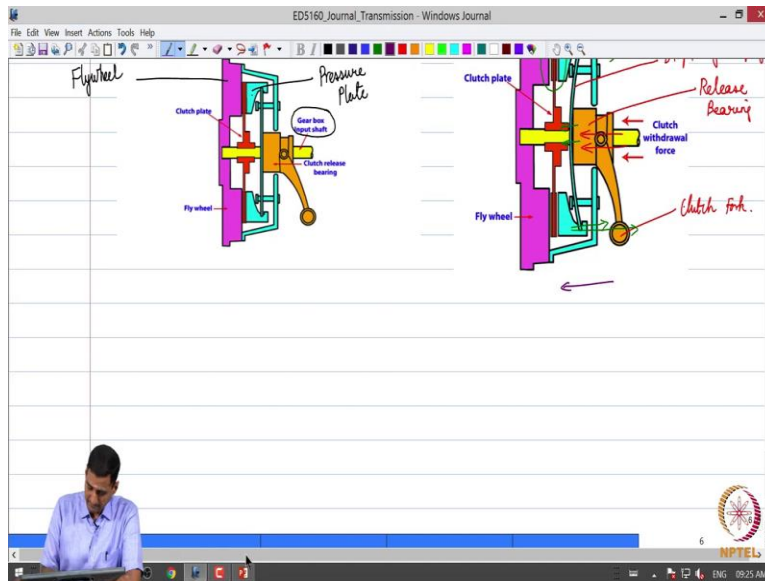


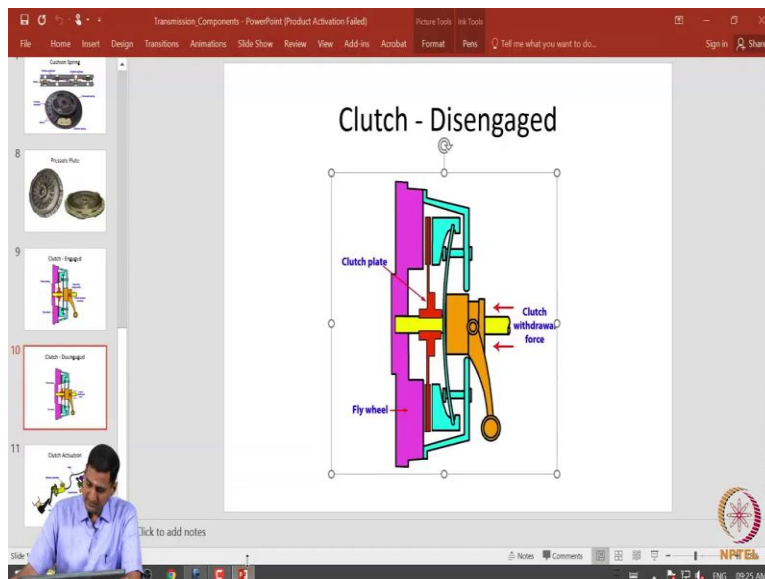
**Fundamentals of Automotive Systems**  
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**Department of Engineering Design**  
**Indian Institute of Technology-Madras**

