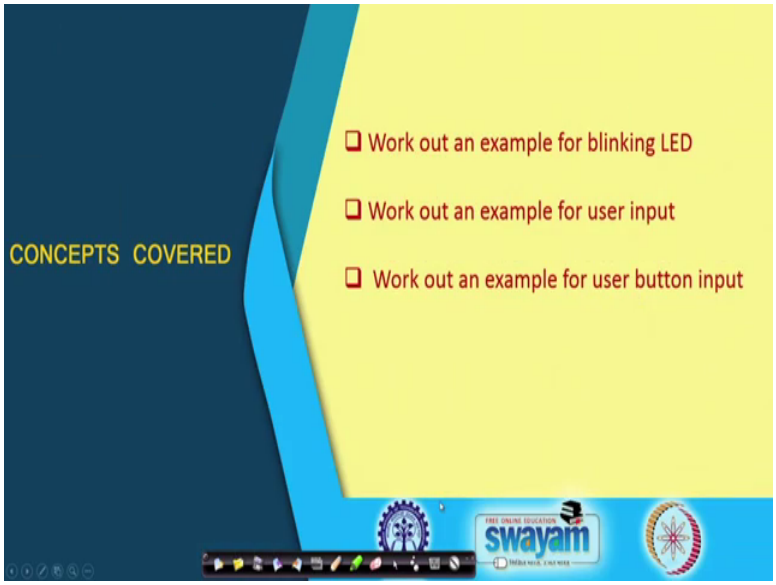
Embedded System Design with ARM
Prof. Kamalika Datta
Department of Computer Science and Engineering
National Institute of Technology, Meghalaya

Lecture – 20
Interfacing with STM32F401 Board

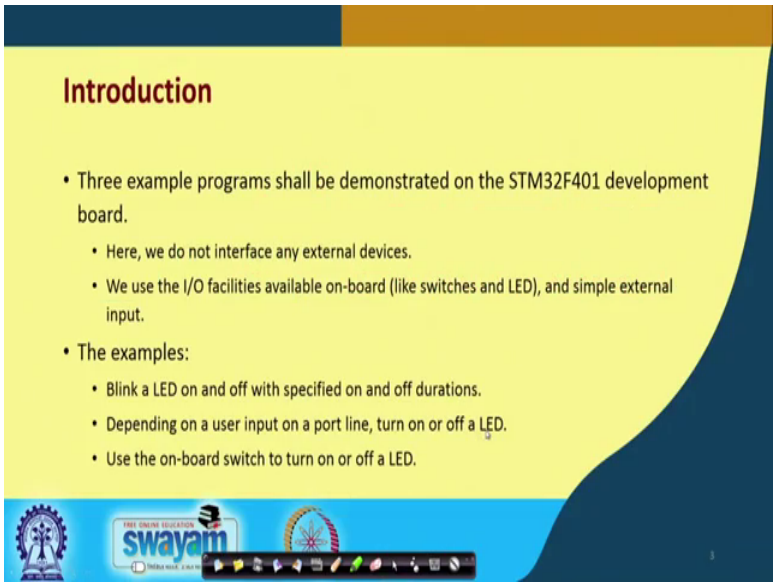
Welcome to lecture 20. In this lecture we will be showing you how we can Interface with STM32F401 Board So, specifically in this lecture I will be showing you 3 example; 3 example program in which, I will be using the onboard LED and the on board switch and I will also connect an external switch to show the input output usage of various pins, let us move on.

(Refer Slide Time: 01:03)



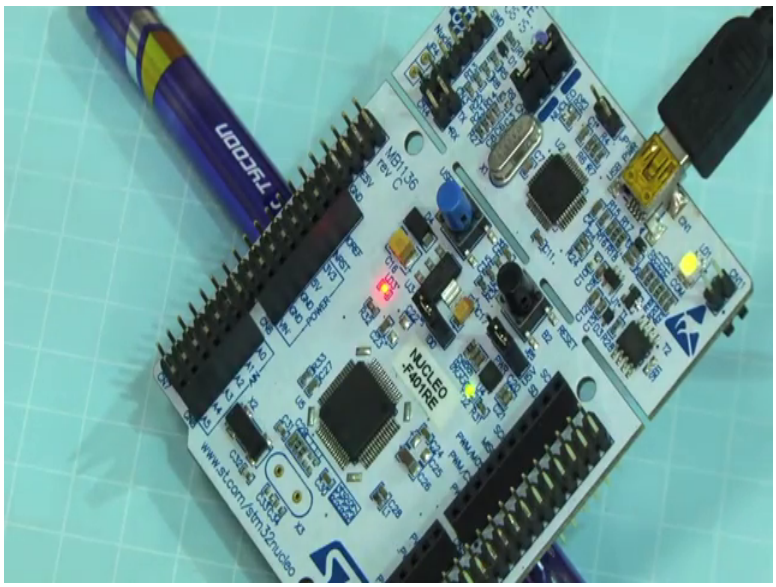
So we will be basically showing you 3 programs as I said one will be the workout example for blinking LED, the next one is an example through which we can user input and depending on the user input, a few things will happen and another one is through user input button ok. So, let us move on.

(Refer Slide Time: 01:35)



So, the 3 example programs shall be demonstrated on this STM 32F401 development board.

