Fundamentals of Automotive Systems
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Lecture-01
Course Overview and Classification of Internal Combustion Engines-Part 01

Greetings, so welcome to this course on fundamentals of automotive systems.

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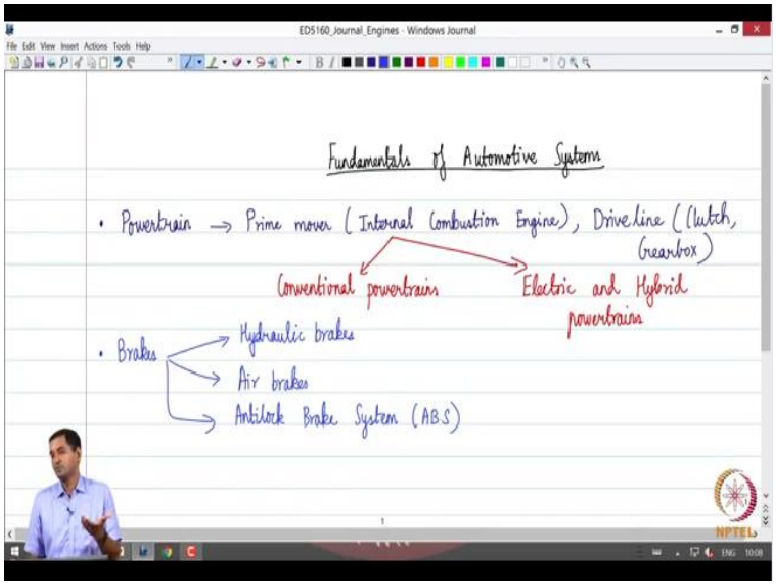

So, we will start this course a broad overview of what we learn and then let me will go to the first module okay. So, what is the objective of this particular course, you know like as the title mentions, the broad objective of this particular course is to gain a fundamental understanding of various systems that constitute a typical automobile okay. So, as part of this course, we are going to learn about the automotive power train.

We will learn about existing power trains which are typically called as conventional power trains. So, these include the prime mover which in conventional vehicle is an internal combustion engine typically abbreviated as an IC engine, okay. Of course if you take electric hybrid vehicles you will also have an electric motor which may supplement the IC engine or in a pure electric vehicle an electric motor will do the prime movers job.

So, this includes a prime mover, it will also include the drive train or drive line which essentially consists of the clutch and the gearbox. So, as part of this course, we will look at both conventional engines, IC engines. So, this is something we are going to spend quite a bit of time in this course. So, we will look at conventional power trains driven by IC engines. We will also look at alternate power trains okay.

So, which include electric and hybrid power trains. So, through that discussion we would identify the pros and cons of each class of power trains and we would also do a preliminary analysis of both okay. So, that is one important module in this particular course. So, the next module will be on brakes, okay. So we would look at both hydraulic brakes, which are typically used in light motor vehicles like passenger cars, you know, like even like commercial vehicles and so on.

We will also look at air brakes, okay, hydraulic brakes, and air brakes that are used in heavy road vehicles like trucks and buses and so on okay, so we look at the construction operation and features analysis, and so on. We would also look at, you know, concepts behind how the brake system performance affects vehicle stability. And that will motivate us to learn about anti lock brake systems okay, abbreviated as ABS okay.

So we will also look at the philosophy behind ABS, how does it work, how is it released in practice and what are the critical aspects that an automotive engineer should be aware of as far as it is operation is concerned, that is also something which you know the next module will be on steering okay vehicle steering.

