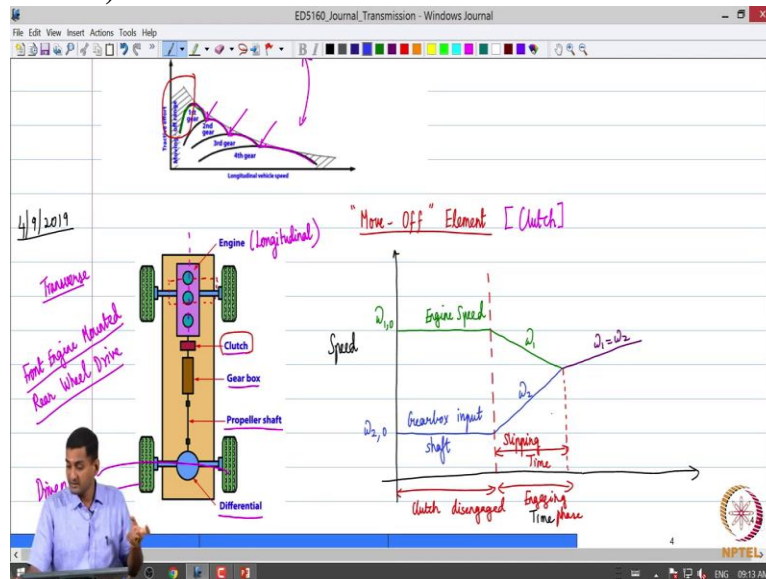


Fundamentals of Automotive Systems
Prof. C. S. Shankar Ram
Department of Engineering Design
Indian Institute of Technology-Madras

Lecture - 31
Automotive Clutch Part 01

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Greetings so, let us get started with today's class. So a quick recap of what we did in the previous class in on we are looking at the components of the power train. And we saw that you know, like what were the typical power speed and torque speed characteristics of IC engines and what is ideally required from a prime mover and why the IC engine does not meet the ideal traction requirements and hence, one requires a multi speed gearbox you know like to match what the IC engine provides to what the vehicle required.

So that is where we stopped yesterday. So, and one more important requirement of an automotive power train is that like the power train should enable the vehicle to move from rest and since a typical IC engine delivers very little torque at a low speeds, we typically require what is called as a Move-off element to enable the vehicle to be moved off from the rest, so that is what we are going to look at today.

So, before we start discussion on the so-called move-off element, which typically in most transmissions that we encounter know like a is realized as a clutch. So we will look at how the different components are arranged in a vehicle. So, let us say you know like we have a vehicle where the engine is mounted in the front this is essentially called as a longitudinal orientation of the engine because you can see that the axis of the crankshaft is along the longitudinal axis of the vehicle.

So, in other layouts, you can also have a transverse orientation of an engine where the axis of the crankshaft is going to be perpendicular to the longitudinal axis when looked at from the top. So that is another orientation of the engine. In this particular schematic, one can see that the engine is mounted longitudinally, and the output of the engine is connected to what is called as a clutch and the clutch transmits the energy to the gearbox.

And the gearbox transmits the torque to a final drive through a propeller shaft and this differential unit distributes the torque to the two driven wheels. So, these are the driven wheels in this particular case. So one called or this is essentially what is called as a front engine mounted rear wheel drive. So, this configuration is what is called as a front engine mounted rear wheel. So, the deep meaning is obvious from the torque because the engine is mounted in the front and the rear wheels are the ones which are driven.

So, this is quite popular in trucks and buses and even some light commercial vehicles in most passenger cars today, you know we would see that the engine is mounted in the front and the front wheels are the ones which are driven then what happens is that like typically the engine is mounted in that transverse position that is the crankshaft is going to be perpendicular to the axle of the crankshaft is going to be perpendicular to the longer axis and the gearboxes mounted close to the engine, the clutch and the gearbox.

So, we look at the configuration also later on. So, that is what is called as a transverse layout. And typically, we will also observe that when we have this front engine mounted front wheel drive, we have what is called as a transaxle gearbox where the gearbox and the final drive are integrated as one and typically when we have a rear engine mounted rear wheel drive also we may have a

similar configuration arrangement of the primary gearbox on the final value. So, these are all different layouts of the power train which are typically used.