(Refer Slide Time: 01:48)

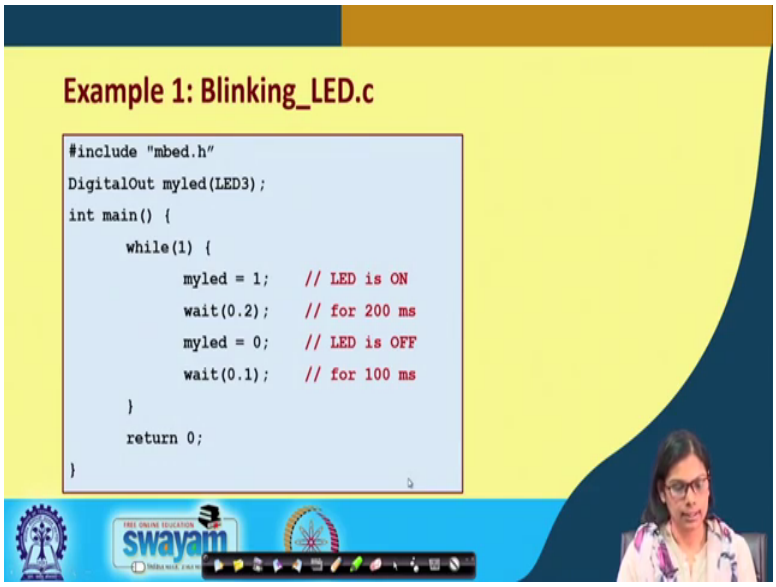


So, I wanted to show you the board ok. So, this is the board and you can see this is the onboard LED, this is one. There is one more on board LED, these are the user button and the reset button of this board and this is also on red and green LED, when we dump the program this LED will be glowing. And, these are the input output digital pins which can be configured both as an input pin or as an output pin ok.

So, the 3 example programs shall be demonstrated using the board I have just shown you and here we do not interface any external device. As I have told you only the external device will be the switch that I will be connecting; other than that we are not interfacing any other device. And, we use the IO facilities available on board like the switches, and the switches and the LED and a simple external input; that is all we will be showing.

So, the 3 example goes like this, the onboard LED will be blinked, it will blink for certain duration and it will be off for certain duration ok, this is the first one. The next one is depending on the user input on the port line and LED will glow. Let us say the LED will be glowing and when I press the switch, it will be off or the other way around. The LED will be off and when I press the switch, the LED will be on. We can do either of these two and we also use this on board switch to turn on and off the LED ok.

(Refer Slide Time: 04:00)



Let us move on. This is the first program. Now let us see how this program actually works. The first one is include mbed dot h which is mandatory for any program, this is the header file, you recall what we used to do in C programming when we write. We include certain header files stdio dot h generally the standard input output. Same way as we are using an online compiler, embed compiler you need to use this embed dot h header file you need to include that in your code. The next one is digital out.

So, we are making the onboard LED, the third one LED 3 is the one will be showing you, we are making that LED as digital output and we are writing with the name myled.

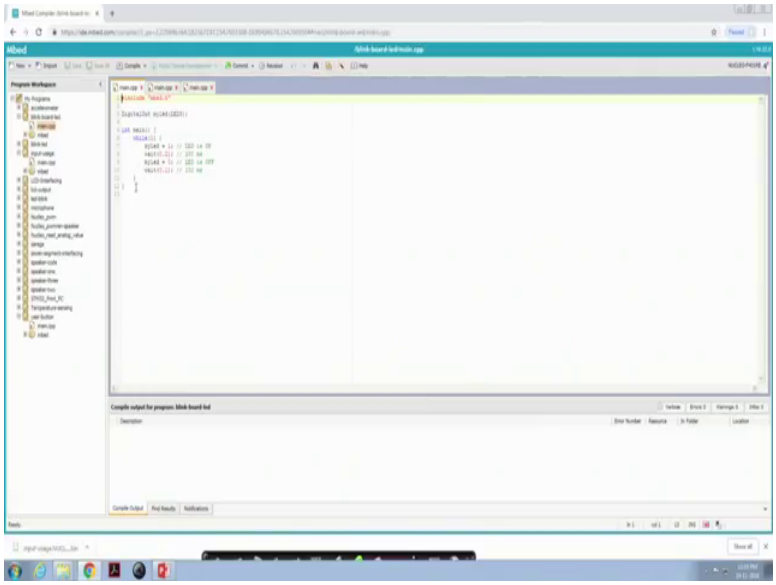
Myled is the name of the LED, LED 3 which is on board ok. This is the meaning of digital out myled LED3. There are many other ports as well, you can make that as digital out. Let us say myled12d0, myled22d1 and so on ok.

Then we start with the main. The main function is the one from where the execution starts, we all know that. So, here in the main, there is a while loop. You see in an embedded application what generally is done, as I have told you an example of a smoke detector. So, it will read certain input and depending on that input, it will perform something and that will go on happening. So, that reading process excreta will go on happen right.

