NPTEL

NPTEL ONLINE CERTIFICATION COURSE

Course
on

Spur and Helical Gear Cutting

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Lecture 05: Numerical Problem MCQ

Welcome viewers to the 5th lecture of the open line course.

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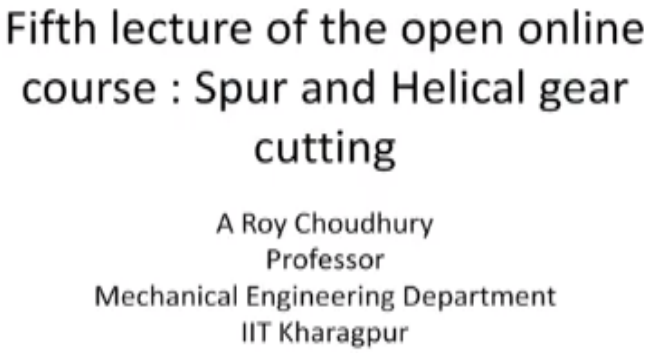

For an helical gear cutting so we have finished 4 lectures in which we have discussed about you know gears in general there functions I mean what purpose they serve and we have discussed some of the you know calculation aspects of gears like what is module and how to calculate gear ratios for optioning a particular rotational speed for a easier rational, rotating craft by employing gears what are the you know geometrical nomenclature of spur gears and helical gears etc.

And some specific special type of gearing like worm and worm gear from machine elements mechanical I mean some mechanical machine elements there which will be required for our sub sequent lectures like screen and nut mechanism etc all things we have discussed and today we will take some invitational problems which will further help you to understand the you know the way in which gears can be employed to shoot our different requirements, so let us start write away and look into some of the numerical problems some multiple choice questions both preliminary and difficult.

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1. Gears with the same module

a. Would always mesh with each other
b. Would always have the same diameter
c. Would always have the same number of teeth
d. None of the above

So the first one gear with the same module would always mesh with each other, would always have the same diameter, would always have the same number of teeth, none of the above, so first of all gears in the same module, m is the same for all these gears and if you are dealing with the different system of unit for example say if you are expressing your diameter in inches we would be saying gears with the same diameter bitch, okay because basically z/ d where d is the bitch diameter in inches.

And Z is the teeth, so what we are saying is that if such gears are taken which all of which have the same module they would always mesh with each other this is correct so in this multiple choice question we have identified the first one is definitely correct, they but all this mesh with each other, second so we are talking of basically you know for gears at this movement it can also be extended tom helical gears, but let us restrict our discussion here, so we should you know

slightly modify the questions this ways is spur gears with the same module would always mesh with each other would always have the same diameter.

No we are not suppose to have the same diameter because you know if a gear of a family if a in a family of gears with the same module if you go on increasing the number of teeth that I increase so they are not necessarily go have the same diameter it always the same number of heat know not all, because if you have all the gears of the same number of teeth what purpose with this serve except for you know transmitting power form one spur to another, so none of the above, so e is correct would always mesh with each other.

Gears having the same module would have larger teeth for larger diameters so all these gears have the same module we have taken a family of gears, so if we take larger diameters we will find a piece having becoming larger and larger would have smaller teeth, for less number of teeth if you have less number of teeth you will find the teeth are becoming smaller in size we have larger teeth for higher number of teeth, just the opposite none of the above so let us see one by one.

Would have larger teeth for larger diameters, so first and for most of the vision that we can make is that if you have the module to be the same the size of the tooth becomes defined, if module is then same the size is size of the tooth is constant the edge addendum or dedendum or working death or total depth or the chordal addendum or chordal thinness etc everything is the same module is the same, so none of the above so let us look at the question once again there would not be larger teeth. There would not be smaller teeth and therefore none of the above is correct.

