Mining Machinery
Prof. Khanindra Pathak
Department of Mininig Engineering
Indian Institute of Technology, Kharagpur

Module - 01
Lecture – 04
Mechanical Transmission of Power

So, welcome to our today's lecture. Today we will be discussing Mechanical Transmission of Power. So, far you have studied about the spectrum of Mining Machinery and also you have studied what are the basic elements that are in a machinery.

Now, the one of the important aspect is the transmission of power. To do these binding operations you have seen that there are very robust machines required and they require very high power because breaking rocks and all these things require very high power. So, this power transmission is one of the very important in all machinery including mining machinery.

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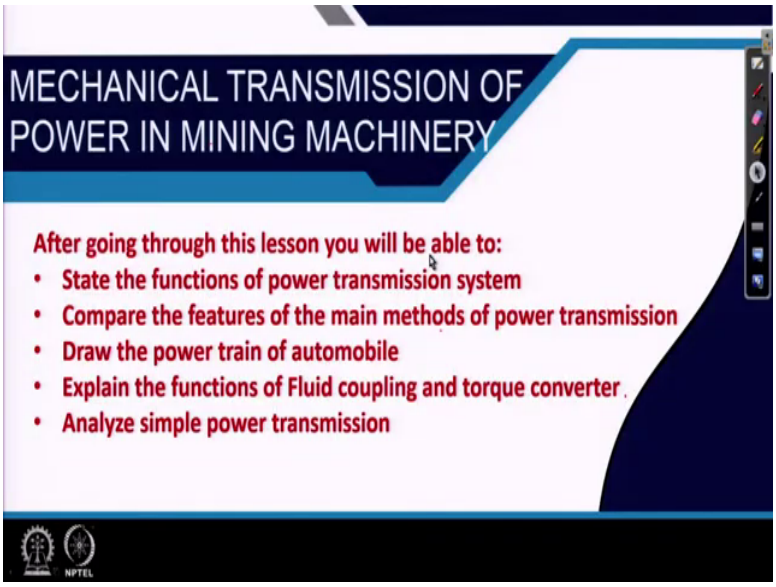

So, we will be discussing in today's class that after going through this lesson you will be able to state the functions of power transmission system, what are the different types of power transmission systems and exactly what are their main functions that you must be able to mention.

Then you will be able to compare the features of main methods of power transmission. Though there will be only an introductory part I will be speaking you will have to work on this. You will have to make a plan of your some tables you will have to make sure that the comparative table and then you will be maintaining your own learning portfolio and so that you can properly explain that what are the main features of this.

And then you will have to draw the power train of automobile just to make some simple sketches so that it can come to your mind that how exactly things are. So, make a habit of

drawing some sketches of the power train of different machines. So, as when you will be studying about the other mining machinery try to collect some of the power train diagram of those big machinery.

Now, explain the functions of fluid coupling and torque converters. These two things we will be telling in our last class we said about a coupling and clutch, but that is there is a the machine elements, but how and why this fluid coupling and torque converters are required very briefly I will be telling and I will be giving reference to some of the YouTube, where you can exactly see and learn yourself.

Then analyze some simple power transmission. We may, if time permits we will be discussing some of the this how the power transmissions systems can be analyzed we will try to do these things.

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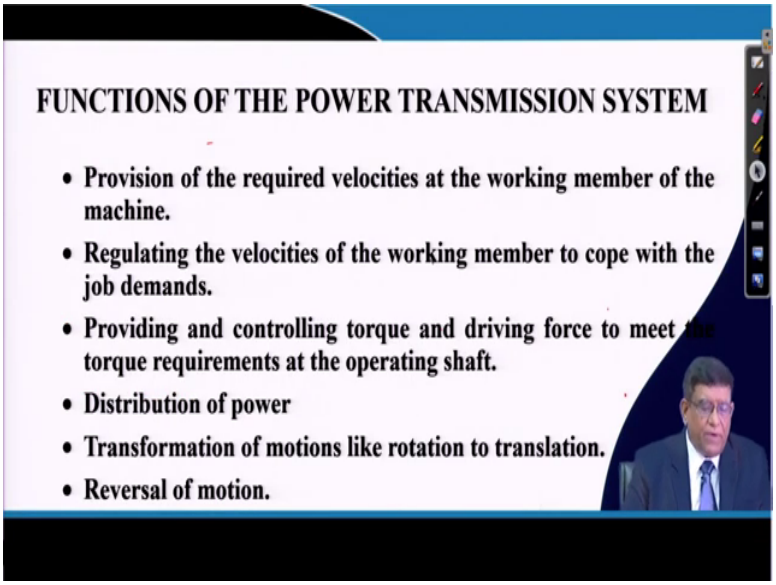

Now, the functions of the power transmission systems you know that these are the provisions of the required velocities at the working member of the machine because they any machine the main part is done work is done by some motions whether it is a linear motion or it is a circular motion, it is a continuous motion, it is an intermittent motion different that exactly tools will be working.

In any mining machinery there will be interactions with a tools with rock or with a tools with another machine parts or there is a movement between relative motion between two parts. These type of things are to be the done by the transmission system will have to do that.

Regulating the velocities of the working member depending on the type of work; say if you are doing a drilling operation the drill bit will have to be rotated. If it is a very hard rock you will have to rotate it very fast, if it is a soft rock you may rotate a that sorry that you may rotate in a the higher speed in case of very hard rock will lead to the high wear and tear of the bit.

So, you will have to control the that a motion at what way it will be there. So, these type of things you will have to know by how the power is transmitted to that and how it is controlled. Then providing and controlling torque and driving force to meet the torque requirements in the operating shaft.

You have seen that when you are driving a car in a very upward gradient then at that time your torque required is more, you are doing a driving at a lower gear that type of things that exactly how the power has been transmitted, how that gear arrangements has been made those are the things need to be learned while learning a machinery.

Then how the power is distributed? If you may be having one source of power. Say for example, in a electric shovel or in a in a hydraulic shovel there may be the that one diesel engine, but the machine sometimes it will have to do a 360 degree swinging, sometimes this machine is raising and lowering, sometimes this a machine will be having its front boom movement.

So, all these different operations are by done by different elements. So, the power will have to be distributed to those particular machine elements or functional elements. So, when a machine is doing number of functions you will have to distribute the power to all this functional group.

Then transformation of the motions like; rotation and translation; so, these are the sometimes you will have to convert different type of motions and sometimes you need to reverse your motion That is your the that that you have seen you your car sometimes is going forward then you are putting into the reverse gear.

So, this type of power to transmit to the main the that your which is we say in case of your car the wheel whether it is going forward whether it is going at a high torque or less torque or it is going back that are the things which is done by the power transmission system of the machine.