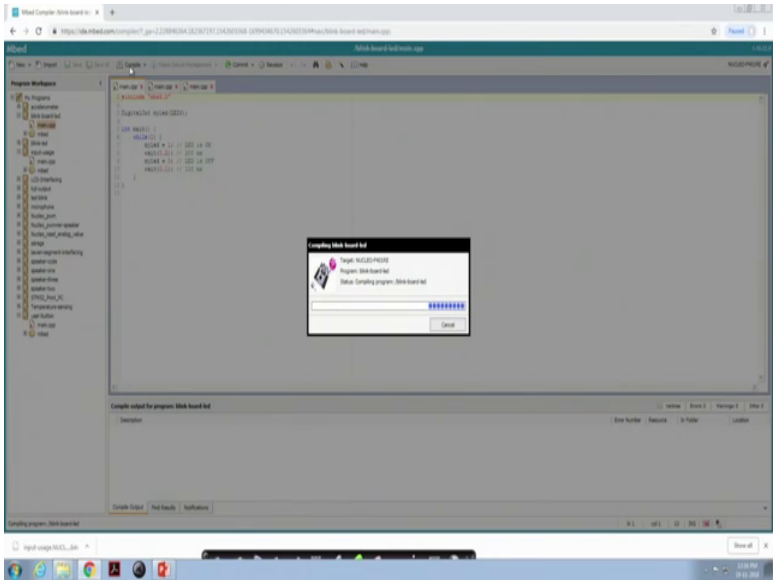
So, that is why I want this entire set of things to happen all the time, that is why it is wild one. So, wild one myled, which is nothing, but this LED 3, the name given is myled equals to one; meaning the LED will be on. When we are making it 1; meaning, the LED will be on and I wait for 0.2 seconds, that is 200 milliseconds. Then again I make myled of making by making it 0 and again I wait for 0.1 second, that is 100 millisecond and this is repeated for in an infinite loop ok.

So, these are the set of codes that are used to connect this LED 3 on board LED 3 using this object myled and I am making it on for certain period and I am making it off for certain period and this is going forever ok. Now I will be showing you this particular code in the board. You can see I have already connected through this USB, this is the USB port that I have already connected to my PC and now what I will do basically or now I will use the online embed compiler, where I will be dumping the same code, the same code just now which I have shown you ok.

(Refer Slide Time: 07:43)

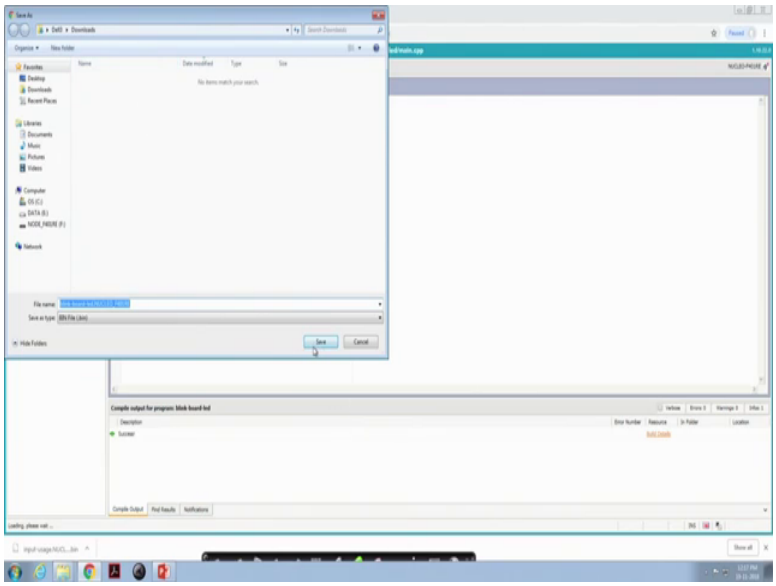


(Refer Slide Time: 07:51)

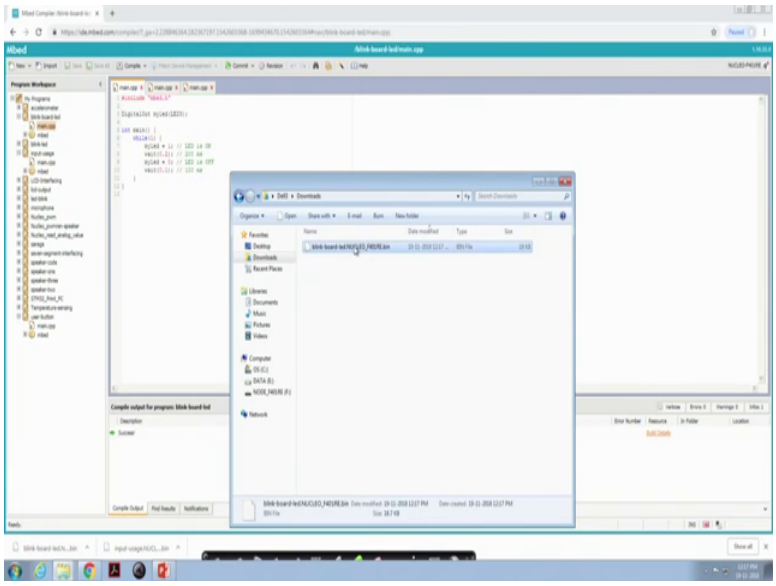


So, what I am doing here? I am compiling the code, the code I have already written the same code just now which I have discussed with you and I am extracting it, I am saving it in the download folder.

