Embedded System Design with ARM
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Lecture – 18
Microcontroller Development Boards

Welcome to week 4 of the Embedded System Design with ARMed course. So, in this week I will take you to the tour of various Microcontroller Boards and specifically I will be discussing about two board; one is STM board and another is Arduino board. And I will also show you how you can program using these two boards specifically.

There are other development boards as well, but in this course we will be taking the opportunity to take these two specific boards into consideration and we will be discussing the experiments based on these two boards.

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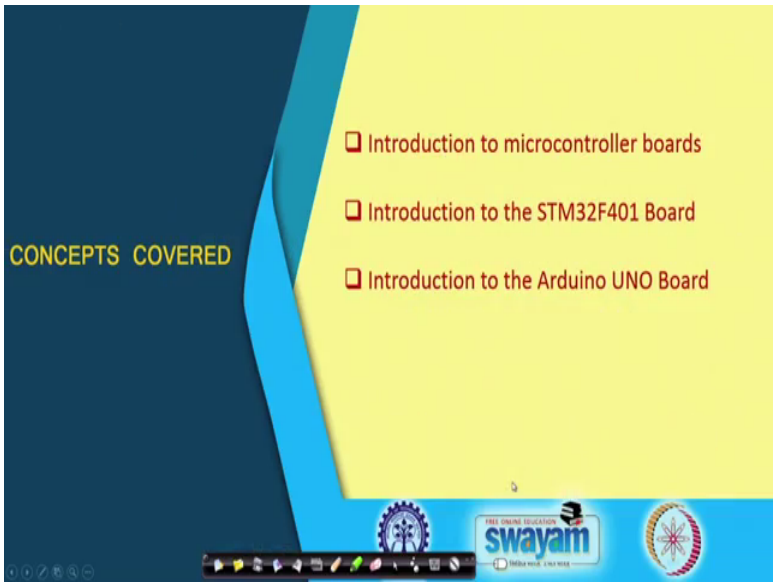

So, the concepts that will be covered in this lecture is like I will introduce microcontroller boards, we already know what is a microcontroller. I will be now discussing about two boards; one is STM32F401 board and another one is Arduino UNO. All the experiments that we will be doing in this course will be based on these two boards.

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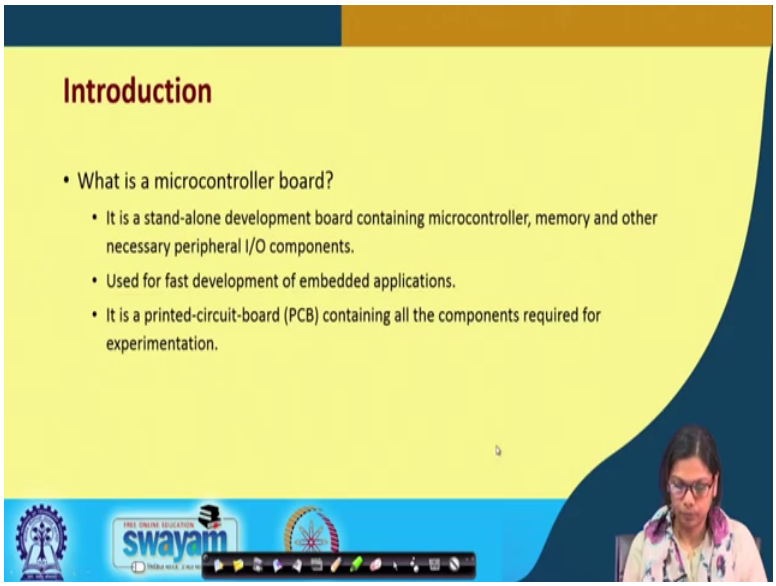

So, let me talk about what is a microcontroller board? We can define it as a standalone development board containing microcontroller, memory and other necessary peripheral I O components. Why it is used basically? It is used for fast development of embedded applications. And, it is generally built on a printed circuit board which is called PCB containing all the components that are required for the experimentation.

So, microcontroller boats are used for this fast development of embedded applications. Nowadays we see lot of embedded application starting from if you think of a small example let us say a smoke detector, what is it? It is a system that will detect smoke if it is present inside a particular room or a particular area, in that case what do you require? You require various other input output devices.