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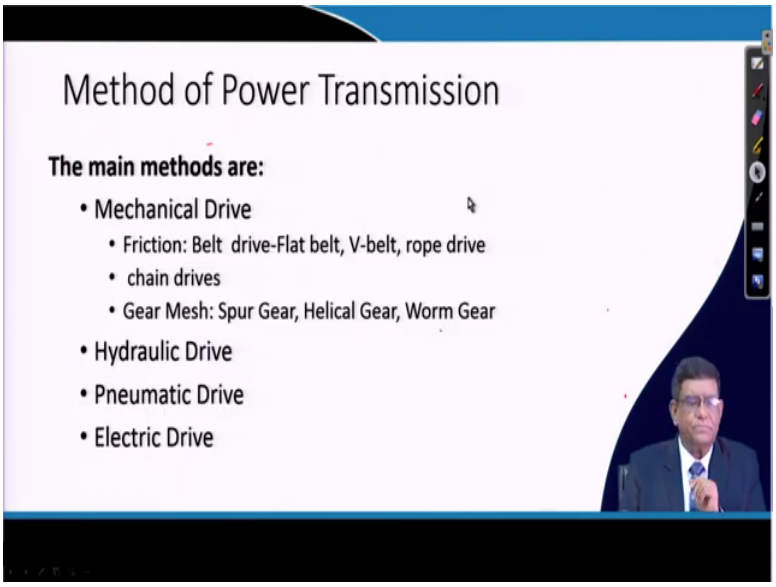

Now, these power transmissions can be done by through mechanical drive. We say sometimes. This drive is the word used for these transmissions that is a mechanical drive can be we say it is a friction drive which can be a belt friction, belt drive and there could be a flat belt and V-belt drive and there are also called chain drives. Then there could be a gear that is a different type of gear whether a spur gear, helical gear, worm gear, how they are connected together to give the motions differently.

Similarly, there could be a hydraulic drive that means, your some whole operations can be this rotated by means of a pressurized fluid is going to a particular component. It can be converted from your rotary motions. You are driving a pump and then the fluid is going and then moving a piston up and down and then you can just exactly work how it is a conversion of this power.

Similarly, it can be sometimes done by pneumatic that is by compressed air you can type dimensions. So, earlier this, this compressed air were the only solution when you were working in a underground coal mine which is a coal dust they become when air and coal dust mixtures is highly explosives.

So, if they are using an electric drilling machine then what will happen? At the time of your switching on and off a small spark will be coming that will be sufficient for creating a big explosions and everything everybody in the mines will get fatal accident. So, there they do not use the electric power to rotate the drill that, but you need to do the drill hole to put the explosives to blast the coal in underground coal mine that challenging job how will you do it.

So, for doing that this compressed air operated drilling machines. So that means, the drill bit is rotated or it is giving a percussion by controlling this whole movement of that steel rod or the functional element by means of the compressed air. So, that should call a pneumatic drive and of course, the electric drive you have seen that your table fan you are seeing over there, it is just a working with your pipes putting a switch.

Now, those electric drive then there were lot of developments have taken place. I will request you to make a some study of yourself study to find out the trend of developments in the drive systems that you will be finding some very good terminology which we will be discussing when the big machines we will be talking about that what is a hydrostatic transmissions, hydro dynamic transmissions.

You can see there is a electric drive their control how the modern this digital electronics is now going to use your most of the DC motors are now being replaced by AC motors how that drives. Say for example, if you are working with a big shovel for scooping that exactly the motion of this your bucket it need to be very smooth.

Your if you are making a whole machines to a big of two or two that is your 200 2000 ton machine it is revolving over there at that time if you are not making a very smooth motion a

small vibratory motions will be giving so much of your momentum which can damage all the parts.

So that means, such a smooth control which could be given earlier only by DC motor, but now it is AC motors can give it because that speed control has become now modern developed. So, you make a study of the development of the power transmission systems and development of the drives over the last 20 years, you will be able to know a lot of things. Try to do not go to the technical (Refer Time: 11:06) at the beginning, but it just have a general knowledge of what are the recent developments in the power transmission system.

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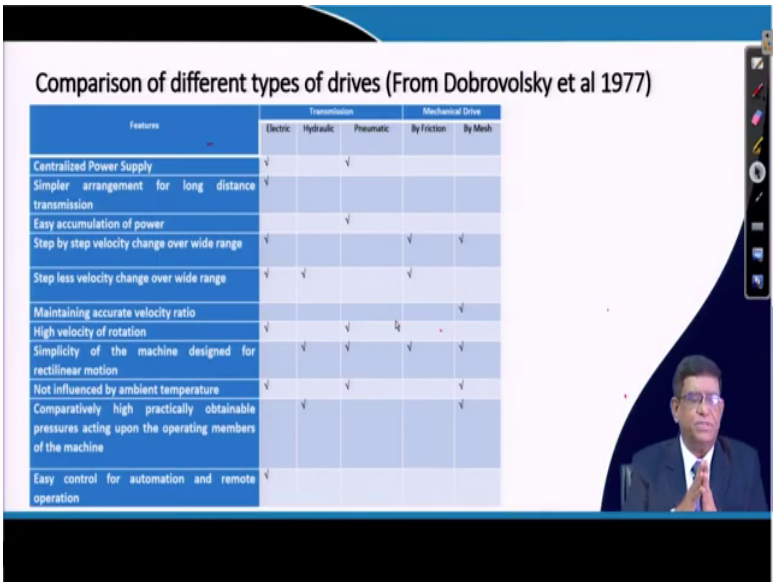

And then if you see here this tried to develop a table like this in which you can find out that what are the main features that are to be achieved by your a transmission system and then how exactly it is done by different methods. If you see the mechanical drive by friction or by

mass that is by gear or by belt or a chain and then the other type of transmission your electric, hydraulic and pneumatic, which features are exactly useful?

Say for example, a centralist power supply can be there for electric and pneumatic system. Similarly, for the easier accumulation of power that is there in case of your pneumatic, your compressed air you can compress it over there and store it and then whenever is required you are just opening a valve you can get it over there.

Then with the step by step velocity charts over a wide range that is can be done in electrical that also can be done by frictions and that your gear systems. Similarly, that you are that maintenance accurate velocity ratio that is possible velocity ratio can be accurately maintained in case of your gear type transmissions.

That is a by mesh gear mesh transmissions you can maintain an accurate velocity ratio; then high velocity of rotations that can be obtained in electric motor and pneumatic motor. So, similarly simplicity of the machine designed for rectilinear motion. That means, if you are to get a translatory motion where hydraulic pneumatic and frictions and gear that can be very easily done, but thing is that they are not influenced by the ambient temperature.

So, if you are the new that is your with the ambient temperature hydraulic that oil their quality may change their viscosity may change and that then it will be performing differently. That is why the electricity pneumatic as well as by your the gear they can be very easily used at any temperature once it is made. But, in case of your friction drive if you are doing a belt drive even if the belt material they may get affected by heat then the friction property will get changed and your things will not be proper.

So, that easy of control and automation and remote operation for that your electric, it can be it. So, have you understood that a once you know that what are the different features of power transmission system and then if you classify in such type of table at a glow you will be knowing a lot of things about it.

