. No.	Raspberry Pi	Arduino
1	It is a mini computer with Raspbian OS.It can run multiple programs at a time.	Arduino is a microcontroller, which is a part of the computer. It runs only one program again and again.
2	It is difficult to power using a batterypack.	Arduino can be powered using a battery pack.
3	It requires complex tasks like installing libraries and software for interfacing sensors and other components	It is very simple to interface sensors and other electronic components to Arduino.

4	It is expensive	It is available for low cost.
5	Raspberry Pi can be easily connected to the internet using Ethernet port and USB Wi-Fi dongles.	Arduino requires external hardware to connect to the internet and this hardware is addressed properly using code.
6	Raspberry Pi did not have storage on board. It provides an SD card port.	Arduino can provide onboard storage.
7	Raspberry Pi has 4 USB ports to connect different devices.	Arduino has only one USB port to connectto the computer.
8	The processor used is from ARM family.	Processor used in Arduino is from AVR family Atmega328P
9	This should be properly shutdown otherwise there is a risk of files corruption and software problems.	This is a just plug and play device. If power is connected it starts running the program and if disconnected it simply stops.
10	The Recommended programming language is python but C, C++, Python,ruby are pre-installed.	Arduino uses Arduino, C/C++

(C) Beagle Bone Board

The Beagle Board is a low-power open-source single-board computer produced by Texas Instruments in association with Digi-Key and Newark element14. Beagle Bone Black is a low-cost, open source, community-supported development platform for ARM CortexTM-A8 processor developers and hobbyists.

Processor:

1. AM335x 1GHz ARM® Cortex-A8
2. 512MB DDR3 RAM
3. 4GB 8-bit eMMC on-board flash storage
4. 3D graphics accelerator
5. NEON floating-point accelerator
6. 2x PRU (PRU-Programmable Real Time Unit) 32-bit microcontrollers

Connectivity

1. USB client for power & communications
2. USB host
3. Ethernet
4. HDMI
5. 2x 46 pin headers

Software Compatibility

1. Debian
2. Android
3. Ubuntu
4. Cloud9 IDE on Node.js w/ BoneScript library
5. plus, much more

Difference between Raspberry Pi and BeagleBone Black

Sr. No.	BeagleBone Black	Raspberry PI
1	Better interfaces with external sensors	Better graphics capabilities
2	Faster, newer, better supported processor	Better audio capabilities
3	Includes an OS out of the box	Better community support
4	Runs Angstrom, Ubuntu and other OS's	Mainly runs Raspbian OS

Applications

The devices discussed above come in wide range of applications. A larger number of people are using these boards for developing sensors and instruments that are used in scientific research. Following are some main applications of the board.

1. Embedded System
2. Security and Defense System
3. Digital Electronics and Robotics
4. Parking Lot Counter
5. Weighing Machines
6. Traffic Light Count Down Timer
7. Medical Instrument
8. Emergency Light for Railways
9. Home Automation
10. Industrial Automatio