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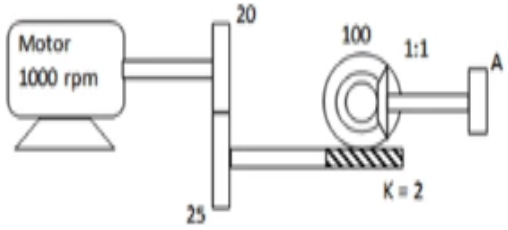
3. The RPM of Gear A would be



a. 20 b. 30 c. 32 d. None of the others

Now for a numerical problem what is this numerical problem of bitch is that the RPM of gear A would be the RPM of gear A would be you know 20, 30, 32 none of the others, so let us start from the beginning okay there is a motor with 1000 RPM and it is connected with 2 spur gears, respectively we present it on the sheet of paper.

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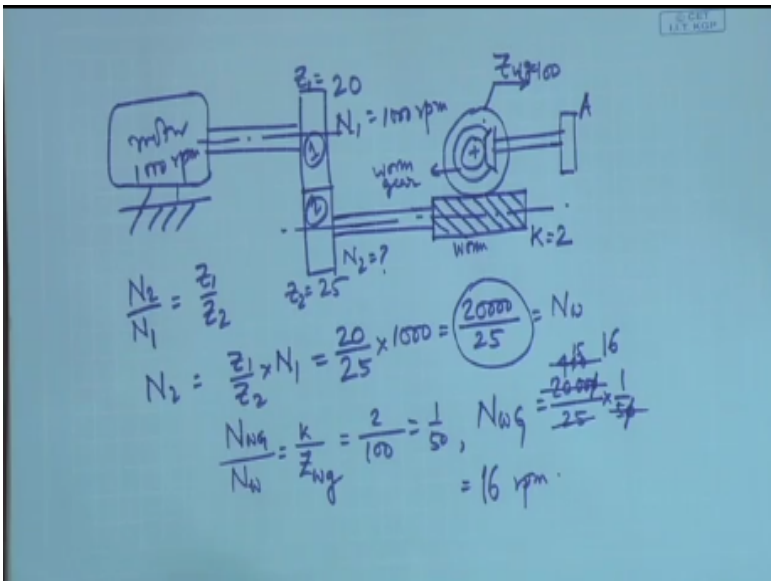

And let us see the calculations this happens to be the motor let us draw quickly because it is already there in front of us this is our motor it is rotating at 1000 RPM these are just hypothetical values you know just a frame of question 20 I have I am having 20 with that I am having 25 so what do we do with this we say we already know $N_2/ N_1= Z_1/ Z_2$ therefore $N_2 = Z_1/ Z_2$ x N_1 N is the RPM Z is the number of teeth, so this be gear number 1 and if this be gear number 2 this is having 25 teeth's and Z_1 = 20 teeth.

And N_1 = 1000 RPM because it is sharing it is RPM with the motor and N_2 is not known, so what is N_2 going to be N_2 is going to be let us putting Z_1 20/ 25 x 1000 so that gives us 20000/ 25 let us not cancel anything at this movement because there is something down the line and up to this, this we studied the last day that is who to read a drawing, what is this suppose to be this is you know the symbol that we are using for a worm there should be actually access lines like this to show they are having a access rotation and it is access symmetric.

So fine this is a worm, how do we recognize a worm K =2 is a giveaway number of starts of this worm = 2 after that let us identify the worm here yes this the worm gear, this is a worm and this is the worm gear so what is the worm given to do how many teeth does it have it has 100 teeth so we will have N worm gear okay divided by N worm must be = k / Z, Z worm gear okay equal to.

So we have this one to be 2/ 100 1/ 50 do we know the worm rotation N worm do we know yes this is sharing it is RPM with gear number 2 so this must be = N worm and k/ z is already found out and therefore we have N worm gear = 20000/ 25 x 1/50 okay, and what is required this one is

again connected with beadle gear where this is a symbol of the beadle gear and it is taken out and given to gear A how many number of teeth does gear A have is not give, it does not matter what ever is the rotation of the worm gear it is given the beadle gear is given by 1:1 ratio to the other beadle here and that is sharing it is RPM with gear A and that is why if you can find pout the worm gear rotation, you have found out the rotation for minutiae of A.