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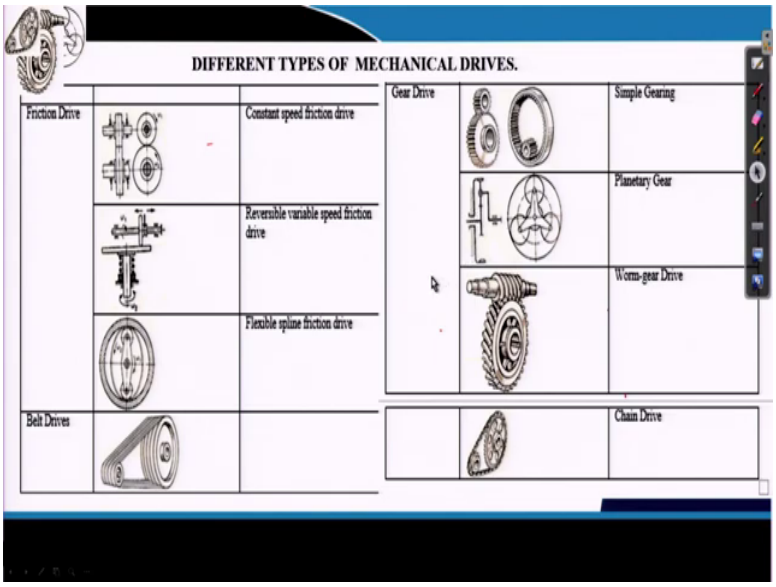

And then you can understand that these types of mechanical drive systems are available. A friction drive that is two wheels when there are two gears or that that if they are connected if there wheel, one wheel is and another wheel is connected together because of the frictions there will be the power transmissions will take place.

So, you can have these are the different type of mechanical drives available. Like a flexible spline friction drive, reversible variables speed friction drives, then the belt drives which is very common. You can see in any the car you might see that a v belts are there for a driving the fans for cooling and all it is taken from there [vocalized-voice]. Then the gear drives; there are different types of gear.

That is in your normally you need to do a little bit of a additional study to find out that whatever you have studied in your second year need to be recapitulated for this paper.

Particularly, for the planetary gear, worm gear and this chain drive these are the mechanical drive. Now, you can see that these worm and worm gear is very a very high ratio of reduction is necessary. Speed reductions, you can use this worm gear. .

So, particularly in case of your some of the machines control like say, for example in a shovel your whole that boom need to be raised and lowered. Now that if the boom is to be raised or lowered at a very slow speed and then the whole drive motors and things will be always running at a very high rpm. From there to reduce it so, that that boom can be raised and then we can use worm and worm will.

Similarly, this planetary gear has got a lot of use you can you will be discussing also the epicyclic gear that this type of gear systems are very very important.

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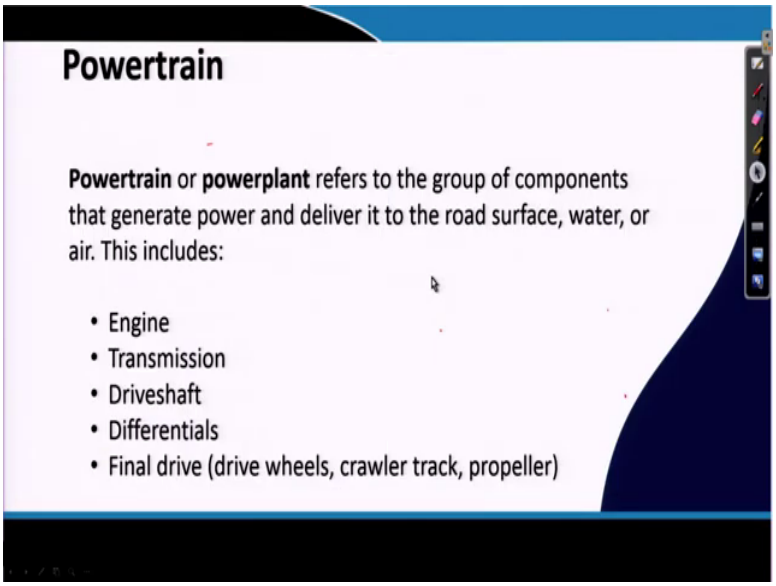

Now, coming to the power train or a power plant that is a where your that how from the source it is going to the you are using. Say for example, when a your wheel is to work that means, your the power ultimately is going to get used as a frictions with the overcoming the friction of the road surface. In a ship when it is moving it is exactly the whole power, it is interacting with the water. When you would think of the aviations the propeller and that in the aeroplane it is just with the air.

So; that means, whole the power which generated from the engine it is going ultimately to the road surface, or the water, or to the air. So, that the whole components which are there it includes from the engine, the transmission system, drive shaft, there will be a differential, there is a final drive final drive that way it is ultimately going to the main end users of the machines.

Now, there is a you know about differential is that in a car you are the two tire when were taking a turn at the time of taking turning you are the outer the wheel and the inner wheel if they are running at the same speed then exactly they cannot because in a when they are taking a turn outer wheel is taking a longer part then this is taking a less part. So, this to be adjusted over there and that is why you might have seen all trucks cars at the back there is a differential.

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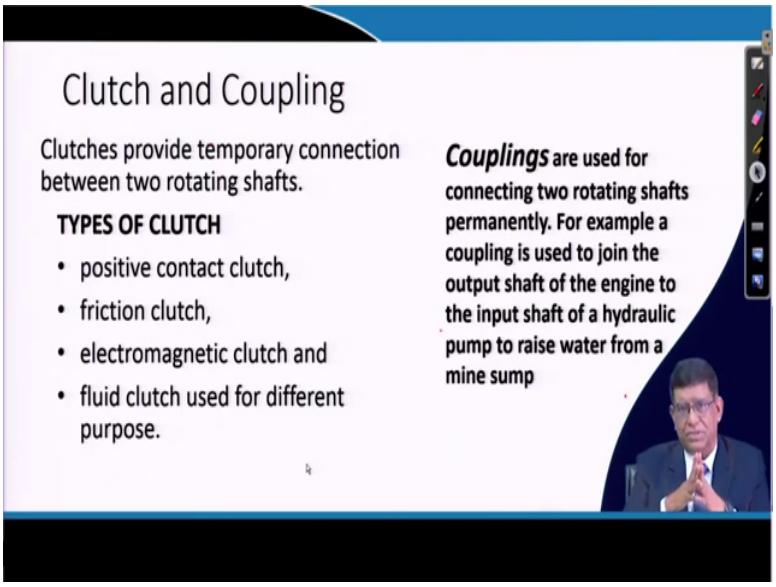

So, we need to understand about how these things works. Similarly in a power transmission system most important (Refer Time: 17:53) clutch and coupling. Now, what you have seen in your car that is a clutch is used for changing gears. Now, what they do? Exactly the temporary connection between two rotating shaft. If a if there are they are in a gearbox there is a gear train in the gear trains they have got different matching gear.

That means that depending on the that your torque requirement if your high torque is required you would be taking a little that is it will have to run at a slow speed; so, for that connecting these two shafts while the machine is running that means, a temporary connections making and breaking done by clutch.

but coupling is a permanent thing that means, when they are rotating at that time they cannot get that open that while they are an operations it cannot be disengaged. They can they will have to be always engaged that is the difference of your clutch and coupling.