But more specifically you need a microcontroller board through which you will be connecting a sensor that will read some analog values which is in terms of let us say smoke inside this room and it will convert digitally to some value. And then we will do some kind of operation to find out whether there is a smoke inside this room or not. So, that it will detect based on that detection various things could be done; one thing that a buzzer could be on and then you can actually hear that sound and you can make out that ok.

There is some issue in that particular room or so, or we could have a system where we can directly send the information that yes, there is a smoke inside this room to let us say

the friability. We will we will look into all these aspects in course of time, but in doing this particular application that is smoke detector you need microcontroller boards. And these microcontroller boards are so, powerful that all these input output ports are along with it, such that you can actually connect directly with a sensor with the buzzer etcetera etcetera to make the complete system.

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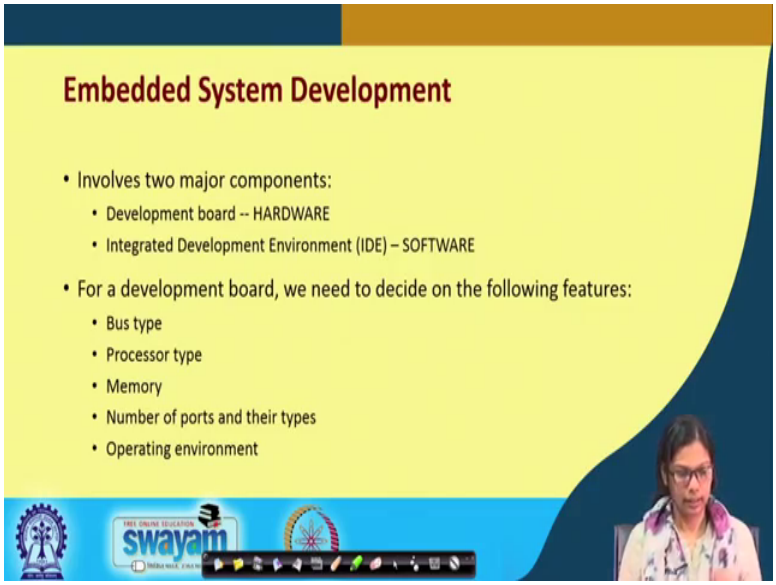

Embedded system development; when we talk about this embedded system development this involves two major components; what are those? One is the development board that is the hardware that is required and another is Integrated Development Environment, we call it IDE that is the SOFTWARE.

So, basically when we think of designing a system then these two things are required; we need a hardware that is the board, but how do we program it we need to have some software associated with it through which we can program it. So, we will also look into that what are the various kinds of IDE that is the Integrated Development Environment that we will be using in this particular course for the two boards. Now for a development board when we when we try to design a system we always think upon that what kind of development board we should use.

So, in that regard upon which criteria we should select which development board to use is based on the following features; one is the bus type another is the processor type. What kind of processor we are using? The memory; memory is one of the vital important

parameter that is required for any design because, if you want to really dump a very large program and you have a limited memory you need to think upon it how will you do it.

So, memory is an important criteria that is to be decided when you develop and embedded system, number of ports and their types we also need input output ports we also need analog ports. So, we need digital ports we need analog ports. So, we need to also decide upon that or what kind of ports are there in that particular board and the operating environment. Like in some development boards we use some integrated development environment we will see that, but for some the compiler is already available online if the compiler is already available online we can use that compiler.

So, only requirement is that you need to have internet connection because you will be using an online compiler. So, to compile your code into the development board you need that particular that software basically. So, that software is there in the form of a compiler online. So, you have to use internet to use that particular software.