So this is the answer let us work it out 5, 5 sorry 0, 0 5 cancels out with this 4, 0, 0. 25 cancels out with this 1 okay and 150 and therefore how much is that 6, 16 none of the others let us have quick look at the calculations have we made any mistake N_2 = N1 x Z_1/ Z_2 okay, and that means this is 20 / 25 x 1000 so this is slightly less than 1000 and this is being given to the worm so N worm gear/ N worm is = 2 / 100 because = 1/ 50 and worm goes up upstairs and therefore it is 20000/ 25 x 1/ 50.

So 50 cancels it this 0, 0 cancels outs initially and 5 x 4 are 20 and therefore this we have 4, 0, 0. 25 goes into it how many times 25, 1, 16 okay so the answer is 16 RPM that is good.

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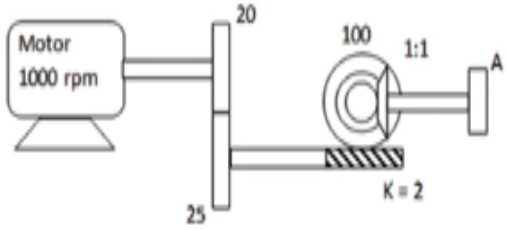
3. The RPM of Gear A would be



a. 20 b. 30 c. 32 d. None of the others

Next we have none of the others is the answer.

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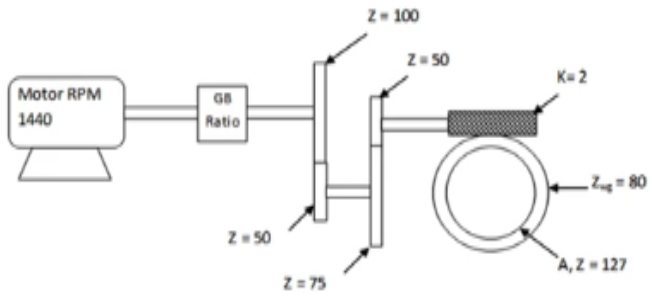
4. The rpm of the gear A is



(a) 54 (b) 6858
(c) 34.01 (d) None of these

A similar problem let us first of all the RPM of the gear box sorry the RPM of gear A is just a movement I think something is missing here yes something is missing here, the gear box ratio let me put some value here now how much do we put here say please a sure gear box ratio equal to 1/4.

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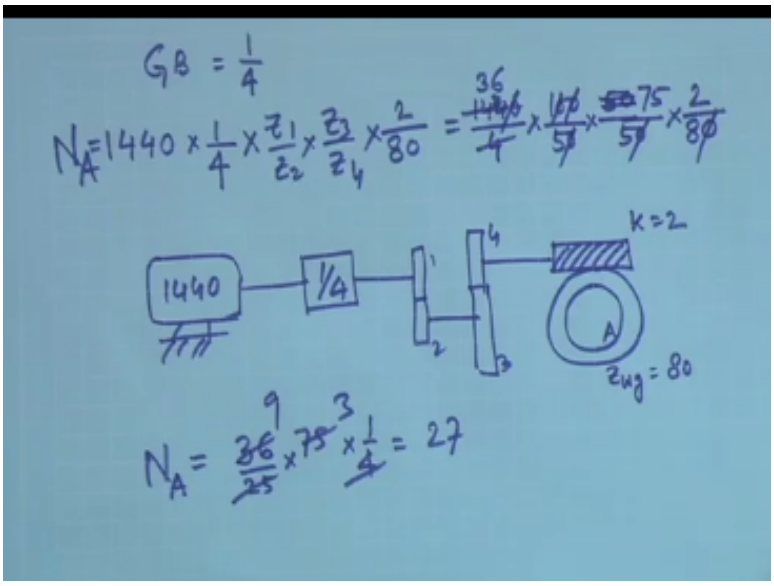