**Lecture - 32**  
**Automotive Clutch Part 02**

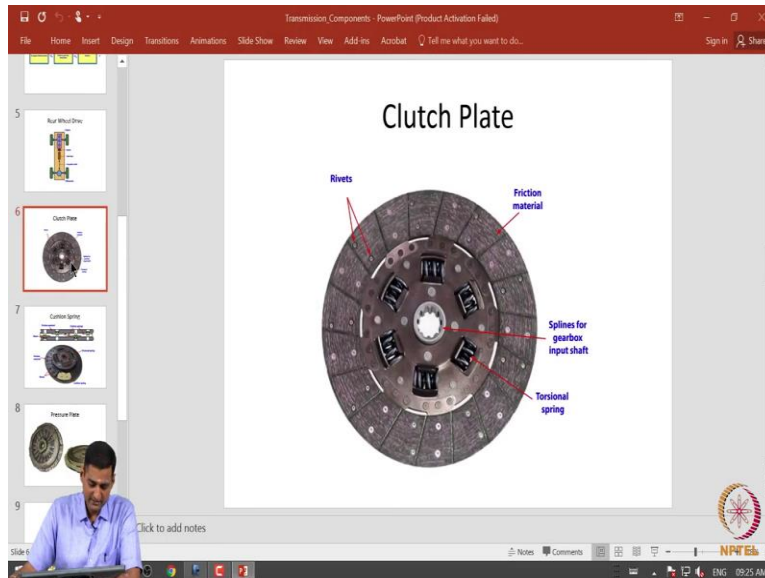
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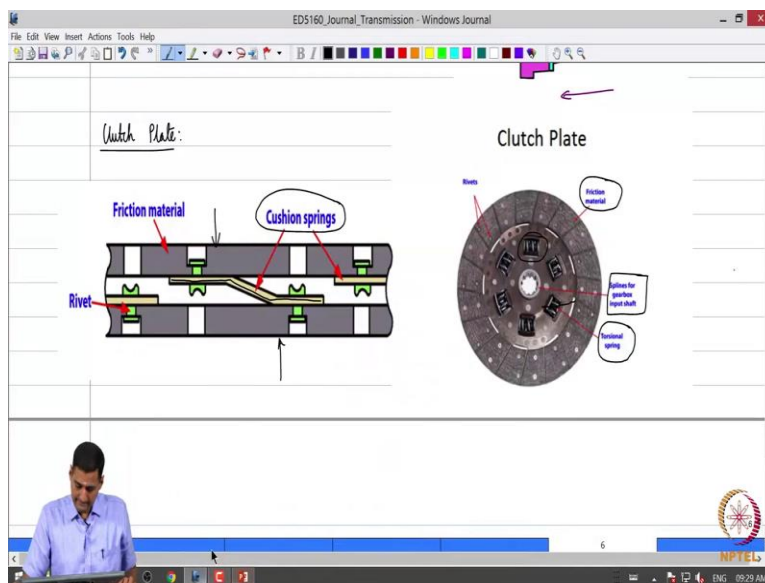
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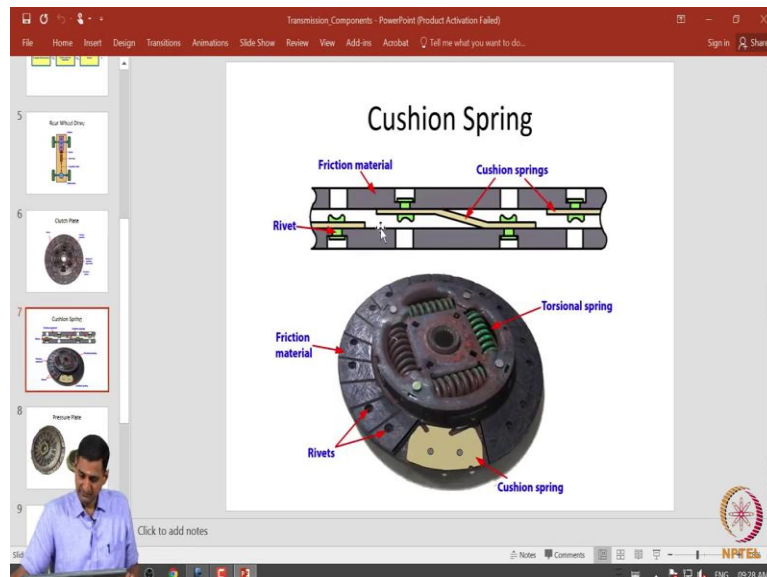
So, the first component that we will look at closely is the clutch plate. So, if we look at a clutch plate we can immediately observe that it has friction material on it. So we can see that this is the clutch plate. So this there are what are called splines for mounting clutch plate on the gearbox input shaft. So, you can see that splines are like repeat like to say projections on the inner surface, so that you can slide it on the corresponding explains on the input shaft to the gearbox, so, that any rotation of the clutch plate is transmitted to the gearbox input shaft.

So, we can see that this central hub of the clutch plate has a splint arrangement. You can also observe that a friction material is riveted on the clutch plate. So this friction material enables that what is a pickup of torque from the flywheels when the clutches engage when the clutch plate is initially pressed again. The flywheel by the pressure play and we can also see these coil springs which are mounted here along the circle.

So these coil springs are mounted in cavities in the core of the clutch plate and then main function is to ensure that they reduce torsional vibrations so they act as torsional springs. So when the clutches initially engaged, imagine that the clutches in between my hands the clutch played, so let us say there is the flywheel and there is the pressure plate. So what is going to happen? The pressure plate is going to push the clutch plate against the flywheel.