So this front engine mounted rear wheel drive we can have front engine mounted front wheel drive, we can have rear engine mounted rear wheel drive, So those are all like popular configurations of the drives, not about powertrains currently, So, but the typical competence or the prime mover, the clutch, the gearbox the final drive, so the those remain the same, the way they are oriented and mounted and integrated may have some small differences depending on the configuration.

So now what does this a move-off element loop? So suppose imagine a scenario where the engine is idling, and our car is stopped at a signal and we want to essentially move the car from this what do we do We engage the first gear and then slowly leave the clutch pedal while slowly pressing the accelerator pedal so that is what we do. Now, in fact, when the clutch pedal is pressed, the clutch is disengaged, so the operation is counterintuitive.

So when we are depressing the clutch pedal we will shortly see that the clutches in fact disengage from the engine fly wheel. So, when we are engaging the clutch by slowly releasing the clutch pedal, the wheels and the gearbox shaft and the clutch are going to be addressed initially while the engine is going to be rotating at some speed correct some nonzero speed. So, there is a speed differential between the 2 and that needs to be overcome.

And it needs to be overcome in such a way that the engine is not suddenly loaded because the engine cannot provide so much of torque at low speeds. So, there should be a smooth transfer of torque to start the vehicle while ensuring that after some time all the components are rotating us one in synchronization. So, that is an important requirement. So, if you want to visualize what happens, let us say the engine is initially rotating at some speed ω_1 so, this is the engine speed.

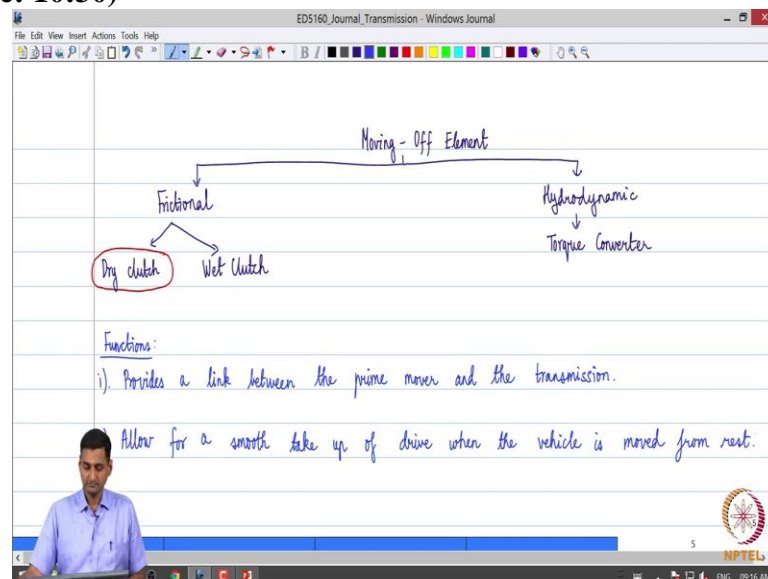
And let us say the input shaft to the gearbox is rotating is at some speed ω_2 it can be stationary also, ω_2 can be 0 also so, there is a speed differential when the clutches

disengage, so in this case the clutches disengage. So one can immediately see that the clutch serves as a link between the engine and the gearbox. So that is one of the primary roles of the clutch.

So now when we start removing the force from the clutch pedal we are engaging the clutch. So, what happens is as the engine speed starts to decrease because of the load coming on the engine flywheel while the speed of the input shaft of the gearbox starts to increase and at some point the speed differential is overcome almost. So, this is the phase that the clutches are getting engaged so this is the engaging phase and this is the period over which there is some slip between the 2 elements after that once this happens these 2 start rotating as 1 unit.

If you look at the engine's output shaft on the gearbox input shaft is concerned. So, this is a typical visualization of how that exists an initial speed differential and once the clutch is engaged that.