(Refer Slide Time: 08:00)

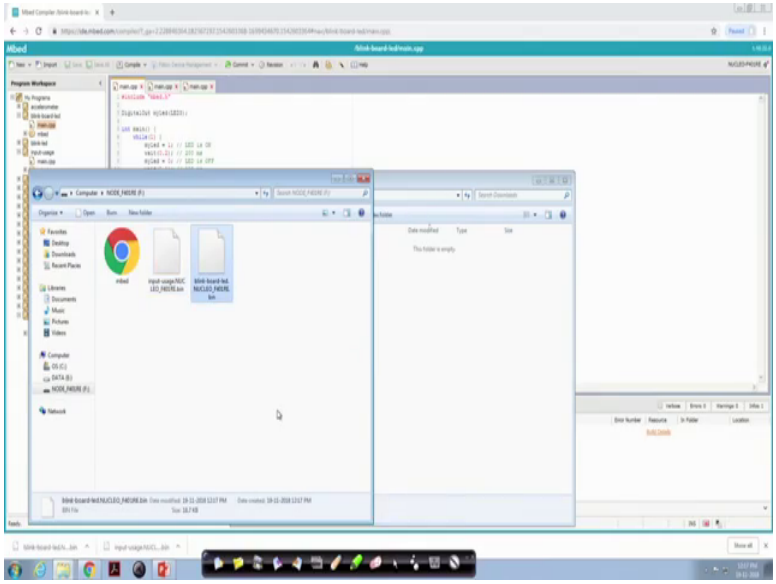


(Refer Slide Time: 08:06)



I open the download folder, I take it, I copy it which is pasted on this particular board I paste this ok.

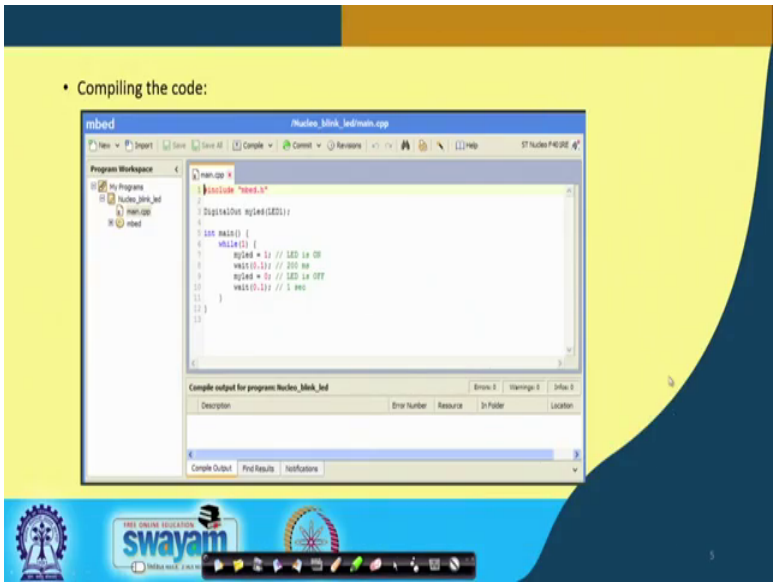
(Refer Slide Time: 08:14)



Now, you see after pasting what is happening? This is the LED 3, which is actually blinking. You can see that, this particular LED which is LED 3 is blinking. Now what I will do? I will just change the delay ok, you concentrate looking here and I will just change the delay of this particular thing; let us say oh the LED will glow for 2 seconds and the LED will be off for 1 second let us say.

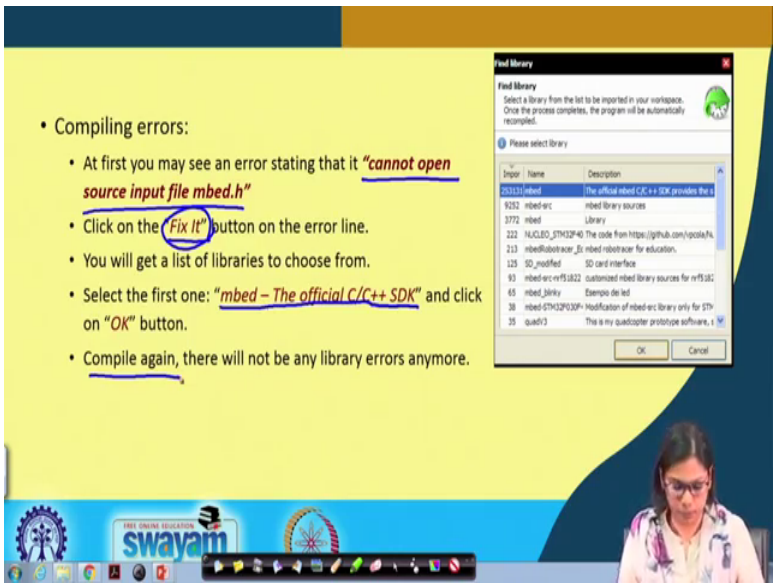
And I again recompile the code, I am recompiling the code, I save it and then I copy it to the nuclear board, I dumped the code into this board. Now you see the LED is glowing for 2 seconds and off for 1, it is glowing for 2 seconds again off for 1. So, that blinking speed has changed ok. So, you can do variety of example using this port. This is a sample example I have shown, how do you use the onboard LED. This is the onboard LED that is blinking for, it is on for which is on for let us say 2 second and off for 1. Again you see it is on for roughly 2 second and off for 1 second ok.

(Refer Slide Time: 10:23)



So, coming back to the program, this was the program and you can change it accordingly to move on.