So let us say the clutch is addressed. The clutch plate is addressed and the flywheel is rotating and some nonzero speed. So suddenly there is a thought which is transmitted and there is a speed differential. So, there can be some gender due to the southern peak of torque. So these coil springs, so to reduce the torsional vibrations that can result due to the engagement between the clutch plate and the fly wheel. So that is the role of the coiled spring.

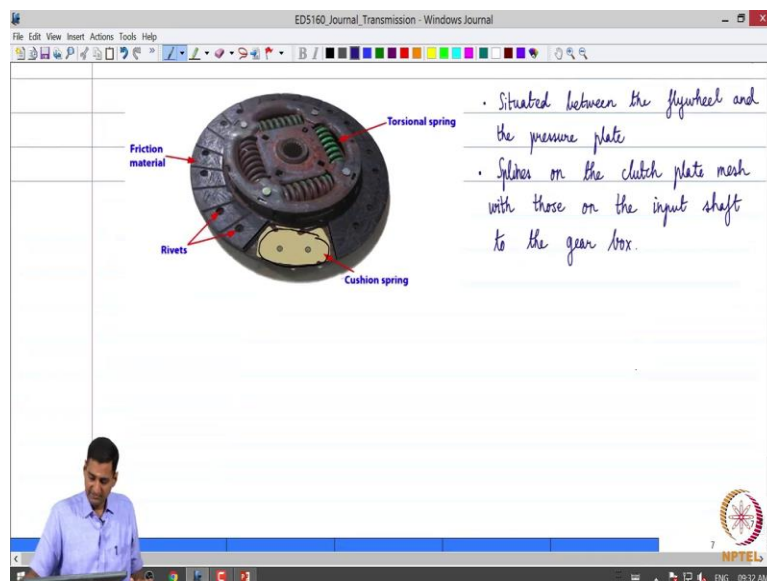
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And it is similar mechanism is also provided along the axis. So if you look at the cut section of this clutch plate, you can see that the central plate of the clutch plate when it goes to the friction material has a show which is like this, it is a thin plate, but it is press like this. Why do you do we think get a stretch like this because it cushions any sudden load that comes along the axis. So imagine that the clutch plate is in between my hands when I press the clutch plate, in between the flywheel and the pressure plate, there is also going to be force along the axial direction, so if I suddenly press it that can be sudden shocks and vibrations along the axis.

So to reduce and absorb those forces, we have these cushions, springs, they are not springs per se, there is a they are not related as typical coil springs, but then the clutch plate material itself has the shape along the periphery, so that the forces are absorbed by these cushions like so, we look at this cut section.

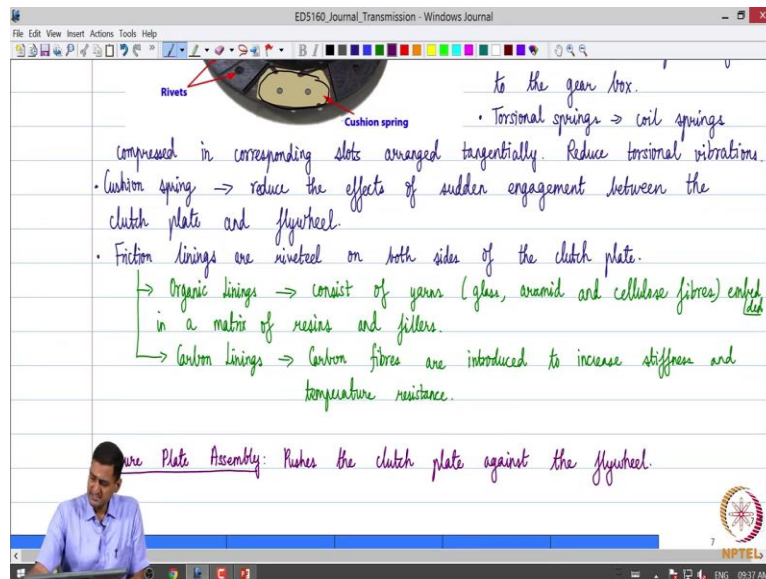
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So, we can see that this material is like the blade of a fan. So, this comes from that can see this what to say these arms attached here to the central hub of the clutch plate. So, what happens is it imagine that these are like some loops like this. So there are plates, which essentially project from the hub and they are depressed like this very small depression. So the first good question so you can see 1 such thing here. So that is essentially attached to the core of the clutch plate.