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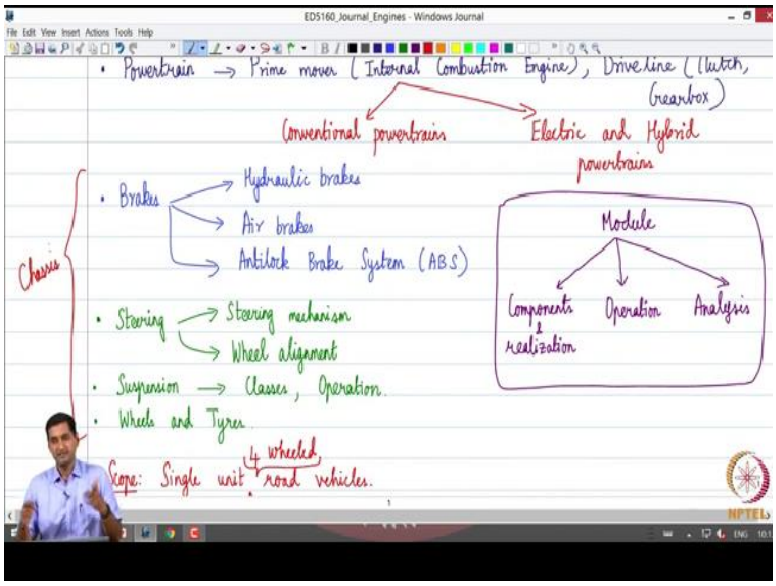

So which will essentially look at various steering mechanisms. So, as we know you know a steering system is very important to ensure that we can orient our vehicle in the direction that we want, right. So, if you want to turn, if you want to control the heading of the vehicle, this becomes very important. So, we are going to look at the automotive steering mechanism. We are also going to look at as part of the steering and the suspension module in important notion which is called a wheel alignment, okay.

The steering and the suspension in the wheel you know like put together should be oriented and assembled in a certain way and there is a set of parameters which essentially quantify this alignment between the various systems, which is typically studied under what is called as wheel alignment okay, we learn what is wheel alignment, what are the important parameters that characterize wheel alignment and what is the impact on the automobile as such, right.

So, we will also look at vehicle suspension once again, our different classes of vehicle suspension okay and what to say how they operate and what are the critical attributes and so on okay. So, when we look at suspension, we will also look at vehicle assemblies and tires okay. So, because these are also extremely important, how the pneumatic tire is interfaced between the vehicle structure and the road becomes extremely important.

Because as far as a road vehicle is concerned, all the forces that are transmitted on the vehicle or through the contact between the tire and the road surface. So, a basic understanding of this interface and the tire on the wheel assembly becomes very important. So, we will also look at that aspect okay. So, our overall objective of this course is to gain an understanding primarily of these are systems and in every module there are going to be 3 broad classes in which I would segregate the information into.

So, in each module we will first look at the components that make up the system okay and the realization of the system. So, what do I mean by that you know for example, if you start with the internal combustion engine, we are going to look at what competence constitute the internal combustion engine, how are they released in practice. So, that is something which we will start off with. Then we will also look at how do they operate.

So, how does each system function, how do various components function and interact with one another to achieve the desired task, okay. So, that is something we will look at, then we would also do analysis, preliminary analysis of each system you know like based on fundamental engineering concepts. So, this would be the broad way in which we will organize the material right. And the scope of this particular course would be primarily on what are called as single unit road vehicles.

So, essentially we will be looking at road vehicles you we will not be focusing on off road vehicles in this particular course. So, on road vehicles and what is meant by single unit it is like a typical passenger car or a truck or a bus right. So there is no articulation, you know, like in a tractor trailer combination. So we are going to look at single unit vehicles. And of course by and large, we are going to look at single unit, 4 wheeled road vehicles okay, so just to narrow down the scope for their own.

So that is going to be the scope of course, okay. So the broad flow of this course is going to be in this manner. So we will start with the power train, we learn will spend quite a bit of time on understanding auto to power train, then we will go to what is called as the chasses get typically,

you know, you put everything together not like people call it as the automotive chasse, right. So essentially we are going to focus on these aspects, okay as part of this particular course.