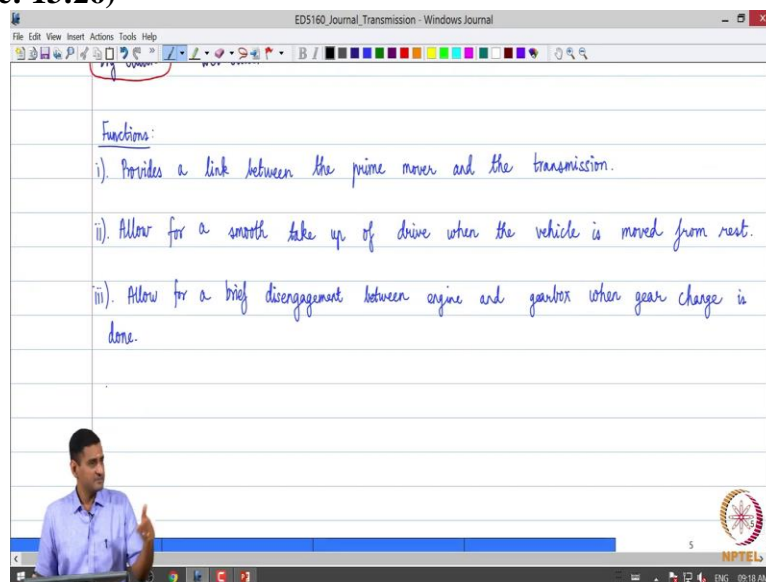
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Essentially there is a slip but as time progresses you know like that slip is overcome and then essentially the engine output shaft and the gearbox input shaft start rotating as one after some time. So, we are going to see how these are released in practice. So, before we look at the construction and realization. So, this moving of element broadly it can be classified as a frictional device or the frictional clutch. So, frictional clutches are further subdivided into what are called as dry clutch and wet clutches and this moving of elements can also be hydrodynamic in nature.

So, a common hydrodynamic moving off element is what is called as a torque converter which is widely used in automatic transmissions, So, we would be focusing on dry clutches, which are very commonly used in manual transmissions, so, that is what we went to look. So, what are the functions of these clutches so we will look at dry clutch, so what are the functions of a dry clutch so, the first function is that it provides a link between the prime over and the transmission, so that is very important then the clutch should allow for a smooth take up of drive when the vehicle is moved from rest.

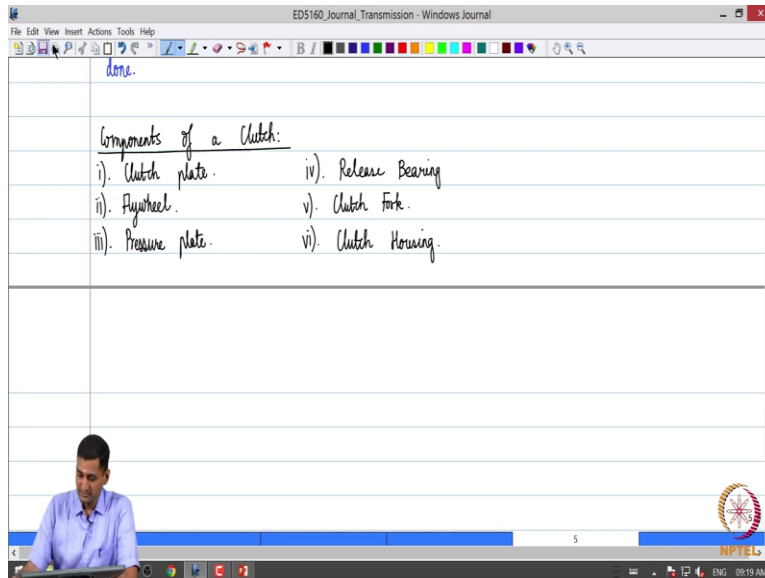
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Also it should allow for brief disengagement between engine and gearbox when gear change, so, these are typical expectations of on this clutch. So, if we look at clutch action perceive what happens is it is a following. So, as we are discussing a friction clutch, so, the flywheel which comes out of the engine is rotating along with the engine crankshaft and the so-called clutch plate which we are going to look at shortly is connected to the input shaft to the gearbox.