So, main some main features of the clutch plate or that it is essentially situated between the flywheel and the pressure plate. So the splines on the clutch plate mesh with those on the input shaft to the gearbox.

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And if we look at the springs, coiled springs these are these perform the role of torsional springs. So these are nothing but coil springs which are compressed in corresponding slots that are arranged tangentially. So, the main function of these springs is that they reduce the torsional vibrations and similarly the cushion spring. So essentially reduce the sudden the effects for certain engagement between the clutch plates unflavored along the axial direction.

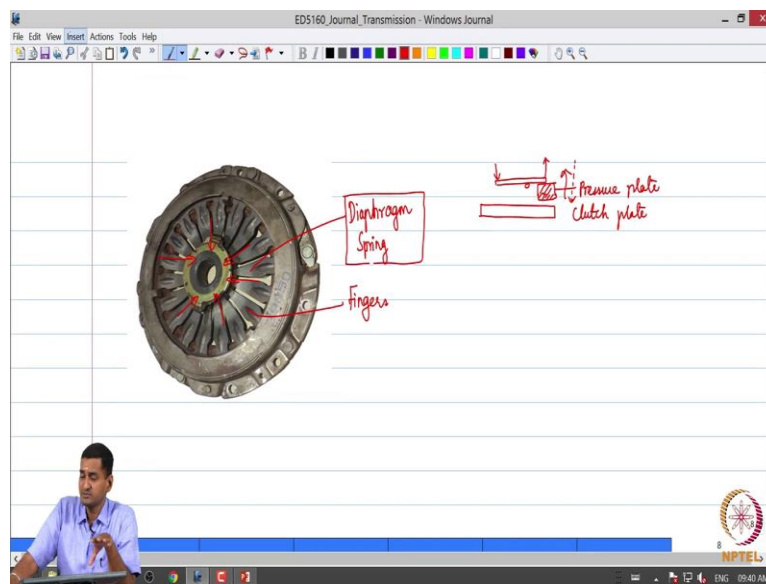
So that is the role of this questions. And typically these clutch friction linings riveted on both sides of the clutch plate please note that the clutch plate we can see that the friction material is riveted on both sides of the clutch plate. So, 1 side engages with the pressure plate another side engages with the flywheel so the friction linings are riveted on both sides of the clutch plates and commonly most automotive applications you know like vehicle applications you know these friction linings mainly organic linings. So, organic linings essentially consists of yarns which are made up of glass, aramid and cellulose fibers embedded in.

So, these fibers provide the structural strength. They are embedded in a matrix of resins and fillers, so that is the typical lining which is used. So, there are metallic linings also used in some

applications off road applications off road vehicles and in some applications you know like this organic linings are also released as carbon linings. So, carbon linings form a subgroup of this organic linings and in carbon linings what happens is it like carbon fibers are introduced to increase stiffness of the lining material and temperature resistance.

For example, they are used in race vehicles you know like where we need to engage and disengage you know very frequently. So and temperature resistance also becomes important. So these are the clutch linings. So, that is the clutch plate. So the clutch plate is pressed against the fly wheel by the pressure plate. So, the pressure plate assembly essentially pushes the clutch plate against the flywheel.