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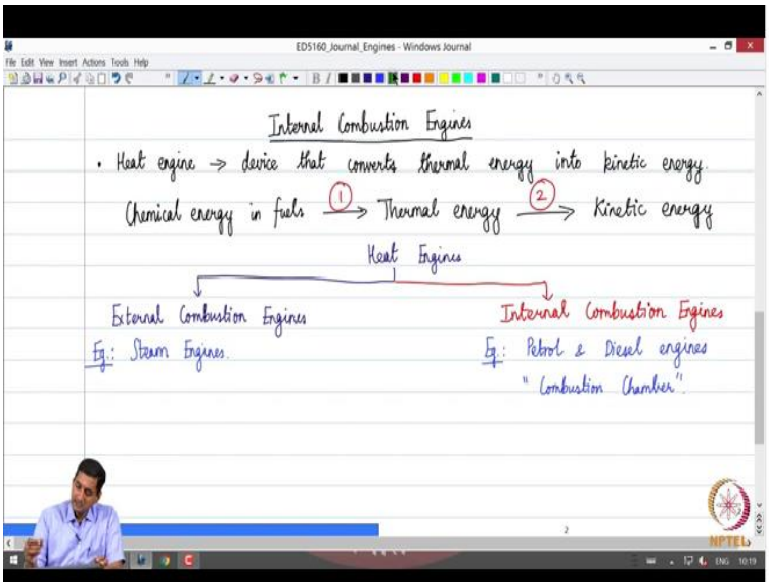

So, to begin with, let me start with internal combustion engines. So we are going to look at the power train. First let us look at the primer over. So, we will learn about internal combustion engines their types, their components, their operation and analysis and certain important features okay. So, an internal combustion engine in general is heat engine. So, what is a heat engine, a heat engine is a device that converts right thermal energy into let us say by and large, you know like kinetic energy.

So that like we can get what is called mechanical work, right. So, that is how people typically define a heat engine. So within the scope of our discussion now we are looking at a device that converts thermal energy obtained from various sources into kinetic energy, it is an energy conversion device right. So, as far as internal combustion engines or automobiles are concerned, what typically happens is the chemical energy stored in fuels is first converted to thermal energy by the process of combustion right.

And then converted to kinetic energy right by using appropriate mechanisms and which is used to propel the vehicle right through the wheel assembles. So, that is what happens in a typical automotive engine right. Now, if you look at broad classifications of heat engines depending on

the attribute that we utilize heat engines can be broadly classified based on how combustion and this energy these 2 energy conversion process happen as what are called as external combustion engines and internal combustion okay.

So we already looking at internal combustion engines but let us look at the difference between the 2. So, what do you think is the difference between the 2 based on the way in which I have written down this energy conversion process, So that is right. So if you have if you call this as energy conversion process 1, this has energy conversion process 2 in an external combustion engine these 2 energy conversion process happens in different components right or different places, right.

So let us say a good example of an external combustion engine. And let us say we take our steam engine, right, so I am sure all of us would be aware of steam engines. So in a steam engine, what do we do let us say we convert water to steam in a boiler by burning some fuel, right. And then the steam is transported from the boiler, let us say to a steam turbine, and there the terminology of the steam is converted to kinetic energy of the what say turbine competence the turbine rotor right.

So, you can see that these 2 energy conversion processes happen in different locations right. So, that is an external combustion engine. On the other hand in an internal combustion engine the 2 energy conversion process happened in the same chamber right. So, our example is a typical petrol and diesel engines right. So what we use in typical automotive applications, you know, like form come under what are called internal combustion engines, okay. So, both the energy conversion process happened at the same chamber, which is typically called as the combustion chamber, okay.

What people call as a cylinder or the combustion chamber is a place where this energy conversion process, these 2 energy conversion process take place okay. So I hope the difference is clear right.

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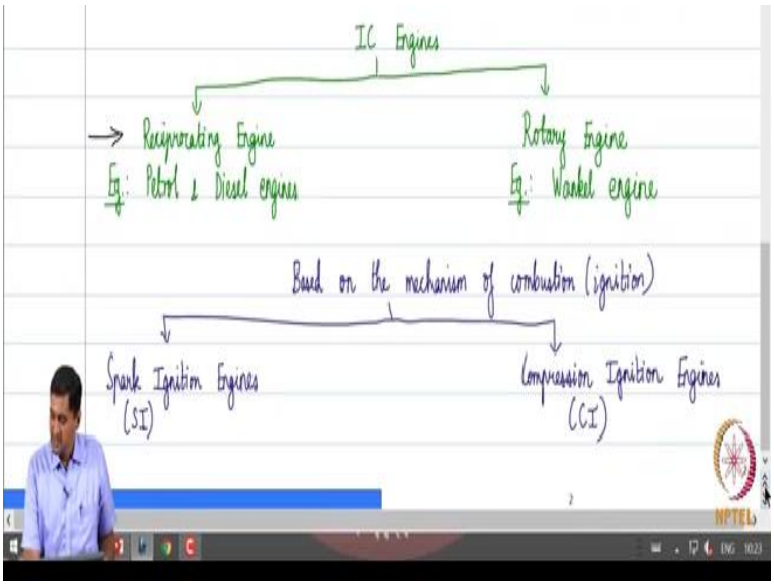