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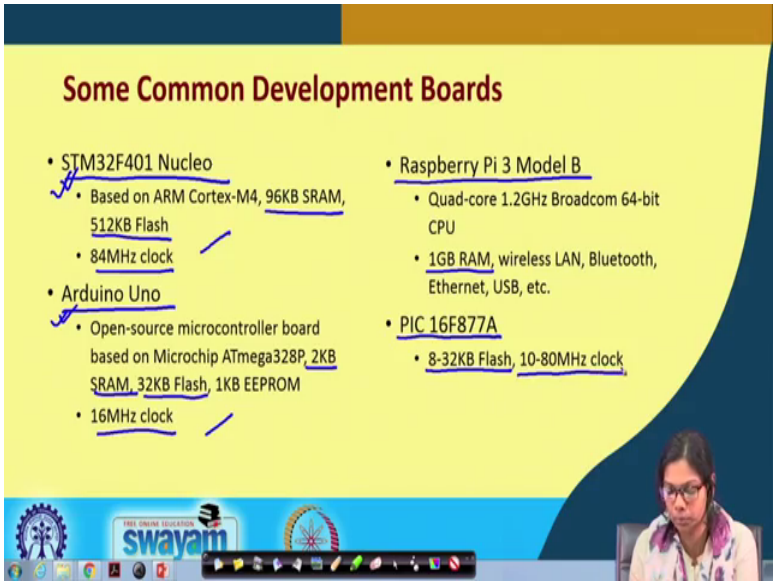

These are some common development boards the one we will be using is STM 32 F401 nucleo board that we will be using, it is based on ARM Cortex M 4 and it has got 96 KB of SRAM. So, these are some of the features of STM 32 F 401 nucleo board and it has got 512 KB of flash memory what is the clock speed of this particular board it is 84 megahertz clock. Another very popular board is Arduino UNO this particular board is a open source microcontroller board which is based on micro chip at mega 328 P it has got

2 KB of SRAM and 32 KB of flash it has also got 1 KB of EE PROM. Now the clock the clock it is having its 16 megahertz clock.

Now, if you see the features of STM bold and if you see the features of Arduino UNO you can clearly make out that STM is much powerful as compared to Arduino. You see the kind of memory it is having 96 KB compared to 2 KB 512 KB of flash and 32 KB of flash clock speed of 84 megahertz and clock speed of 16 megahertz. Now I should also tell you one important thing when I am talking about the functionalities the very important thing is that this does not mean that the application you are running will not run in Arduino UNO and only run in STM it depends on what kind of application you are running. So, the application which we will be showing in this particular course could be run base using both Arduino UNO board as well as STM 32 F 401 nuclear board we can use any one of the board either this one or this one for our development.

But when you think of a very huge application that you are trying to build which requires higher memory. In that case of course, you can see that STM 32 F 401 nucleo board will be preferred more. Now, there are even more powerful boards one of which is Raspberry Pi 3 model B which consists of quad core 1.2 gigahertz broad com and 64 bit CPU along with that it has got a 1 GB of RAM, wireless LAN, Bluetooth, Ethernet and USB. So, you can now see that that Raspberry Pi model can be used as a computer itself it has got such a high end features, that can be used for any sophisticated application development although we will not be using Raspberry Pi in this particular course.

But for very high end application development you can of course, think of using Raspberry Pi another microcontroller board is PIC microcontroller board. So, this is one of the model which is 16 F 877 A the feature is like this it has got 8 to 32 KB flash and the clock speed can range from 10 to 80 megahertz. So, when you think of the developing very very simple kind of applications then of course, we can think of using this PIC based microcontroller systems.

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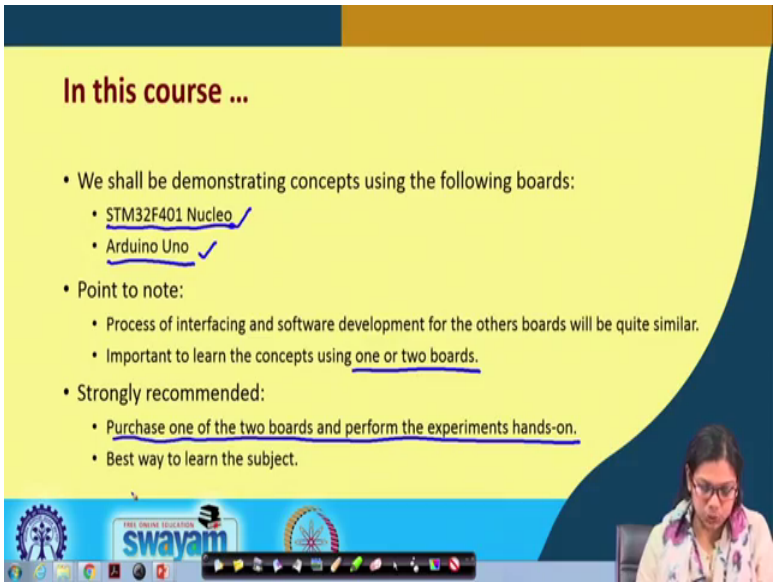