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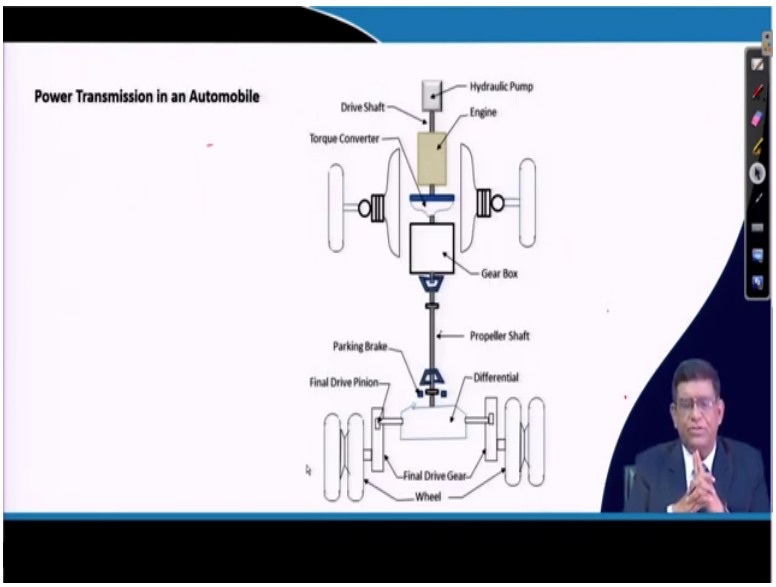

This one you can see over here as a automobile. You can try to draw this type of diagram that is your the main gear box is here. From that there is a one word you can see here the torque converter that is from the engine in between there is a torque converter. Now, we will see what is a torque converter.

Now, from that gearbox you are giving to a propeller shaft in between there will be a coupling and then there is going to a that is your parking brake is there then differential there from the

differential it is going to the final drive of this that your where the wheels are connected. So, this is a simple power train of a automobile of an automobile.

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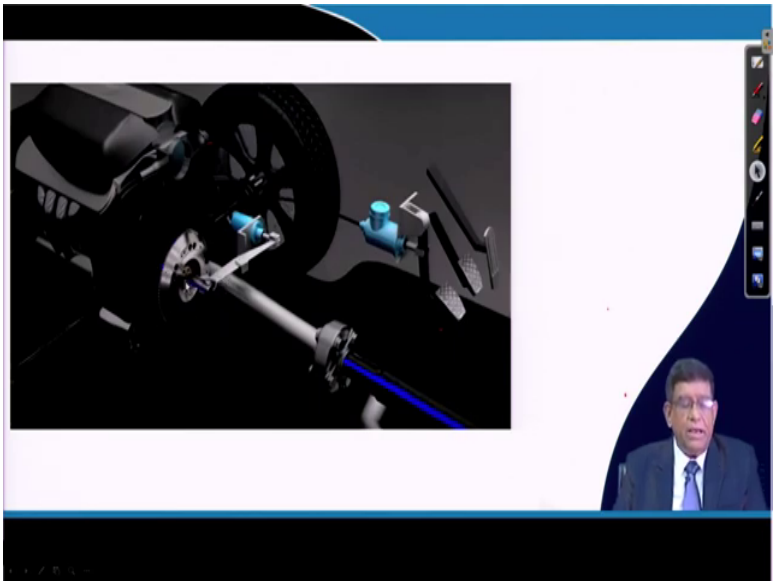

Now, you can see here in that automobile what happens. From the engine this is the fly wheel. You can see the fly wheel of a that engine.

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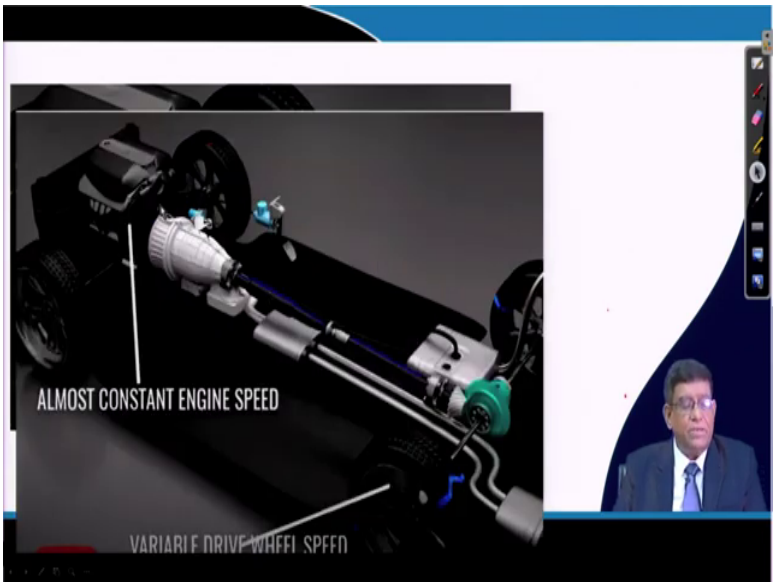

Now, this is to be connected that with a your power transmission system to that shaft; so, that it goes to the differential and it goes to the other rear side of the that extends. Now, when the engine it will be running at a constant speed from that we will have to control the speed of the car. So, that is why a transmission system is required.

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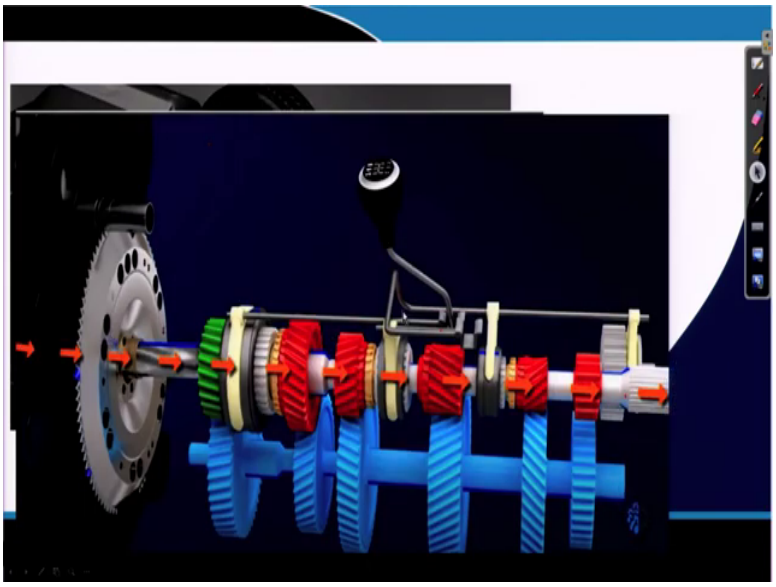

Now, in that what is there? If in a manually operated you can see here the clutch is there. From that clutch it is connecting different these gears at a gear 1, 2, 3, you can change it over here. By that these engines power will be going and the driven shaft will be running at a different speed.

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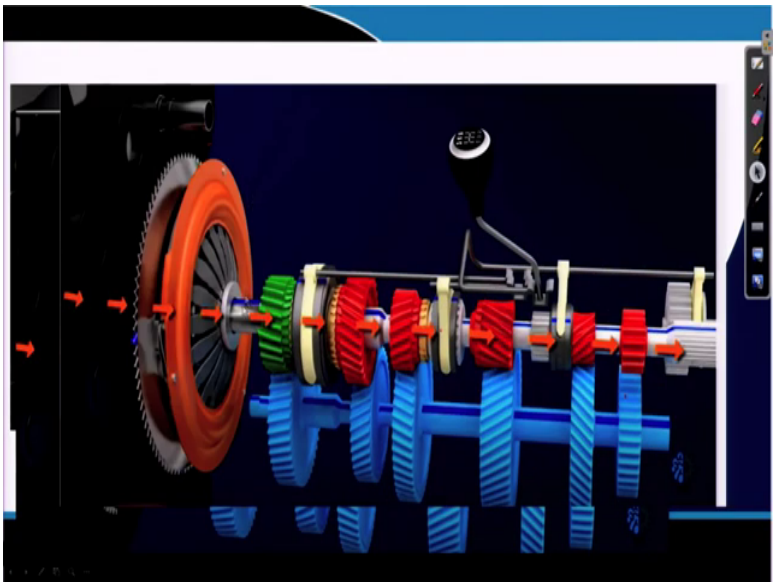

So, this how they are doing? For that we are using a clutch here that is a from that we are connecting these drives.