(Refer Slide Time: 10:32)

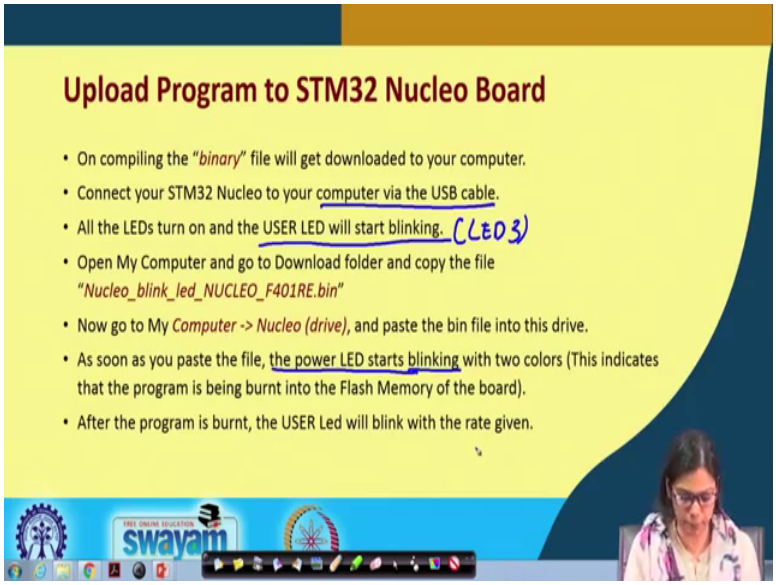


This is one of the error, that you might get when you do it for the first time ok. You can see this error, the error is like cannot open source input file embed dot h. Then what you need to do is that, you need to click on fix it. You will be seeing this button in the down corner and the button on the error line, you click on that fix it and you will get a list of

libraries to choose from ok. And in that case you have to select the first one, which is embed the official C C plus plus SDK.

So, this you must remember that once you are you are doing it for the first time, you might get all these errors, like I told you in the previous slide regarding and in the previous lecture, regarding you have to install a particular driver for it, driver STM driver and then you have to check whether the driver is installed properly or not. In the same way, in this case you have to do this particular thing, like you will get this error, if you get this error please do the needful select this embed official C, C plus plus SDK and click on button and again you compile it and you will see that there will not be any more library errors ok.

(Refer Slide Time: 12:00)



Now, how do you upload the program? These have probably already shown you, how you have to do this, on compiling the binary file this will get downloaded to the computer. Then we need to connect this STM Nucleo to your computer or laptop and via this USB cable and all the LEDs turn on the user LED will start blinking because, this user LED that is LED 3 is the user LED which will blink for certain period and it will be off for certain period.

This is the program and now you go to my computer nuclear drive and paste the bin file into this drive, which I have already shown you, as soon as you piece that file, you will see that the power LED starts blinking. I will show you for the next program if you have

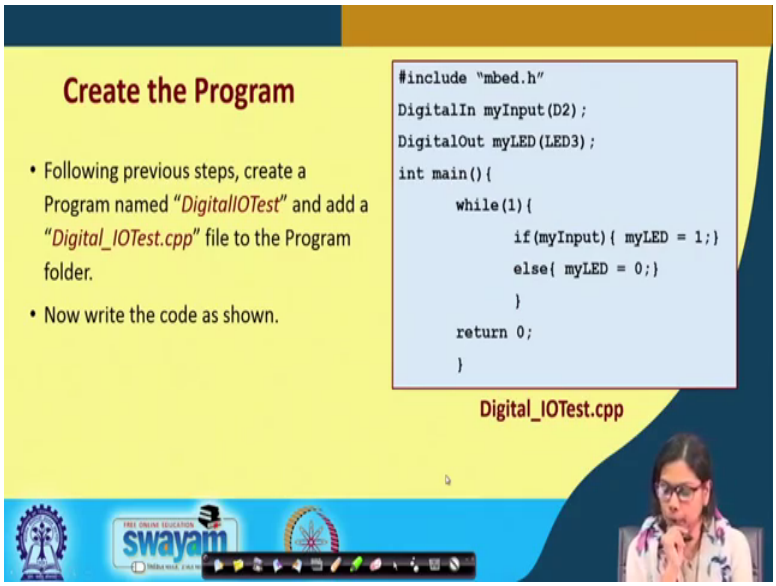
not noticed it, then I will be showing you for the next program and with 2 colors. This indicates basically that the program is burned into the flash memory ok. The program that we have written, we have compiled, we have downloaded it. Now we are putting it into this device ok, that is shown with that red and green LED. And after the program is burned the user LED will blink with the given rate that is there.

(Refer Slide Time: 13:37)

Now, I will move on with example 2 testing for I O pin configuration. In this experiment we try to provide a digital input to the microcontroller. Now how do we provide this digital input to the microcontroller, we will be using a switch, a matrix switch where we will be using one individual point, one individual switch of that one and check the response by blinking again the same LED 3, which is present on board. We are not using an external LED now.

So, well need a single you can also do using this, where a single strand of small where and you connect with five volts supply and ground with the board and will use this power output of the boat to take the digital input. This also you can do, but alternatively we have used this switch, matrix switch where I will take one individual switch to make that input to one of the input port of that board ok.