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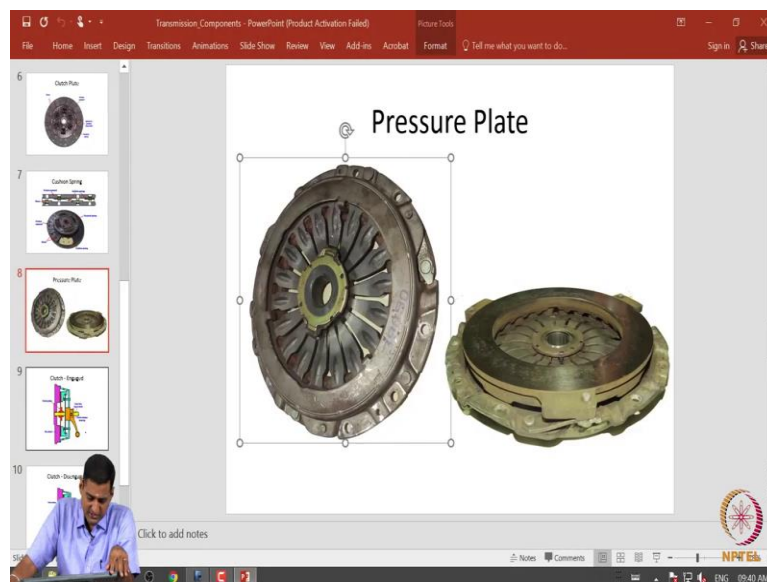
So how is this pressure played realized let us look at that so, this essentially a pressure plate assembly, so called diaphragm spring. So, this is what is called as a diaphragm split. So what happens is it like these diaphragm springs have these so called fingers we can see these slender projections and slender metallic plates which are coming towards the center and these fingers are piloted about despite bettering and then connected to the pressure plate on the other side.

So what happens is that like when we depress the clutch pedal, we are any way going to apply a force on the center of the structure through the release gearing. So when we apply a force, which

essentially acts on this, this finger acts like a pivot. So, when we apply a force like this, what is going to happen it is going to be pulled up, but the sand is connected to the pressure plate. So, what happens to the pressure plate, the pressure plate also moves up and the clutch plate is here.

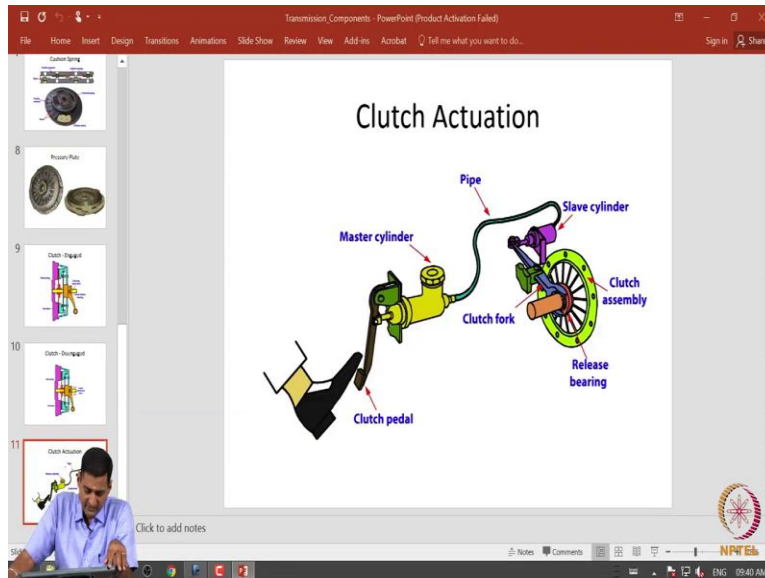
So, when the diaphragm spring is pressed in this way, the pressure plate is moved away from the clutch plate by the spring action of this fingers when the force is released, the motion happens in the opposite direction, and the pressure plate then pushes the clutch plate against the flywheel. So this so called diaphragm spring is used to engaging and disengage the clutch. So that is what that is the role of this diaphragm spring on the pressure plate. And the actuation of these diaphragm springs takes place through by means of the release gearing and what happens in when we engage the clutch pedal is a falling.

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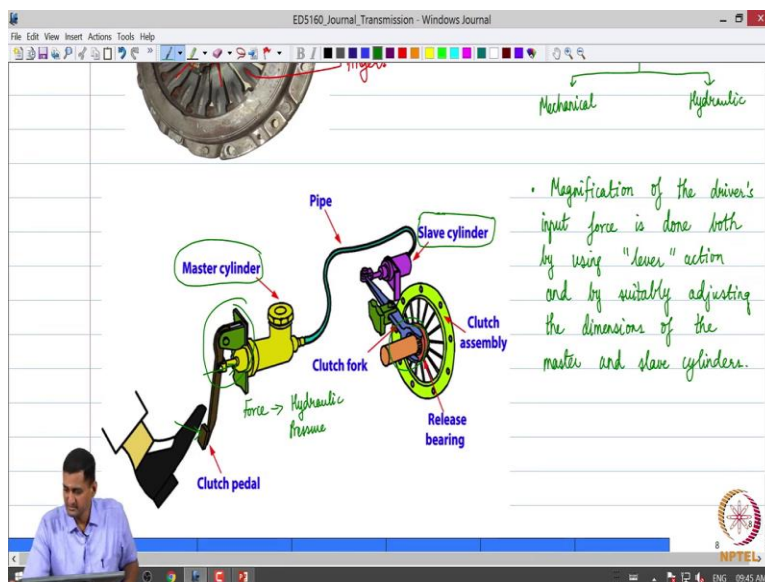