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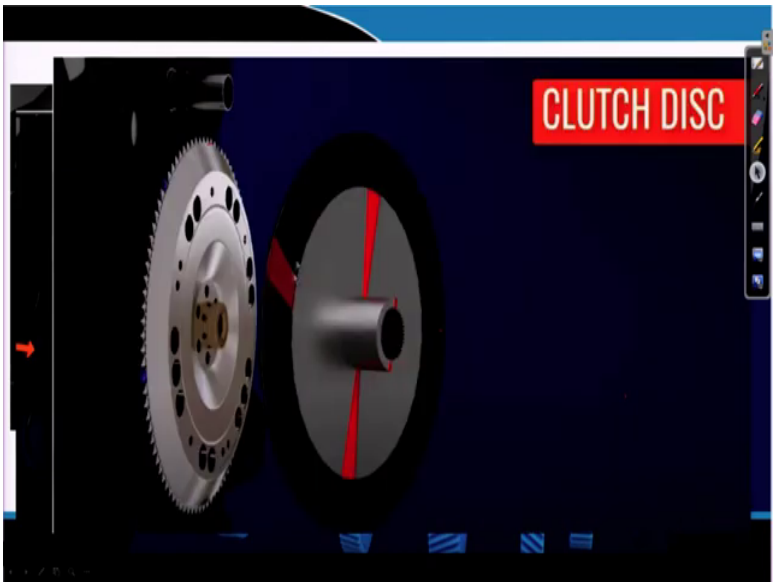

So, this you can see here the clutch disc. What is done? In the previous one you can see in that clutch disc this is connected or splined to the means, (Refer Time: 21:07) that your gearbox. Now, here this is a plate where we have got both sides of friction, this will be connected with a splined very with that your fly wheel.

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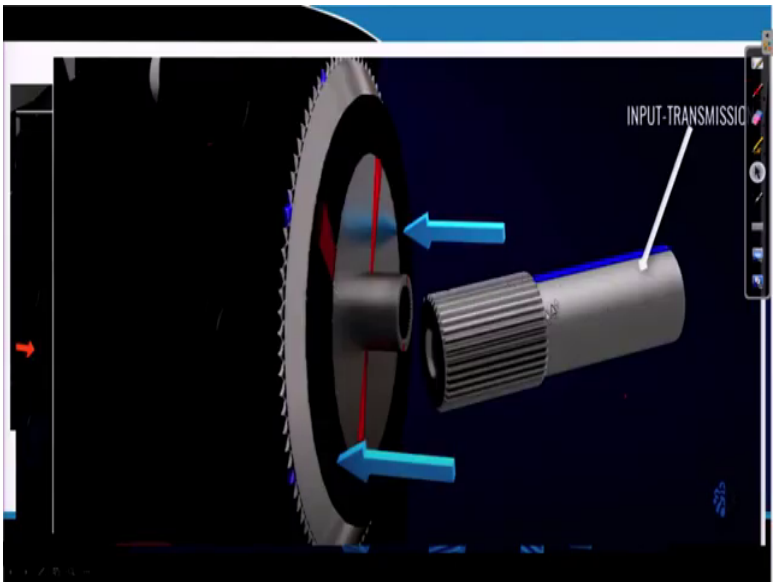

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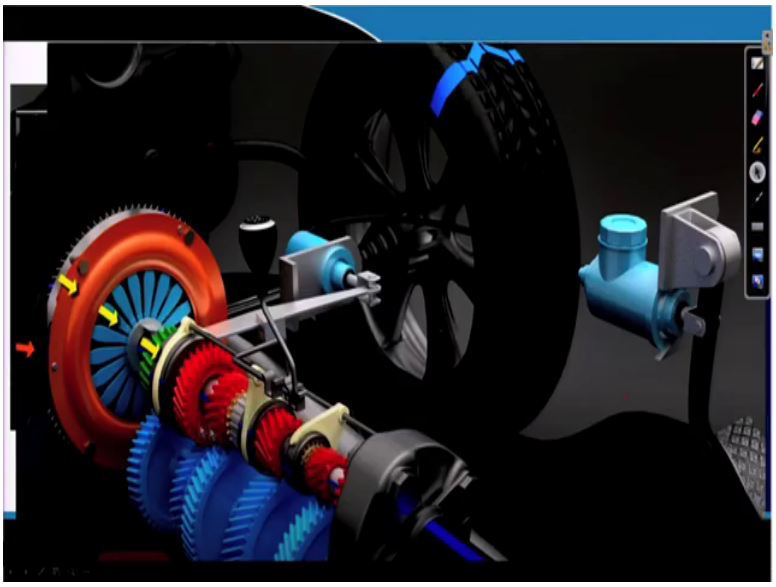

And then what will happen? When these get rigidly connected your and by controlling the clutch you can engage and disengage and that is why you are with this clutch operations you are engaging or disengaging this disc with the gearbox and whichever shaft you want to connect you are doing that. That is that which is happening that shaft the same that your matching gear you change.

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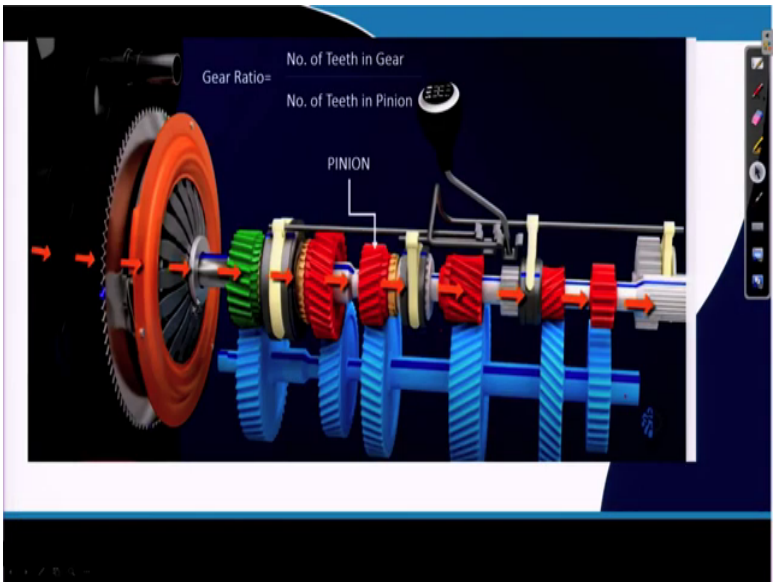

So, that is how exactly you are getting a different gear ratios depending on this clutch whether you are connecting these one these one like that your first gear, second gear, third gear. So, this is a in any geared range you will find there is a pinion and a gear. That smaller one is called your pinion and their teeth ratio and that gives exactly the whole you can calculate that how at the end shaft how much will be the torque coming, how much will be there speed coming that can be done.