Okay we start with gear box ratio to ¼ after this so in that we can find out what is the rotation for minute of gear A motor RPM so we start with motor RPM 1440 RPM then it passes through the gear box we simply multiply the ratio because this is going to out the input so input x output / input is we going to give us the output, output RPM of the gear box must be = 1440 x ¼ this x by this gear ratio which is coming after this you know in these gear ratios that we have in the figure okay the figure is some out like this motor gear box and then gear 1, gear 2, gear 3 and gear 4 then comes worm and simply a gear mounted on the worm A and this is z_{wg} = 80 k =2.

So in this case this we have defined as ¼ this is 1440 and this is 1, 2, 3, 4 typically this becomes you know you can show it by calculation this is Z_1 / Z_2 x Z_3 / Z_4 okay multiply it by worm to worm gear once again this must be worm rotations for minute, so k / Z okay multiple by k / z k is 2 and this is 80 and this rotation shared between gear A and the worm gear, so this must be the rotations for minute of A alright.

So how much is this 1440 / 4 x let us see gear 1 as 100 / 50 x Z3 is 50 sorry Z3 is this one it is 75 / 50 okay x k is 2 and 80 is z this is answer naturally it would not match with the answer because I am very sorry that the gear box ratio was not given we have simply assumed some gear box ratio and found it out any way.

Let us do the preliminary calculations there are 000 in the denominator there are 0 in the numerator and this one will differently cancel out with 3, 2, 6x 4 are 24 so this is 36 so 36 / 25 x 75 x ¼ this gives us 3, this gives us 9, 9 x 3 are 27 so N_A is coming out be 27 okay I suspect that

the gear box ratio in the actual problem which I had designed previously it must have been ½ in that case it would have come out as 54, okay but any way whatever we have started with this thing stands by itself okay the rotations per minute of gear A would be 27 if we take this gear ratio to be ¼ that is it okay. So we will know the not able to bring your problem exactly as did you give the approximate is not mentioned I am sure you have understood this, thank you. So let us pass on through another problem.

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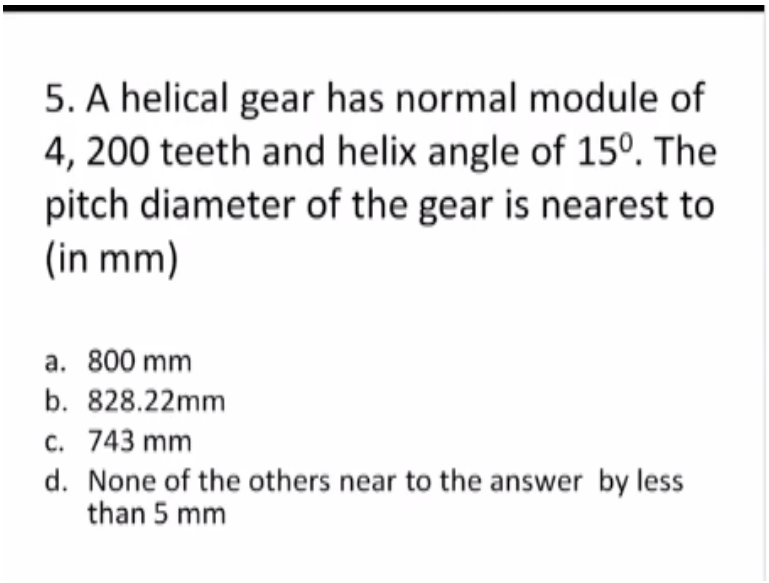

A helical gear has normal model of 4, 200 teeth and helix angle of 15^0, the pitch diameter of the gear is nearest to (in mm) 800 mm, 828.22 mm, 743 mm and none of the others are near to the answer by less than 5mm that means none of them are correct basically, okay. So let us first see I have till now we have been discussing about spar gears now we are talking about helical gears and last in the last lecture we had talked about a problem of this type.