Now, as I have already told you in this particular course we shall be demonstrating the concepts using the following boards. The first one is STM 32 F 401 nuclear board and another one is Arduino UNO. Now, there are certain points to note the process of interfacing and software development for the other boards will be quite similar. As we will be only discussing about STM board and Arduino UNO you can if you want to interface any other board the process will not be very very different.

So, you can of course, do that, but it is important to learn the concept using at least one or two boards, such that you know that we know two aspects of the boards. And what is strongly recommended for this course unless and otherwise you do that you will not feel the essence and you will not understand this course to this level. If you purchase at least one of the two boards and perform the experiments using this. So, we will be coming up across many hands on experiments in this particular course.

So, we request you that you should go ahead and purchase at least one of these boards and you can do experiment along with us when we show you; if you are interested of course, and I believe that that is the best way to learn this subject.

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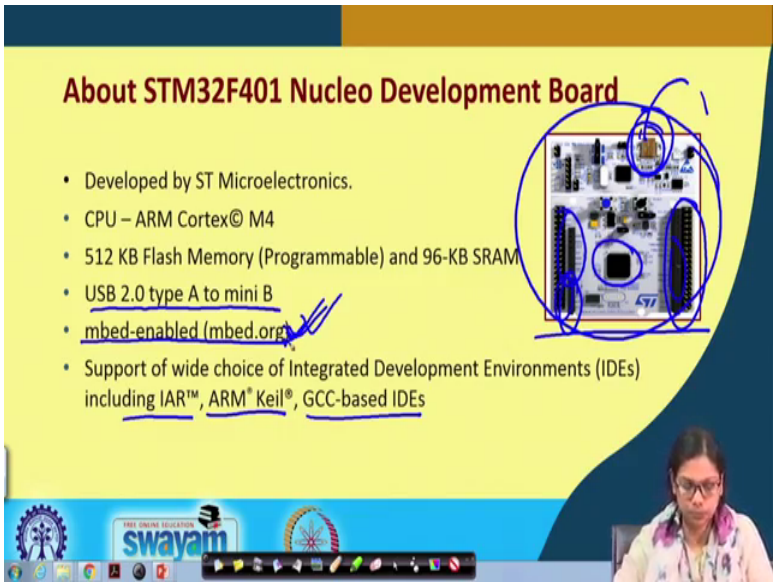

Now, I will move on with STM 32 F 401 nucleo development board, this is the board this is the board which we will be using it has got some digital pins it has got some analog pins, there is a power thing this is the USB connection through which you can connect through USB. So, let me talk about a little bit about this board.

So, this board is developed by a company called ST microelectronics. The CPU inside this particular board is ARM Cortex M 4 it has got 512 KB of flash memory which is programmable and 96 KB of SRAM. As I have already told you that this is the USB connector. So, here a USB 2.0 type A to mini B is used. So, here you can connect that particular USB we will be showing you in subsequent slides how it looks like.

So, for connecting from here to your PC you require this USB. Now the way we have done programming here using this particular board is mbed enabled. So, what we do is that we go to a website that is mbed dot os dot o r g I will give you the exact URL for it and there we actually write the code and we dump the code into this particular board. And then accordingly you connect through these IO pins or you connect through the analog pins you can do various other things.

But, we actually in this particular course we have used this online mbed compiler. There is a wide range of choice of integrated development environment so, you can also use ARM Keil or GCC based IDE's including IAR. So, that is up to your choice what you

will be using, but we have preferred in this course and we have shown through this mbed enabled through mbed dot org.