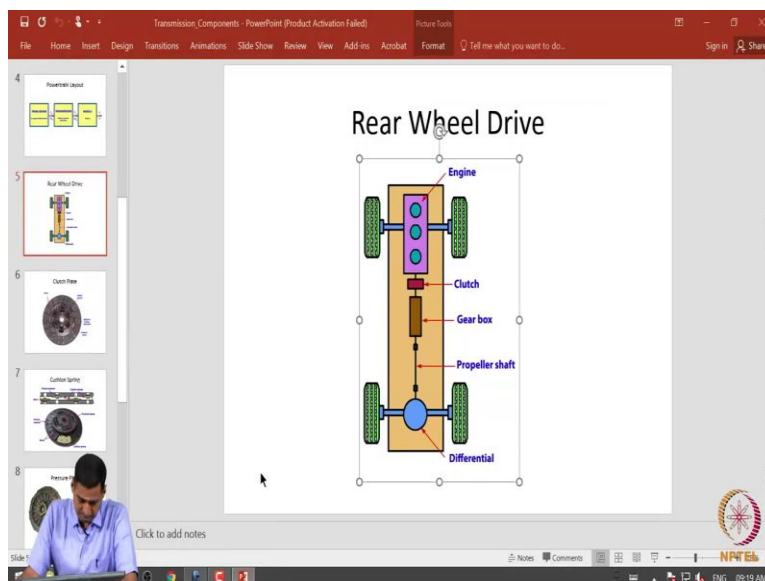
Then let us say the vehicle is addressed and the engine is rotating at some nonzero speed. When the clutch is going to be engaged, this clutch plate is pushed against the flywheel and there is a speed differential and due to friction, the speed differential is overcome and the torque is transmitted from the flywheel to the clutch wave and they start rotating as watt, that is why it is called as a friction clutch

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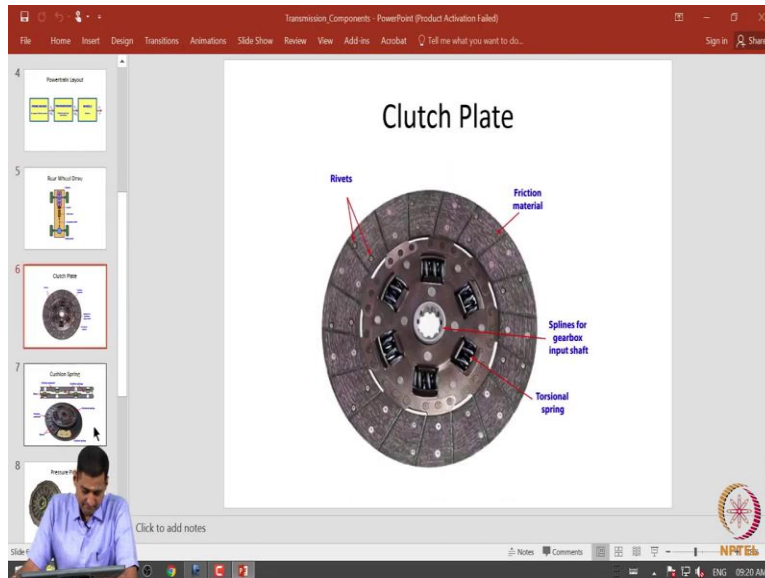


So what are the typical components of a dry clutch so, the main component is what is called as a clutch plate. So, the clutch plate is pushed against the flywheel by what is called as a pressure plate, a pressure plate assembly. So, this pressure plate is the component which pushes the clutch plate in you know against the flywheel and when we want to disengage and engage the clutch that it happens through a mechanism that ultimately uses what is called as a clutch fork and the release gearing you know to do this action. And all these components are housed in a clutched housing, so these are the main components.