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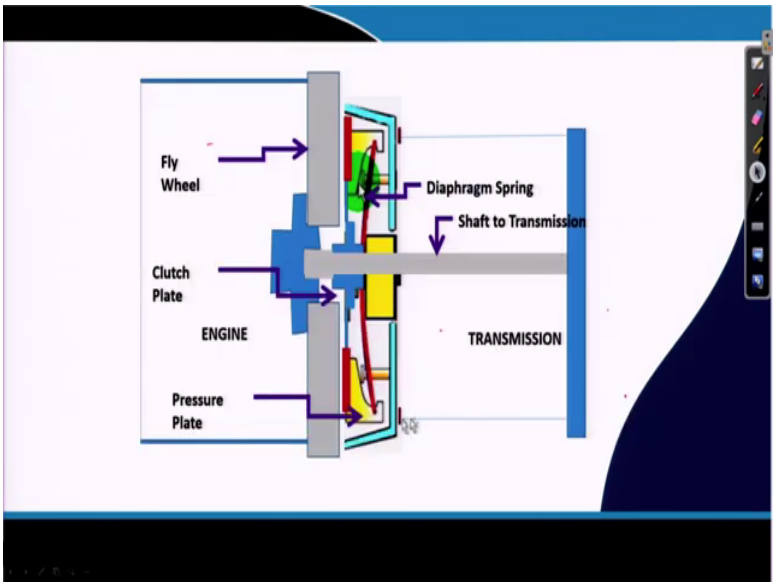

So, now in a how exactly the clutch systems work? As I said that engine fly wheel is there and before that in it from the engine it is rotating say at a constant speed. Now, this is a propeller shaft or the shaft for transmitting over there the transmission side. Now, you are having a diaphragm spring by which this your clutch pressure plate is there. By giving the pressure that clutch will be engaged to this one. So, when it is engaged over here it will start rotating otherwise not.

So, this is a schematic diagram of this particular system. You can see here this is your the tire from spring. Exactly this is a very specially designed. If you are giving a pressure over here when you press like this this that yellow part this will be coming out and then there will be a disengaged. So, this thing is here at that schematic diagram and then by this you can explain

exactly how a clutch and this clutching is done in a mechanical transmission system. [vocalized-voice]

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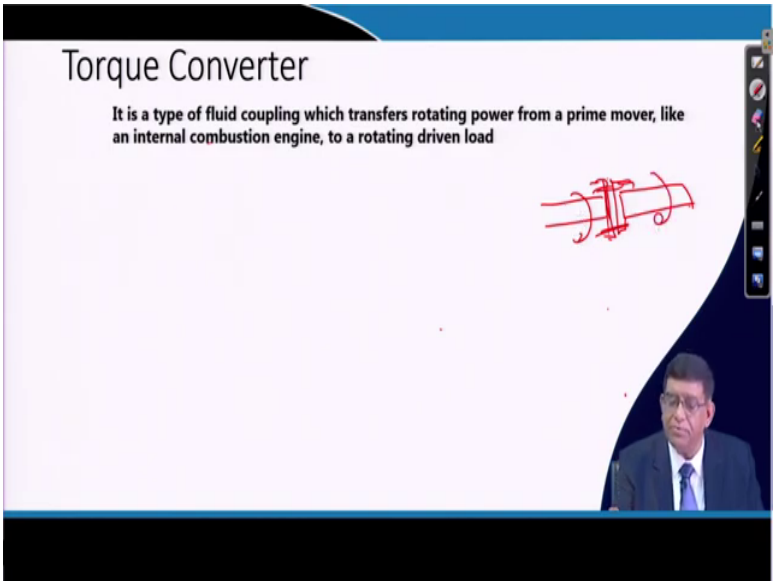

Now, as they say that there is a torque converter. This torque converter it is a type of coupling is a fluid coupling. Normally, what we see in your engineering drawing class you have done I think drawing of a flexible coupling or a flange coupling.

In a coupling what if there is one shaft this is exactly your this one shaft is there and then another shaft is there these two can be coupled together. You can have a plate over here and then we take out and boom we can join together. So, that if it rotates it will also rotate that type of systems can be made.

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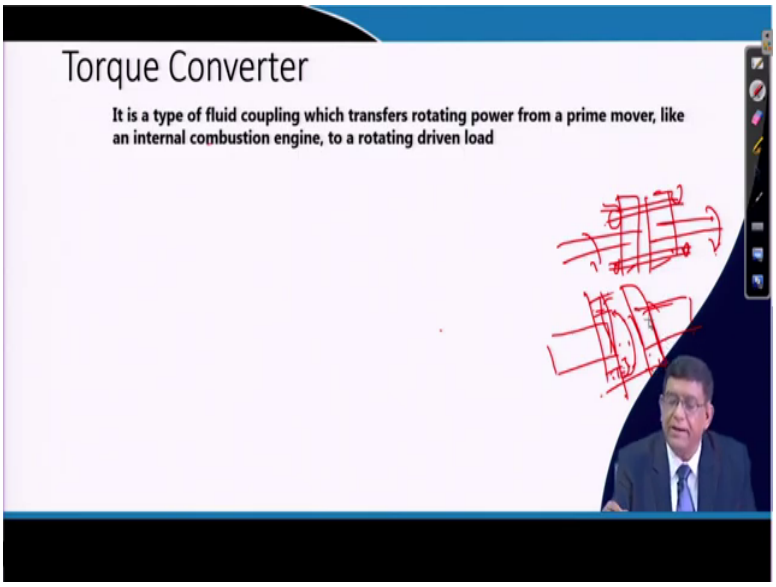

But in some cases it is not done. If in between these we are not having the you are not having these two plates to connect over there. This is a shaft, this is a set driving shaft and this is your driven shaft we are connecting by a nut and bolts over here these two plate tightly and they are rotating. [vocalized-voice]

But if we are having this shaft and this shaft in between we are not having we are having in a box all our oil and then we are having a system by which exactly we make this fluid to rotate now these fluids will make this to rotate. So, what happens here? That is your if in the driven shaft already very heavy loads are there.

At that time your that your the when that the driven shaft is to be rotated, then because there is a heavy load over there the driving shaft which is connected to a motor say, it will have to give a very high torque and for that the motor connect will be drawing a lot of current.

And if that high current will be passing that will be your I square R loss will be very high as a result there will be a that you will get the motor get damaged. So, that is why, what is done? If your the driven shaft is start slowly moving first and then it takes the full load and to do that system in between there is a coupling called fluid coupling.