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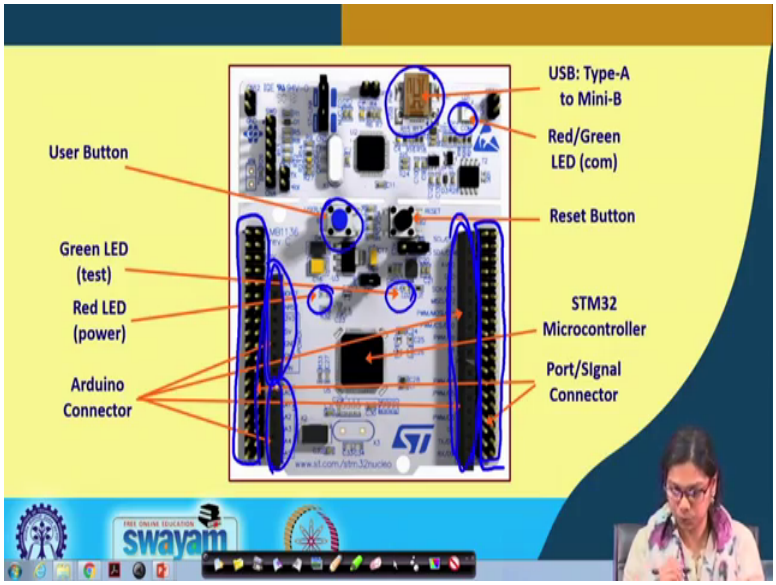

Next so, this is the typical diagram of this board there is a button blue color button let me. So, you can see there is a blue color button out here that is the user button this is the reset button which will be used to reset the device here is the connector I was talking about type A to mini B and there is a red green LED ok. So, whenever you will dump a code here through this USB you will see that this green and red LED will glow we will we will look into all these aspects. Now there is a green LED here there is a test led there is a red le LED which is a power LED which is here and these are the Arduino connectors.

So, these which will be using are all Arduino connectors and there are many other ports you can see these ports these ports are basically these port or signal connector which we can also use ok. So, you can see that apart from these connectors there are many other connectors that can be used, but in our experiment we have mostly used these Arduino connectors these set of connectors here and here we have used those. So, this is the typical broad diagram of this STM board that we will be using.

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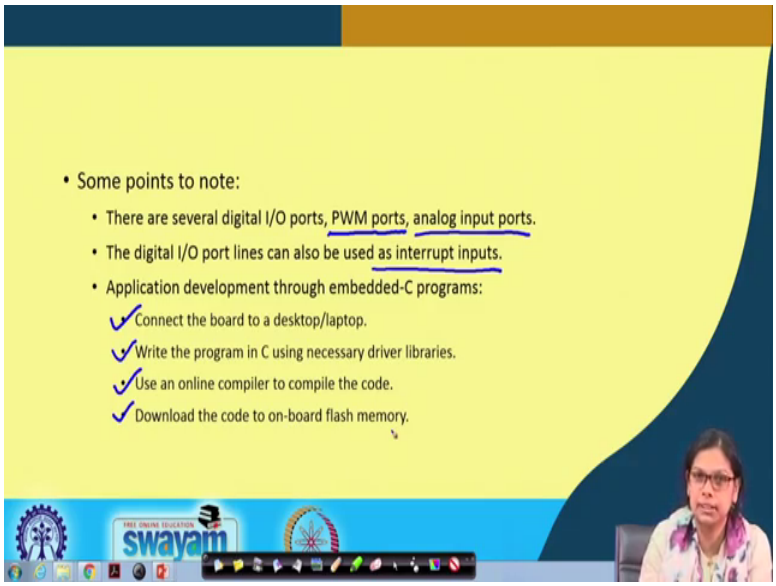

Now, at this point there are some points to note as we know there are several digital IO ports there are also PWM Ports pulse Width Modulation enabled boards and there are analog input ports. The digital I O port lines can be used as interrupt inputs as well this is already discussed in more detail it will be discussed later and for application development through embedded C programs what needs to be done you need to connect the board to a desktop or a laptop that we will be doing ok.

The first thing first I have already shown you the USB connector through that USB connector you have to connect that to either a desktop or a laptop, then you have to open the id that is there and then you need to write the program.

So, once you write the program in C using necessary driver libraries those are present, then you can use this online compiler to compile the code. Once you compile the code this particular code gets downloaded, you can find this in your download folder. And you can then copy that particular code and put it in the device and I will take you through the tour of this particular thing which I have just told you. But these are the following steps that needs to be followed when you are using this particular STM board ok.