What was this problem? The problem was this that if you have a spar gear with module = 4 and teeth = 200 we can straight away calculate the pitch diameter to be module into the number of teeth equal to 800 in this case, let us write down.

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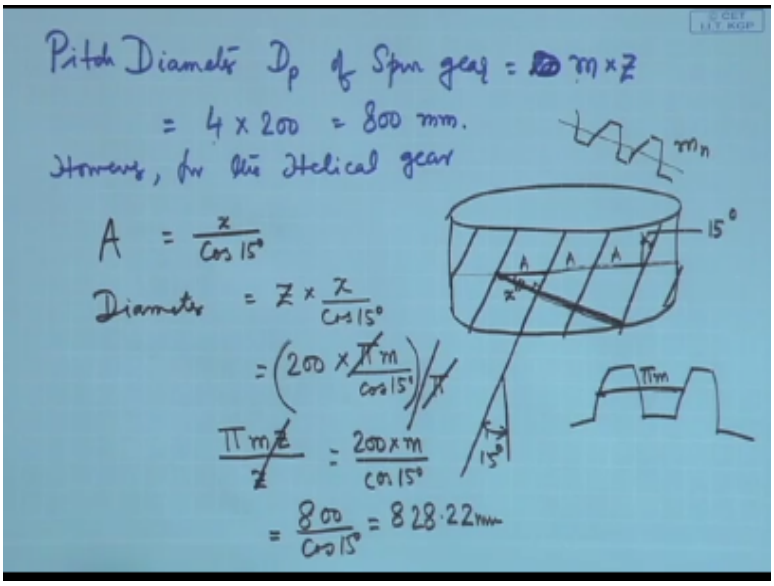

Diameter, sorry pitch diameter D_p of spar gear = 200 sorry let us give the symbol first, m x z = 4 x 200 = 800 mm. However for the helical gear this is the spar gear say yeah these are the teeth of the helical gear in a helical gear what happens is, that this distance taken normal to the tooth orientation this one corresponds to okay these dimensional if it is sectioned here it will be coming something like this.

This section if you take it if you cut it along this you will see the teeth this way and this one corresponds to the measurements as per this module that is why this is said to be corresponding to the normal module okay m_n in this direction however it is slightly larger naturally this distance is replaced by this distance it will take a section this way okay, so we are when we are mentioning this four okay we are talking about if you look at the problem once we are talking about normal module so in the fear coming back to the hand drawn figure.

We are talking about this distances teeth distances they correspond to the normal module okay, hence if that is so the diameter which is existing here and which is the summation of A, A, A like that okay it is slightly larger than the you know the distances which are obtained by the calculation of the normal module, so each of these sections they are replaced by this one and what is this angle, if you remember this angle is equal to the helix angle in this case say this is 15^0 this angle.

Let me write 15^0 so if this is 15^0 this is a right angle and therefore this angle will be 15^0 okay and this angle will be 15^0 and therefore we find if this is equal to x this one is equal to I mean A is

equal to we can write A = x/Cos 15^0 right, and how many A's make up the full diameter, if you go fully round as many number of teeth as many A values so instead of having X values here the diameter is made up of Z x X / Cos 15.

Let us replace 200 x now what is this x = this x = the distance covered by 1 tooth okay, how much is that, that must be equal to Π x m, so Π m okay/ Cos 15^0 if you find this out okay I think it will be coming out to be 828.22. So please calculate this because the top one just a moment, yeah if you look at this figure this distance which we are showing here this distance is nothing but the total okay this total divided by number of teeth Π m z/z so it is Π m.

So this thing is equal to the circumference right so if you divide the circumference by Π this cancels out and this becomes equal to 200 x module / Cos 15, which is equal to how much is that, 800/ Cos 15^0 and that will come out to be 828.22 mm so I hope this is alright this is equal to Π x m we go on as in Π m / Cos 15^0 z number of times and we get this value okay. So the answer is 828.22mm.