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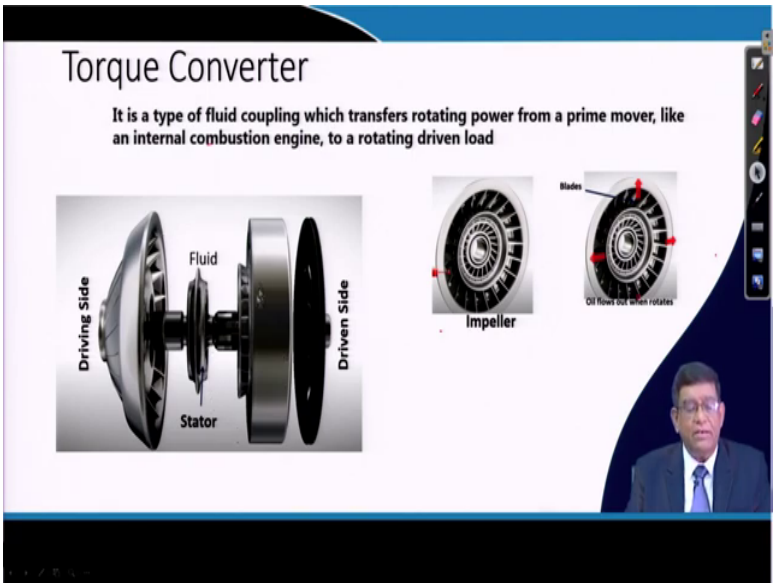

Now, the fluid coupling is a device which we can use like this. We are having a driving side and we are having the driving driven side here. So, there is in between these two box there are the fluids. Now, when this fluid will be rotating that when it is going over here then there are

these impeller these blades are there. These blades will start rotating and then the fluid will be passing through it.

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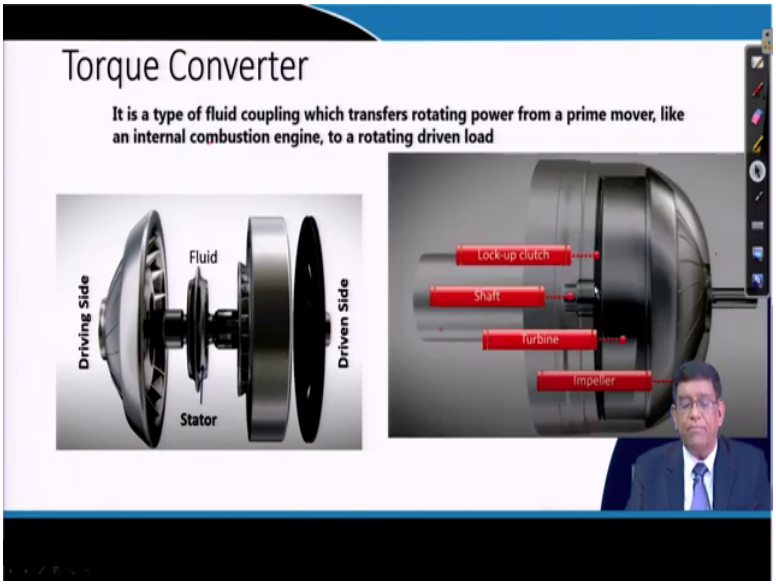

So, as a result the in between the fluid will come and that is exactly in between we are keeping a stator by which the fluid will be thrown from here and then it is rotating and again it will come back over here like that the fluid will slowly getting a high speed over here.

It is something like your fluid coupling is if you are having a table fan and just in front of it you keep another table fan then if you make the other fan on that are the opposite fan also blades will be started rotating because the air in between they starts rotating. So, that same principle is used over here.

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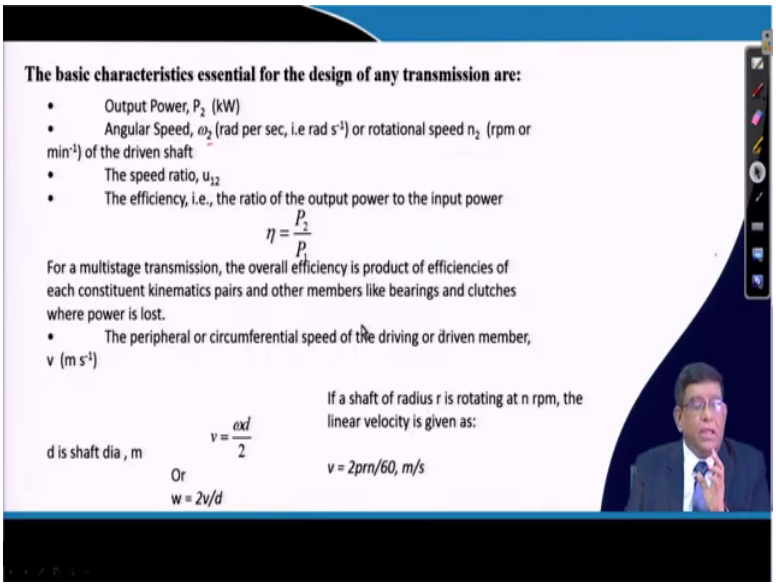

So, now this is a if this convert the torque converter, it is exactly from here we are getting a accelerated speed you can have a whatever the torque required for your changing the depending on to the load requirement you can do with this. So, that is how a torque converter is used.

So, now, the basic characteristics that is essential for design of any transmission system. Say for example, your output power is a P 2, then your angular speed of that is given as a v omega 2 and that will have to be rotated at a speed say n 2. Then the speed ratio it is there by n 2 by n 1 and then the efficiency of the system is given by the ratio of the your power input and the power output.

So, now in case of your the multistage transmission the overall efficiency is the product of efficiencies of each constituents of the kinematic parts. So, there could be number of times

that different things get rotated. So, their efficiencies get multiplied. Nowadays, there is a another thing is your the peripheral circumferential speed of a driven system driven member that we can find out if we know the angular speeds and that shaft diameter from there you can find it out.

So, if the sub radius is given from that if your power is known and then you can find out the velocity. So, whenever you are going to get any machines thereby from the dimensions of the diameters and things and that engine parameters you can start finding out [vocalized-voice].

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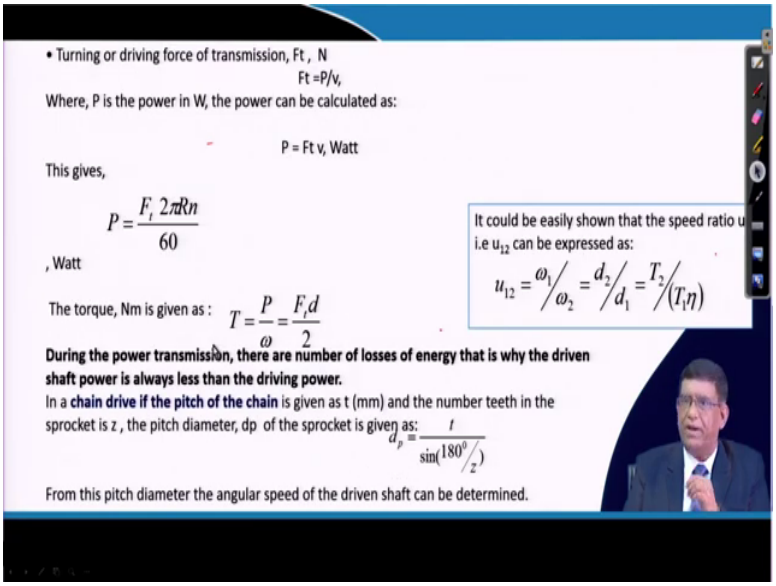

And you can find out this what is the turning or driving force ok. So, this that the power can be found out if you know the that your driving force is given then with the velocity you can find out how much is the power. So, that power is related to your the total driving force and

then which is depending on this 2 pi r n by 60 by this you can get and then the torque which is available it is it can be calculated out by this formula.