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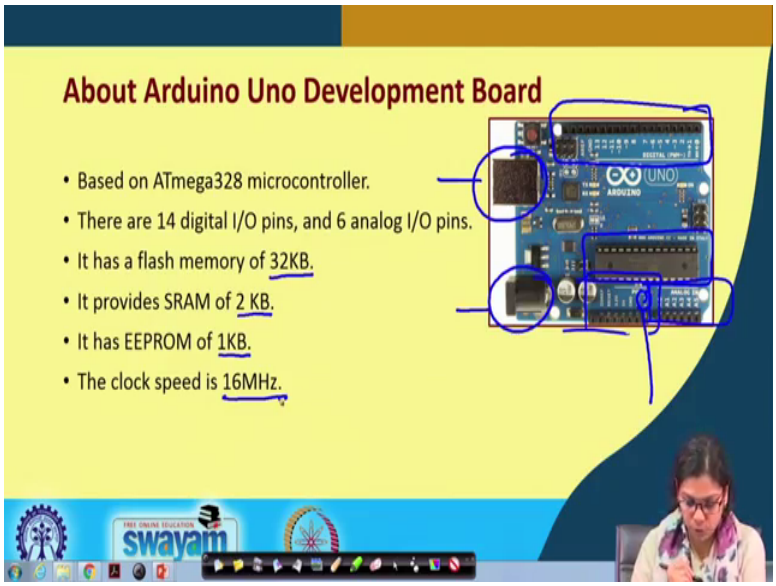

Let us now move on and I will be discussing about this Arduino UNO development board. So, this is the Arduino UNO development board you can see these are the digital and PWM ports this is the analog ports, this is for the power, this is the microcontroller chip that is there. You can use the USB connector to power it or you can also use this you can use through this 9 volt battery to power it and there is also another one here, sorry this v in basically it can be used to power it.

So, about this Arduino UNO development board as I have already told you it is based on AT mega 328 microcontroller, there are 14 digital input output pins when we say that there are 14 digital input output pins. That means, each of these pins can be programmed to use as an input pin either or it can be used for output pin. And there are 16 analog input pin, it has a flash memory of 32 KB it provides SRAM of 2 KB it has got an EEPROM of 1 KB and the clock speed is 16 megahertz. So, these are some typical features of this Arduino board.

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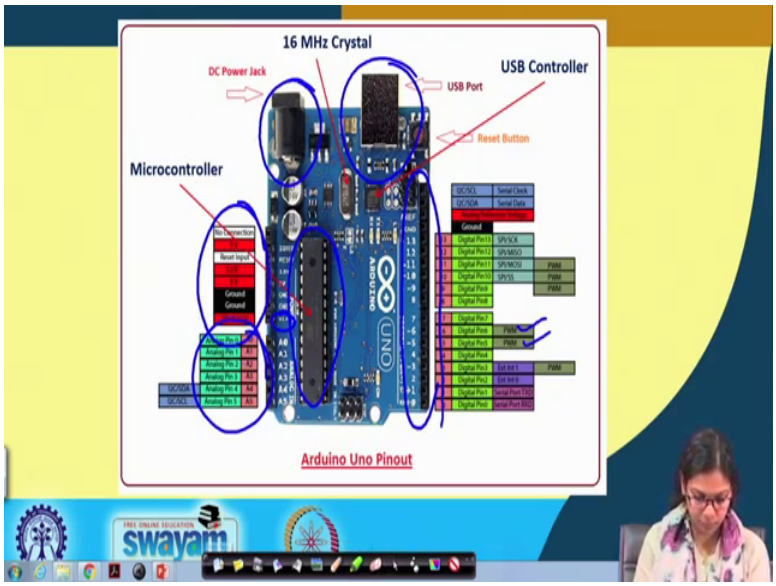

Now, let us move on this is the broad diagram. So, as I have told you this is the USB port through which you can connect to the USB port of the PC. This is the microcontroller that we are using these are the analog pins set of analog pins, these are for the power. And if you see these are digital pins, but some of the digital pins are also PWM, we will look into this specifically what is PWM?