Our scope is going to be on internal combustion engines and internal combustion engines which are abbreviated as IC engines, IC standing for internal combustion okay, some people will write it as ICE okay. So they can be classify based on the type of mechanical motion that is used in the energy conversion process to there is how thermal energy is converted to kinetic energy, okay. So if an IC engine uses reciprocating motion to convert the thermal energy into kinetic energy, then it is what is called a reciprocating engine or a reciprocatary engine okay.

So, if a rotational motion is used to do this energy conversion that engine is what is called rotary internal combustion engine, okay. So that is the difference okay, depending on how the second energy conversion process happens. So, here reciprocating motion is used to do the energy conversion process from thermal energy to kinetic energy in a rotary engine a rotary motion is used to convert the thermal energy to kinetic energy, okay.

So, reciprocating engines are our typical one second petrol and diesel engines, you know like most petrol diesel engines use a piston right in the combustion chamber to essentially convert the thermal energy into kinetic energy. You know, like basically do you have translational motion which is essentially repeating right now that is a reciprocating motion right. So, a common example of a rotary engine is what is called a Wankel engine okay.

So, where rotary motion is used to achieve this energy conversion process okay. Our focus will be on reciprocating engine. So we are going to look at internal combustion engines, we are going to look at reciprocating engines okay. So I am going to classify engines based on other attributes now you know shortly you know like then we will see what will be the scope of our discussion right. Then you know based on the mechanism of combustion or I would say ignition okay we look at all these terms later on okay.

So we can have what are called as spark ignition engines and compression ignition okay. So, spark ignition is typically abbreviated as SI, compression ignition is typically abbreviated as CI. So, I would expect you to know what an SI engine and what a CI engine refer right. So, SI means spark ignition, a CI means compression ignition okay. So what does this mean you know like so the terms themselves are self explanatory. So, what do you think is a spark ignition engine.

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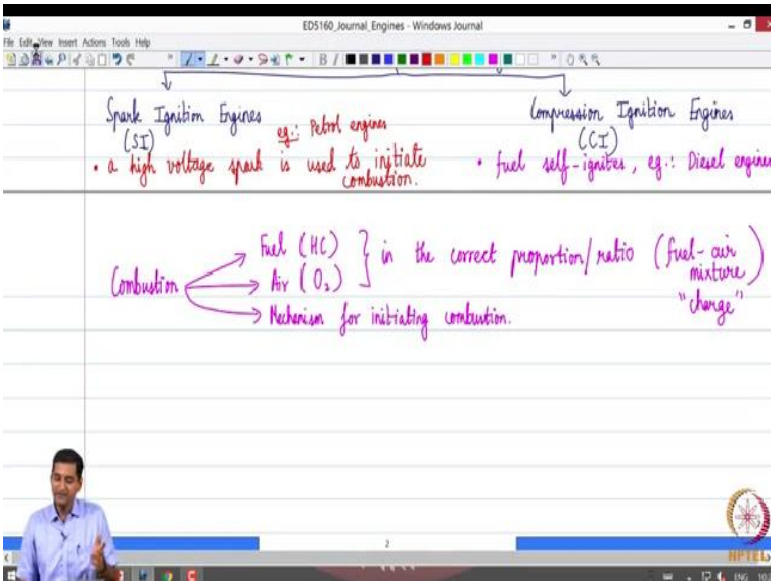

So, yes, so as the name indicates a spark a high voltage spark is used to ignite or to initiate the combustion process okay. So, in a spark ignition engine, so in a SI engine, you use a high voltage spark to ignite the combustion process. So, in general if you are looking at combustion pursue, so, that is the process by which the what to say fuel and air are mixed together and ignited in what to say an engine to convert the chemical energy in the fuel to thermal energy, that is the first energy conversion process that I talked about, right.