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So when we activate the clutch pedal there can be multiple what to say means so this clutch actuation can be mechanical can be hydraulic. So please know that it is a good amount of forces needed to depress this diaphragm spring good amount of forces needs to be applied on the release gearing to essentially disengage the pledge and what is the source of this force the human pedal input please note that the driver typically presses the clutch very, frequently when while driving a car. So, imagine driving in city traffic you know, we have to press the clutch often.

So, we need to provide enough mechanical advantage so that the force which is applied by the driver is sufficiently small and is magnified from the input to the release wheeling such that the



clutches engaged and disengaged, appropriating. So, early clutch mechanisms used a purely mechanical action where we had cables and levers and the magnification of the force was new to live around action. So, nowadays you know like in most clutches, you know we use a hydraulic means of magnifying this force.

So, when the driver process the clutch pedal, so, what happens is that like there is something called as a master cylinder in the clutch mechanism, when you come to brakes, we will see that there is a master cylinder in a hydraulic brake system that is different. So, in this master cylinder what happens is it this force is converted to a hydraulic pressure. And this pressure is transmitted through the fluid in the pipe and that then goes to what is called as a slave cylinder which is closer to the clutch assembly.

So, the slave cylinder, then actually it is that clutch fork and the clutch for then goes in, presses the release bearing and disengages the clutch. So, that is how the action on this hydraulic system works. So, the magnification of the drivers input force is done both by using lever action because still you even here there is a lever, magnification one here and another action here there is a lever arm action and by suitably adjusting the dimensions of the master and slave cylinders because by suitably adjusting the sizes of the master and slave cylinders, we can adjust the magnification of the nodes. So that is how the clutch actuation takes place.

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The torque transmitted by the clutch is

$$T_c = (\mu F_{axial}) r_m n$$

$\mu \rightarrow$  clutch lining friction coefft. (0.3 to 0.45 for organic friction linings).

$F_{axial} \rightarrow$  Axial force applied on the clutch plate.

$r_m \rightarrow$  average radius.

$n \rightarrow$  number of friction surfaces.

$n = 2$ , for a single-plate clutch.

$n = 4$ , for a two-plate clutch.

So finally, the torque which is transmitted by the clutch at steady state is given by following. So let us say the coefficient of friction of the clutch friction lining is  $\mu$  and let us say an axial force of axial is about  $P$ , because the pressure  $P$  is pushing against this. So there is going to be the tangential friction force, the lump tangential friction falls on the floodplain. And let us say we lump all this falls at a mean radius  $R$  of course the contact is over the face of the friction material.

Let us say we lump all these forces at a mean radius and multiply it by  $n$ , where  $n$  is the number of clutch plates. So friction surfaces on the clutch plate. So this new is the clutch lining friction coefficient. So typically around point three 2.45 for organic fiction and linings that are used. So if axial is the axial force applied on the clutch plate or  $\mu M$  is the mean or average radius used in this calculation and  $n$  is indicates the number of friction surfaces.

So,  $n$  is typically 2 for single plate clutch and  $n = 4$  if we have a 2 plate clutch they will be equal to 4. So, typically we use a multi plate clutch when we want to transmit higher torques so that is when we use a multiplayer pledge for example in heavy vehicles and so on that we want to transmit more work the go for the multi plate clutch. So, this is the, this is a broad overview of the friction clutch which is used in the automotive power train.

So, just to go back to the layout of the power train, so, in today is class we have looked at the clutch. So, tomorrow we will look at the gearbox, which is did not scream from the clutch in about 10. We will see how they are released, what are its features and so on. And then we will look at, you know how to put all these things together to match the specifications of the gearbox to the vehicle performance equipment is given a particular engine. So that is something that we will. So I will stop here for today. Thank you.