In course of time but this is what is all about the pins of this Arduino UNO, you can see there is also a DC power jack through which you can provide you can power this entire board and as I told you there is also a v in through which it can be out.

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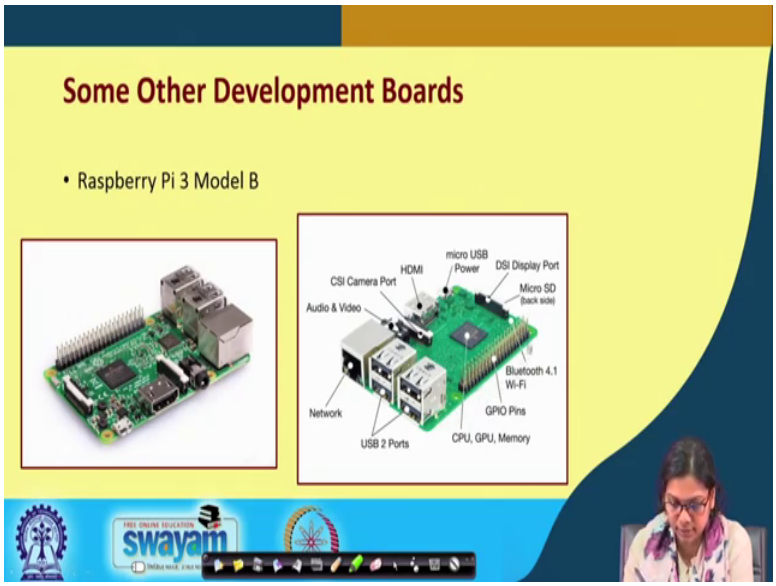

As I have already told you there are some other development boards as well one of which is Raspberry Pi 3 model which is much more sophisticated. So, typically what it has got you can see that USB these are have got two ports; this is for the network it can also process this audio and video.

So, you have this and it has got also an HDMI port there is a micro USB power point as well this is a display port. You can also put a micro SD in this back side, it is also Bluetooth enabled and this is the CPU this is the GPU the memory and these are the pins that are that can be used this is all about this port.

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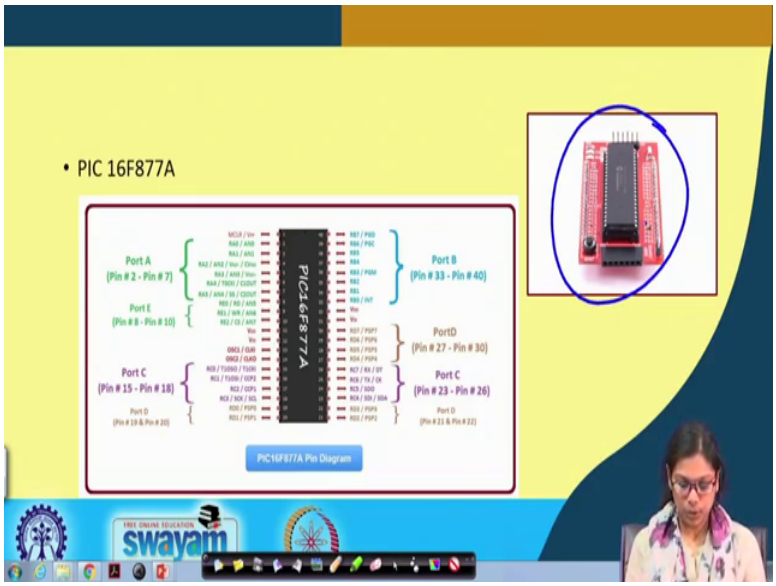

PIC board typically consists of these pins and these are some typical features this is port A; port A is from pin number 2 to pin number 7 port E is from pin number 8 to 10 and port C is there port B port D and port C. So, each of the pin has got certain functionalities and there are various features of this particular pin. So, this is a sample diagram showing PIC 16F877A microcontroller this is how it typically looks like ok.

These are the pins through which you can connect and you can do programming with ok. So, we have actually come to the end of this lecture and what we have discussed here is basically we have discussed about two important boards; one is the STM board another is Arduino UNO more specifically. But we have also given you an overview of how other board looks like. So, in the subsequent week I will be focusing on the STM board in more details.

Thank you.