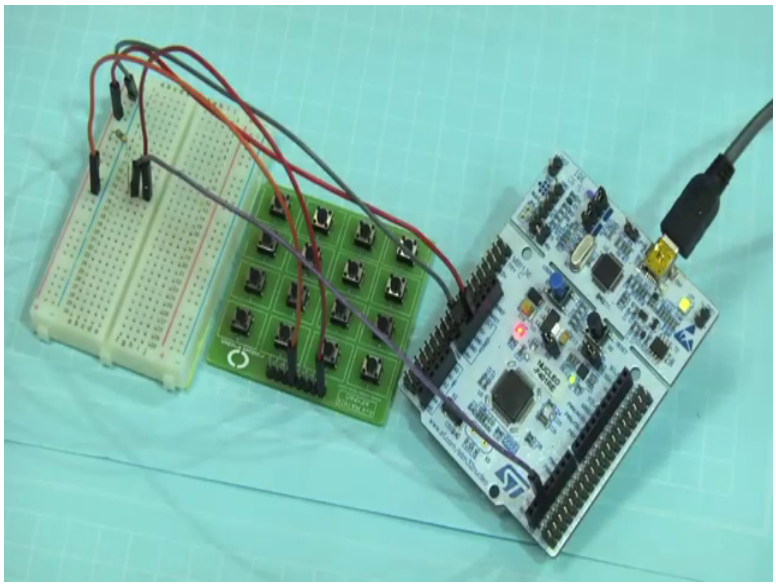
(Refer Slide Time: 14:50)



So now, how the program it will be. Here as I told you, I am making one of the input output port as input port. So, we have to do DigitalIn the object is my input. So, you have to use my input in your program and which port the D2 port is made the digital input port of the board and digital output will be the same LED 3, on board LED. What this code is actually doing?

So, this is main, this is while 1, if my input; that means, if this is 1 basically myled will be 1. We need to check what it is receiving initially, if it is receiving 1, then the LED will glow, else when the switch is pressed, then it will receive this my input will receive 0. Then myled I will make it off, but now earlier I have put up a program which was continuously doing the same thing, but now I am doing based on the switch input ok. If the switch input, we have not pressed the switch then it will the LED will glow, if we have pressed the switch the LED will not glow ok.

(Refer Slide Time: 16:31)



Now, we will see how the code works. This is my switch basically, this is my switch. Let me tell you what I have done. If you see this is C1, this is R 1 ok. So, this is row 1, this is column 1 ok. This is row 1, this whole 1 is the row 1 and this is column 1; similarly, this is row 2, this is column 2 and so on. I am using row 1, column 1 means, this particular switch, the first one, the first one i am using as a input switch ok.

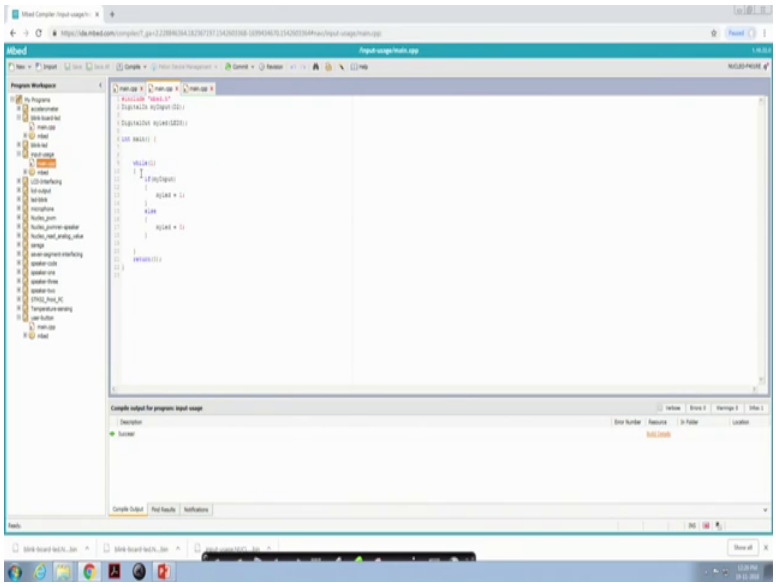
So, what I have essentially done in this particular code in this particular connection first let us understand. 1 port, so this is 1 is my BCC, which is connected to the port BCC 1 2 3 and 4 and this is the ground which is connected to port ground ok and now you see one thing, how this connection goes. One end of the switch is connected through resistance to BCC, this is the BCC, another end of the port is connected to another end of the port is connected to ground, you see this is the ground. This particular line if you see this one is the ground and minus and this one plus is the BCC ok.

And from this common point am taking input. So, this bcc point has come here and the ground has come here and one part of one point of the switch I am directly connecting to ground, another part of the switch I am connecting through BCC, using this resistance ok. And from where I will be taking the input, you see I will be taking the input from this particular point, this particular point ok. So, from here I take the input to port D 2 ok.