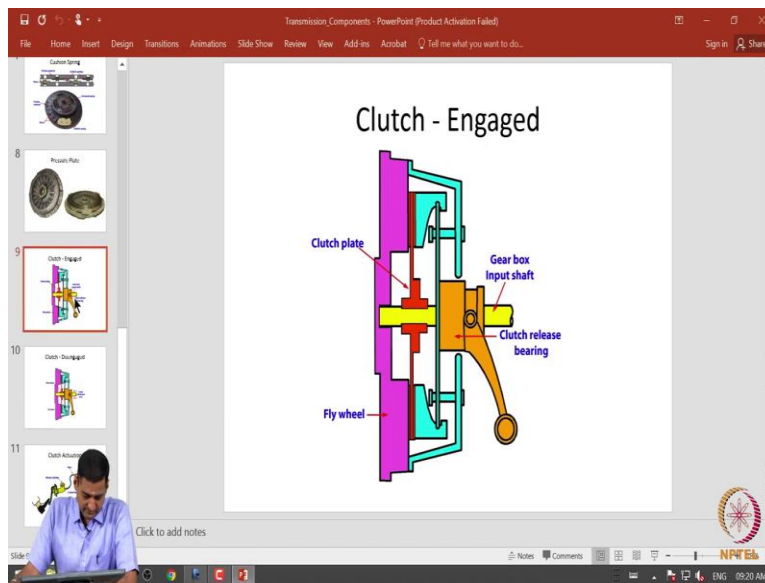
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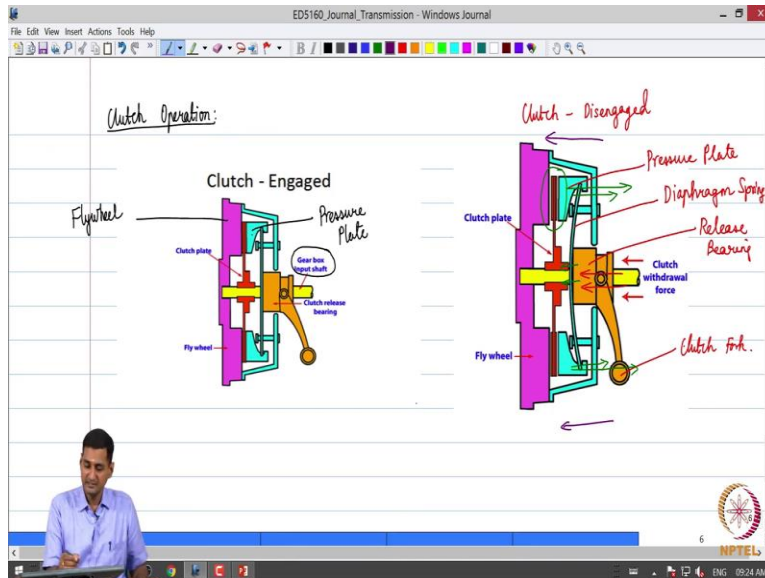
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So let us look at what happens these are components various are components of a clutch so this is a schematic, but this shows the clutch operation. So, we will look at each component in detail. Typically, what happens is that like when the clutch is engaged you can see this clutch plate this, of course is very simple schematic? So, this red element which is a clutch plate, this is the flywheel and this element is the pressure plate. So, when the clutch is engaged that means we are not pressing the clutch pedal, so, the clutch plate is pressed against the flywheel with that pressure plate.

And this clutch plate is mounted on this gearbox input shaft. So the flywheel is rotating along with the engine. So what is going to happen when the clutch plate is pushed against the flywheel by the pressure plate after some initial slip, the clutch plate and the flywheel and the pressure plate are going to rotate as one unit and the energy is transmitted from the engine through the flywheel through the clutch plate through the input shaft to the gearbox to the transmission and further downstream, in the powertrain.

So that is how the energy transfer happens when the clutches engaged. So now when the clutch is disengaged, what happens so we can immediately see that when the clutches disengaged or in other words the clutch pedal is not pressed, when the clutch pedal is pressed, what happens is there is a force, this is the release bearing and this is the clutch fork. So, then the clutches what is

a clutch pedal is pressed, what happens is in a force is applied by the release gearing on what are called what is called as a diaphragm spring we look at what this is shortly.

There is a spring called diaphragm spring on the pressure plate. So, when this force is applied in this direction, so, you can see that the forces are played in this direction, this end of the diaphragm spring moves to the left in this diagram, So, it moves the pressure plate assembly to the left so, when the pressure plate is moved to the left, which holds the clutch plate against the flywheel is released.

So you can immediately see that the contact between the clutch plate and the flywheel and the pressure plate is broken. So the link between the engine and the gearbox is now broken. That is what happens when the clutch pedal is pressed. Please remember and the clutch pedal is pressed the clutches disengage. Now if I release the clutch pedal the exact opposite sequence of operations so what happens is this force is released.

Now, the diaphragm spring will move like this it will push the pressure plate to the left and then the clutch plate will be pushed against the flywheel and the motion will be transmitted to the gearbox. So that is what happens in this friction clutch. So these are the various components, you know, and there is all the friction clutch works. So let us look at each and every component and we will observe how they contribute.