## Course Name: Engine System and Performance Professor Name: Pranab Kumar Mondal Department Name: Mechanical engineering Institute Name: Indian Institute of Technology, Guwahati Week - 06 Lecture – 19

## Lec 19: Key elements of ECU: Microprocessor and Memory chips

I welcome you all to the session on engine system and performance. Today, we shall discuss the ECU. We have already studied this, that is, the electronic control unit or engine management system. But today, we shall discuss the key role of this particular unit, and in this context, we will see the key elements of this unit as well. So, the heart of an ECU is the microprocessor or CPU. So, the microprocessor or CPU is the heart of the electronic control unit, and this CPU or microprocessor is a solid-state device that controls the information flow to the computer.

A set of information is designed into this microprocessor to tell it what to do. Following this program—that is, a set of information, which is also called a program, designed into this microprocessor—and following this program, the microprocessor performs calculations and then makes decisions to do certain things. So, today we shall try to discuss this particular unit or element of the electronic control system or engine management system, and then we will see how the ECU gives output to several parts of the engine components, receiving some signals from the sensors.

So, following the program, the microprocessor performs calculations and makes decisions on what to do and what the output should be. So, if we now look—rather, we shall try to draw the key elements of the ECU, that is, the electronic control unit. If we draw it, as I said, the microprocessor is the key or heart of the CPU, receiving some input signals. It will give some output. The microprocessor cannot store data or information, but it receives some input signals, typically those signals coming from different sensors, and those are electrical signals.

The microprocessor should do some calculations, and then we will decide what to do next. So, the microprocessor is designed with a set of information, which is also known as a program, as I mentioned earlier. This microprocessor cannot store information or data for decision-making, so the output is the decision it needs. This particular unit, the key unit of the ECU, the microprocessor, needs access to a great variety of information or data because it cannot store information or data. That information and data are stored in these two memory chips. So, this is a memory chip. This is ROM. And another memory chip is RAM. So, this is also a memory chip.

This microprocessor cannot store information or data, but it needs access to a great variety of information data to make decisions. That information or data includes specifications, formulas, etc. Now, what we can see, this information or data is stored in these two memory chips. One is RAM, and another is ROM. So, what is RAM? RAM, that is Random Access Memory. While ROM is read-only memory.

So, these two are the memory chips which are there with the microprocessor to store information or data. Now, as the microprocessor cannot store information or data, but it needs some information to make decisions based on the inputs. Essentially, those are electrical signals. So, microprocessors should have a provision to get some information or data, which are nothing but specifications, formulas, etc. So now, these two chips, let us discuss the difference between them. So, RAM and ROM. What are the differences?

So, these memory chips may be volatile or non-volatile. What does it mean. So, if we go to the next slide, memory chips may be volatile or non-volatile. So, if we go to the next slide and let us discuss or elaborate more on this. A volatile memory stores information as long as the battery is on. Battery power is available to it. So, characteristics of this particular memory chip, that is RAM and ROM, and that is why we are first writing what is a volatile memory because memory chips may be volatile or non-volatile. So, this is the keep-alive memory. This is also known as KAM, is a volatile memory.

So, if the power is lost, battery power is off, or the battery charge is low, then all information will be lost. So, this is the volatile memory. So, all information in the memory chip will be lost if the battery is disconnected or the battery charge is low. A non-volatile memory, on the other hand, you can understand from the definition itself, is ROM, read-only memory.

So, a non-volatile memory is ROM, read only memory and the it is reverse and the information stored in it and the information stored in it is not lost even when battery is disconnected. So, this is the non-volatile and volatile memory. I mean the difference between volatile and non-volatile memory chips.

So, now let us discuss about briefly about the read only memory and then we shall discuss about random access memory. So, another important salient point of this memory chip that is ROM. Particular salient point then we shall discuss. So, if I write in a bullet

point that some ECUs have removable chip called Programmable read-only memory (PROM). So, this particular ECU have chip, memory chip, which is already programmed, with programmable chip. But the question is, the program cannot be altered. Once the chip is programmed, the program cannot be altered. If we need to change the PROM, we can change.

which is programmed differentially. So, that is important. So, once programmed, a PROM cannot be changed. However, it can be replaced by another PROM which has been programmed differently.

The microprocessor will look at the information from the engine sensors and compare it or them. To the read only memory data, to make a decision on what to do next. So, this is very important kind of. Put it in a box that this is how micro processor tries to read data from memory chip.

So, it will look at the information from the engine sensor essentially ECU will receive some input from the sensor those sensors will be the input to the microprocessor and microprocessor on receiving some input from the engine sensor or sensors they will receive some input and then compare that information or compare that particular information to the ROM data. Because in ROM there is already some program data, some stored data and then compare and then we will take a decision what to do next.

Now let us look into another important type that is random access memory or RAM. So, if we go to the previous slide, here, random access memory. The first point is the RAM or Random-Access Memory stores information temporarily. As long as the ignition key is on, the microprocessor can read information. The second is, the microprocessor can read information from the RAM and then erase it. Write new information in it. So, the microprocessor can read information from the RAM will store information temporarily as long as the ignition key is on and then the microprocessor can read information from the RAM, then erase and write new information in it. So, basically that RAM will store information temporarily as long as the ignition key is on and then the microprocessor can read information from the RAM, erase it, and write new information. So, that is how it works. The next salient point here: the RAM stores information from the sensors, the results of calculations, and other data that continually changes. The last important point that I will write about this chip is: when the engine is started. So, that last point is very important because if the engine is turned on. So, if we go back to the previous slide, we have written that RAM will store information temporarily as long as the ignition key is on.

So, when the ignition key is on, that is, the engine is in the on condition, then the RAM will store data temporarily and then the microprocessor can read information from the RAM and then erase and write new information in it. So, the engine is running. So, continually, the microprocessor will read information from the RAM and then erase and write new data. If we go to the next slide, the RAM stores information from the sensor, the result of calculations, and other data that continually changes.

So, that means random access memory is something you can access randomly. The microprocessor can access this data randomly. So, it will change continuously. Now, when the engine is turned off, then the RAM data is erased because it has no meaning of storing the data, and the data will not be of any use the next time the engine is started. So, this is all about two different types of memory chips, which are very important for the microprocessor's functioning, and the microprocessor is an important element for the ECU.

So, we have studied about sensors and we have seen that typically, the input to the sensors or a sensor is a physical variable. And the output from the sensor is an electrical signal. And that electrical signal will go to the microprocessor. And the microprocessor will give some decision to the ECU about what to do next. either analog or digital.

Now, typically for the modern engines, digital circuits, digital signals are replacing the analog signal in the electronic control or electronic automotive system. So, the difference between analog and digital signals is very important to know for the electronic circuit, which are typically used in the ECU. So, I will discuss this particular, this is very important to know because without knowing about analog and digital signals we cannot go for further discussion on electronic circuits but there is an important difference between these two signals analog and digital signals it is recommended that we shall start our discussion with the analog signal because it is very intuitive to understand the analog signal because digital signals are more complex to understand but we shall discuss about this particular topic that is the analog signal and then digital signal and then difference between these two in the next class.

So, with this I stop here today and we shall continue our discussion in the next class.

Thank you.