So, what value it will receive initially it will receive close to 5 volt ok. So, after getting the resistance with the voltage drop etcetera, so this is all about the connection, there is

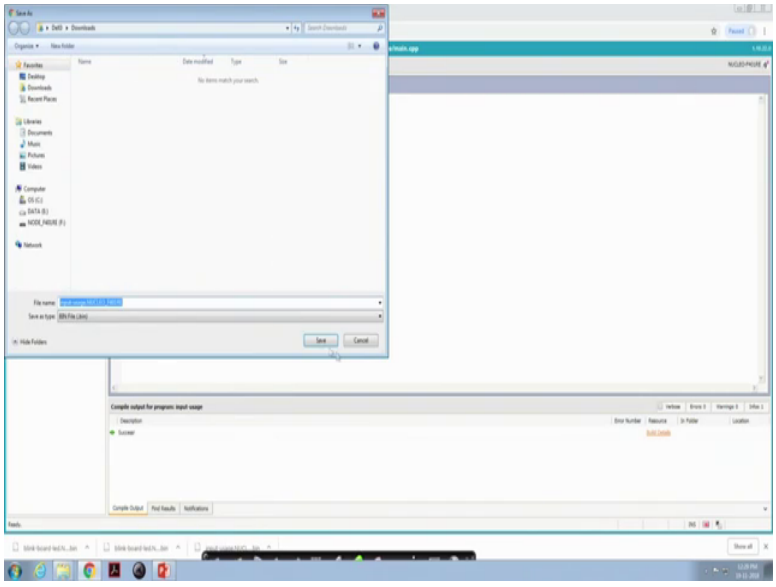
nothing else that we are doing. Now we will be using this instead of the user button of the board, instead of these buttons we will be using this particular switch ok, instead of these user switch we will be using this switch. Let me first dump the program.

(Refer Slide Time: 19:36)



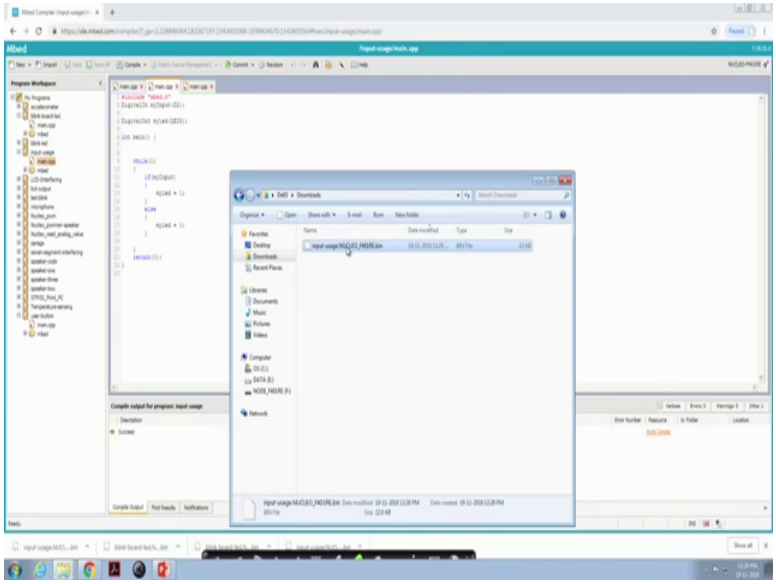
This is input usage, so this is my code the code just now which I have discussed with you.

(Refer Slide Time: 19:53)



I will compile it, I will compile it, I have downloaded it and I will paste it.

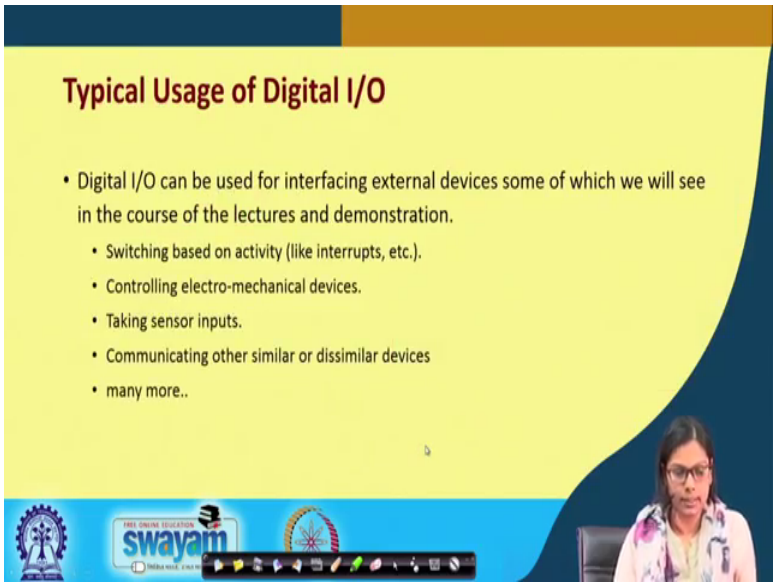
(Refer Slide Time: 19:59)



But while pasting it, I will show you this board again, because then you can see that this particular LED will be blinking, if you can see that ok. So, let me try to show you, I will I will now copy, I will cut here and I will show you here. Can you see that? It was glowing ok. Now as you know that this switch is now getting 1 value, because from where this input is going, from this point the input is going to D2 ok, from this point the input is going to this D2 ok.

So, it is receiving 5 volt, that is why this on board LED if you can see it is glowing, this is the onboard LED it is growing, but now I will press the switch, you see, when you press the switch it is not glowing. What value it is receiving now it is receiving a 0 value, again I release it, you see the LED start glowing ok, again I off it, I click it; that means, it is getting a value 0, it is off again I release it, you can see this again glowing. So, using this particular button, I am making this LED on and off fine. So, this is this particular program which i have already shown you.