So, during a power transmission there are number of losses or the energy that is a driven shaft and the power is always less than the diving part. That is why that is a you whenever you are to determine what will be the motor power.

Say for example, this type of analysis you will be doing when we will be studying about the conveyor belt drive that conveyor belt the total material to carry how much power will be required. Then the motor power requirement depending on this efficiency of the motor how much energy is getting lost you will have to do it over there.

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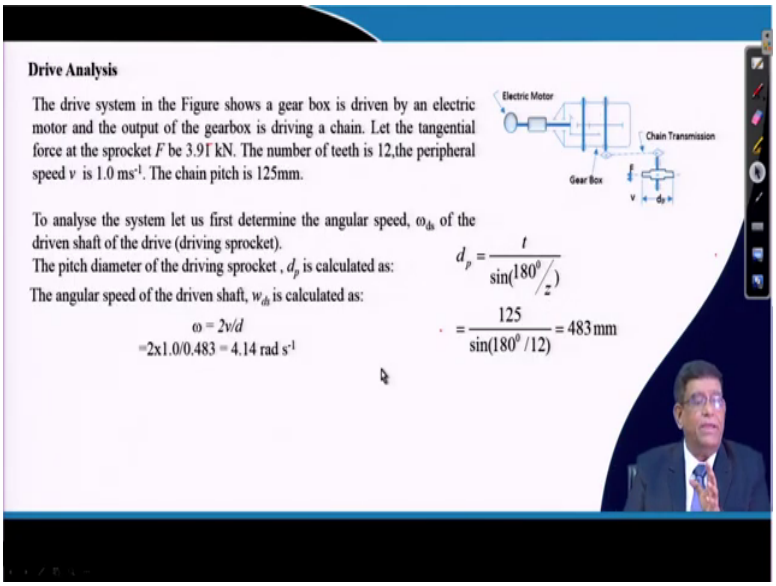

So, these type of analysis will be carried out. So, you can formulate, you will be solving such type of problems that if you are having an electric motor then we are having a gearbox and from that gearbox you are taking by a chain drive and then this from that chain drive we are driving another motor.

Now, at this end what will be the torque coming and then to get how much will be that velocity requirement and then for a given that your efficiency, what will be the motor power, such type of analysis can be done as a level you will be learning mining machinery.

So, I request you to do a simple problem like this. You takes any values in between. Say there you are giving it a tangential force of the sprocket, we are giving a 3.91 kilo Newton and number of teeth is a 12 and the peripheral speed is 1 meter per second and the chain pitch is given 125 millimeter.

Now, you can find out exactly what will be the your power requirement in the motor. Now, this type of problem of course, today I am just introducing it. While you are going to study different machines, systems like your the conveyor belt drive or the chain drive or the crawler drive there you will have to do this work.

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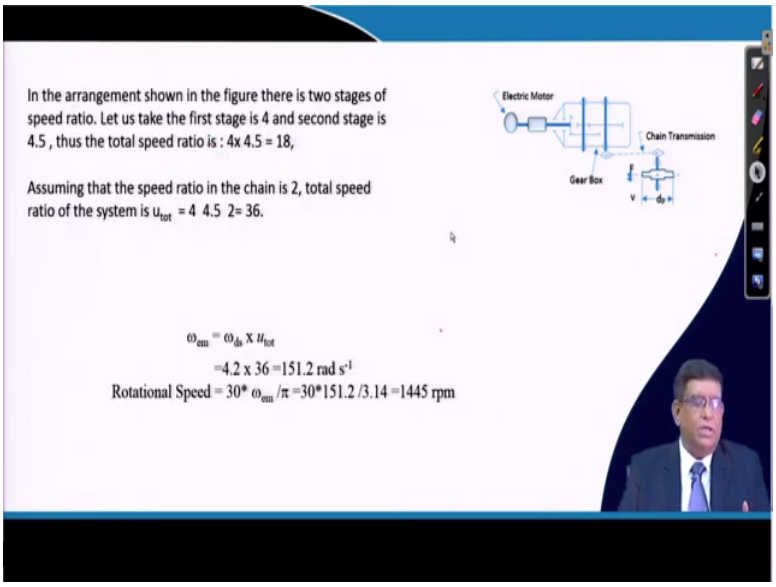

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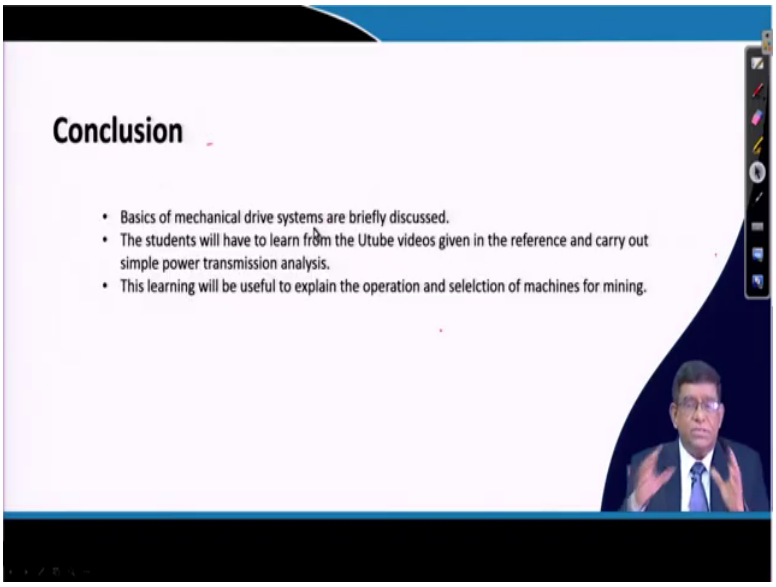

So, you are you try to solve these problems of how the power transmissions will be carried out. We will be coming back to this discussions or calculations of the power requirement of the drive motor for different type of power transmissions like your belt drive or by the chain drive or the crawler drive. Exactly where in case of your belt drive this a form a friction between the conveyor belt and the steel drum and in case of your crawler there will be sprockets, on that sprocket the chain will be moving.

So, that how those drives are given there will be doing in our subsequent classes these things. Today we will stop it here. So, what you have learned so far is the basics of mechanical drive systems. They are very briefly discussed. The, you will have to learn from the YouTube videos that the how exactly things work [vocalized-voice].

And then we will be like turning to our learning for analyzing to explain the operations or for selection of machinery. So, that power transmissions will have to be known. For say for example, if you want to select a conveyor belt for taking say 10000 ton of coal carrying per hour on a conveyor belt then to drive that belt, what should be the motor power that we will have to calculate and that type of analysis we will do in our subsequent classes on the transportation machinery and things like that.

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So, with this and I request you to go through the some of the videos where you can see the clutch, when you can see the how a fluid coupling works, how a chain and sprocket work, you can easily make your things and start exactly writing down the explaining how things work.

Another thing also I suggest as a learning strategy. Please go through that how stuff work and in that how stuff work videos and descriptions you will be able to exactly update your

knowledge about the machines and then when you will be doing some small these design calculations it will be very easy for you to learn this subject; so.

Thank you very much.