So you need fuel right which are typically hydrocarbons okay, we need air mainly oxygen in air, right because it is an oxidation reaction chemically and we need a mechanism for initiating combustion. So we need these 3 what to say requirements items right to have combustion. Of course we need fuel and air in the correct proportion okay, so they should be the correct ratio or correct proportion for effective combustion, okay.

So that is very important. So if you look at the hydrocarbon in the fuel you know like hydrogen should be completely oxidized to water vapor H2O and carbon should be completely oxidized into CO2 okay in an ideal combustion process. Now, even if I introduce fuel and air in the combustion chamber in the correct ration I need a mechanism for initiating combustion right that is where the above classification comes into play right.

In a spark ignition engine on an SI engine I use a high voltage spark to ignite the mixture the so called fuel air mixture okay. So we use this term fuel air mixture okay to refer to a suitable mixture of fuel and air. Some people also call this as charge okay. They will use the term charge in the context of IC engines means in only they are referring to fuel air mixture okay. The process of charging which we will look at later is to essentially the process by which we bring in fuel and air into the engine combustion chamber and mixed them properly right to get them ready for combustion.

So, we look at all those aspects as we go along. So, even if I charge the combustion chamber right I need a spark to ignite the mixture in a spark ignition engine okay. On the other hand in a compression ignition engine, what happens is that we push the engine operating conditions to such a level that the fuel ignites on its own okay every fuel will have what is called as a self ignition temperature.

And when you take the fuel to that temperature, it ignites on its own okay. So, here, fuel self ignites. So you do not need a spark or any other external mechanism to initiate the combustion process. So, example diesel engines are compression ignition engines, petrol engines are spark ignition engines okay. So for this reason you know like people will call as petrol as spark

ignition engines what to say diesel less compression ignition or CI engines okay. So they are used interchangeably for this particular reason okay. So this one classification right.

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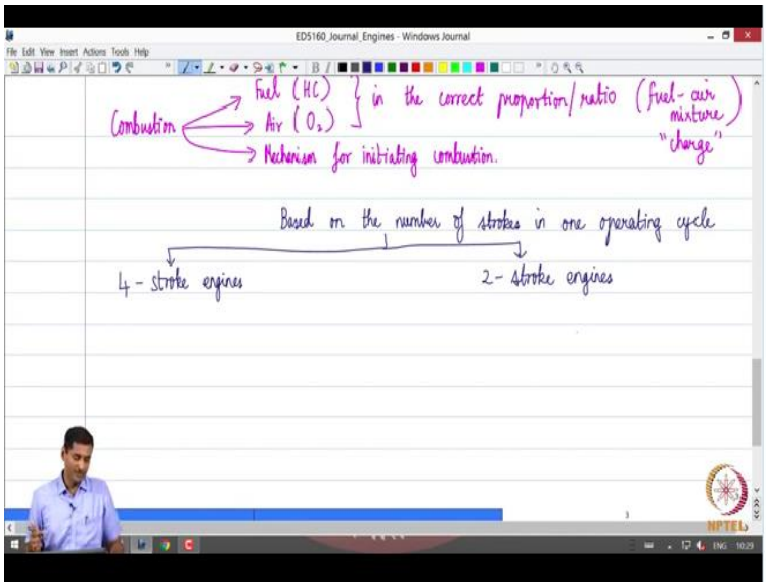

So, another criteria for classifying IC engines is based on the number of strokes in one operating cycle okay. So of course in our course we will consider both spark ignition and compression ignition engines okay, we are going to look at both right. So, we look at what is an operating cycle and what do we mean by stroke and so on right as we go along. So, based on this criteria we have what are called as 4 stroke engines and 2 stroke engines.

And as we can readily interpret from the terminal itself a 4 stroke engine is an engine where we need 4 strokes of the piston to complete one operating cycle of the engine okay, a 2 stroke engine is one where one operating cycle of the engine is completed in 2 strokes of the piston okay, so there is a difference. So we are going to one second look at both okay and then like learn what are the pros and cons and so on right.

So today in on 4 stroke engines are universally used in road vehicle applications, 2 stroke engines what to say are on the way out due to emission issues, we will figure out why right as we go along.