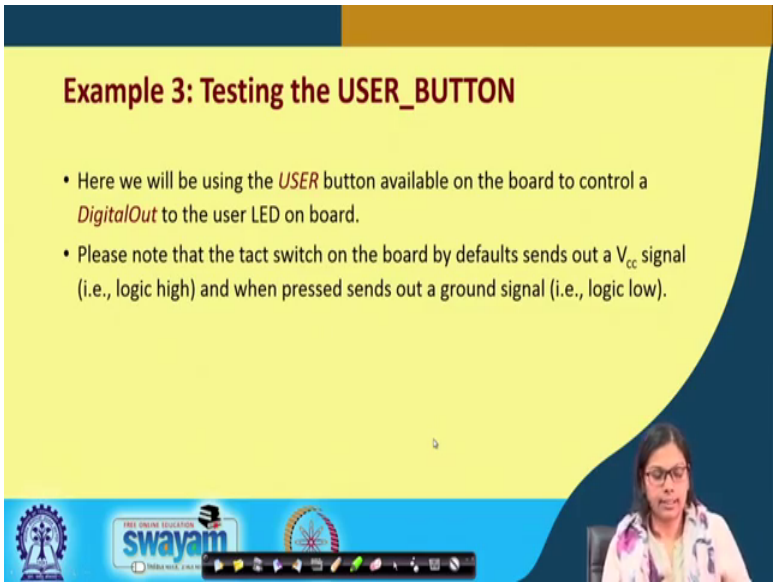
(Refer Slide Time: 21:36)



Now, let me move on this typical usage of digital IO. So, this digital IO can be used for interfacing external devices, some of which we will be, will also see in this course of the lectures and the demonstration. And this is basically switching based on activity. So, like something like interrupts will be looking into or controlling an electromechanical device ok.

Even for taking sensor input, if I press the button then only it will take. You can also try out doing various other things. Communicating other similar or dissimilar devices and there could be many more usage of this IO pin ok.

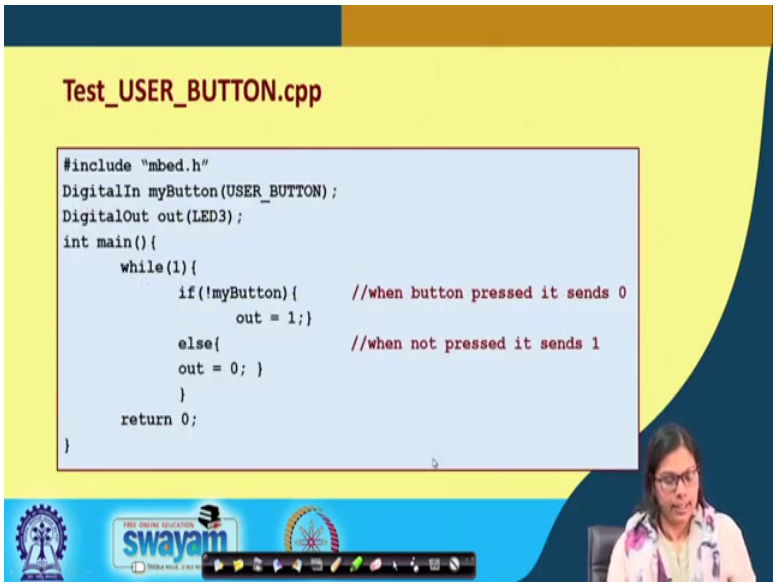
(Refer Slide Time: 22:23)



The last example is testing the user button. We have also seen that there is an onboard user button in this particular board. So, here we will be using that user button available on board to control a digital out to the user LED on board. So, same thing but now based on this user button I will make changes to this onboard LED ok.

Of course please there is something you must note that this tact switch, the switch which is on board by default sends out a V CC signal. So, when it is not pressed, it will send out a 1 signal and when pressed it sends out a ground signal; that is logic 0. So, this particular thing, we have already seen in the previous example with the switch I have already shown you and this will be showing the same aspect, but with the on boots switch ok.

(Refer Slide Time: 23:35)



Now, let us first see the program. This is the DigitalIn, now I am DigitalIn making that user button, this is the onboard user button and the name which I am giving for using in my program is my button and digital out is the same LED on board LED, which I have given the name out in this case. Let me see what we are doing it. If not my button, what I said when the button is pressed it will send the 0, but when the button is not pressed it will send out a 1. If not my button; that means, if 0; that means, the button is pressed then out will be 1, else if the button is not pressed out will be 0 ok, and return 0 ok.

So, this is a simple code, where instead of that that other button we are using the onboard button that is the user button and the code goes like this, if not my button; that means, if this is 0, then out which is the onboard LED will be 1; that is it will glow ok, else it will not glow ok. So, I will show you now the code for it. Let me this is the user button, so I will just, I will just dump the code, which I have just discussed. I will just copy it and we will paste it and now you can see that it will start glowing yeah that LED ok.

Now, this is the user button, the LED is not glowing but when it is pressed it is glowing because in the code it was if not my button, then it will glow, I release it, you can see it is not glowing. This is the LED I am talking about, when it is pressed it is glowing, I release this it is not glowing. Again I press, it is glowing, again I release, it is not glowing ok. So, this is the one I am showing with this particular onboard LED. The simple code that I have just shown you is there ok.

So, these are the few experiments I have shown you in this particular lecture where I have shown you 3 codes basically one for blinking the LED, one for how will you provide user input through some switches. Here I have used one of the matrix switch and how you can use the onboard switch, these are the 3 programs that have you shown.

Thank you.