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5. A helical gear has normal module of 4, 200 teeth and helix angle of 15^0. The pitch diameter of the gear is nearest to (in mm)

a. 800 mm
b. 828.22mm
c. 743 mm
d. None of the others near to the answer by less than 5 mm

So what we observe is that the pitch diameter of the helical gear is going to have higher diameter than the corresponding spar gear if they have the same normal module.

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6. Power has to be transmitted from shaft A to shaft B. The centre distance of the shafts is 750 mm and the speed ratio (output rpm/input rpm) is to be 1:2. If one spur gear pair is to be employed with module 2, the number of teeth on the driven gear is

a. 20
b. 250
c. 200
d. 25
e. None of the others

Power has to be transmitted from shaft A to shaft B the centre distance of the shafts is 750 mm and the sped ratio output/ input is to be 1:2, that means the sped has to come down to half of its with the general value if once spar gear fails is to be employed with module of 2 the number of teeth on the driven gear is 20, 250, 200, 25 none of the others, okay. So let us write out.

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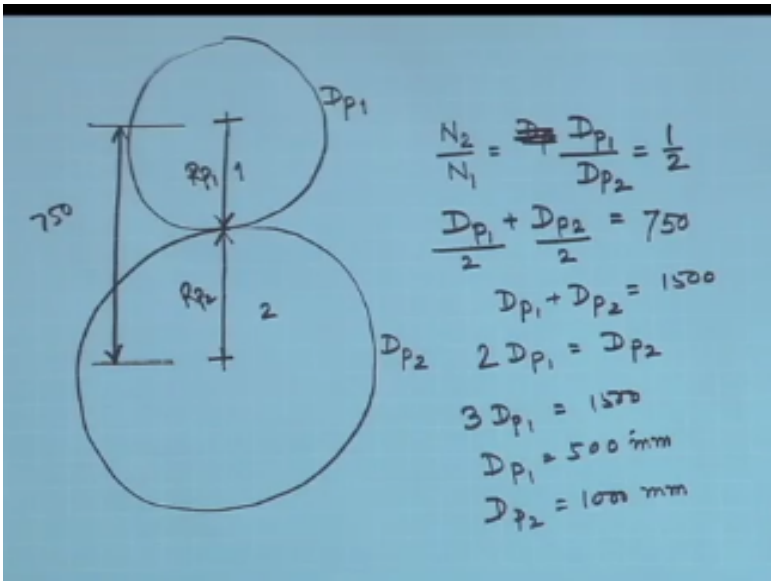

This is the centered distance how much is this, this is equal to 750 I have to employ two gears say hypothetical let me draw them this is one gear and this is another gear I have to employ them what are they diameter, I do not know but if these are representing the pitch diameters D_p 1 and D_p2 in that case I can say that definitely this speed ratio n2/n1 must be equal to D_p2 sorry D_p1 /D_p2 that means if n2 is less D_p1 must be less okay.

So having how do we get this, from the basic definition of pitch diameters we are obtaining this, what is Dp1 + Dp2 =, well Dp1/2 + Dp2/2 is simply equal to this distance plus this distance Rp2 and Rp1 so it must be 750 so we write Dp1/2 + Dp2/2 must be equal to 750 that is cool, what is n2/n1 supposed to be, n2/n1 is supposed to be half so we further get so let us send this to that side Dp1 + Dp2 = 1500.

And Dp1 = sorry 2Dp1 = Dp2 that is good let us replace Dp2 so we get 3Dp1 = 1500 therefore Dp1 = 500 and therefore Dp2 must be equal to how much let us see, Dp1 = 500 so Dp must be equal to 1000, which means so the diameters have been found out so let us see what is to be calculated so is this understood that Dp1 and Dp2 can be found out from two relations that is the centre distance which is equal to the sum of the two radii.

That is equal to 750 and Dp1/Dp2 = the ration of the rotation per minute stated, by using those two we have solved Dp1 and Dp2 but the question of different.

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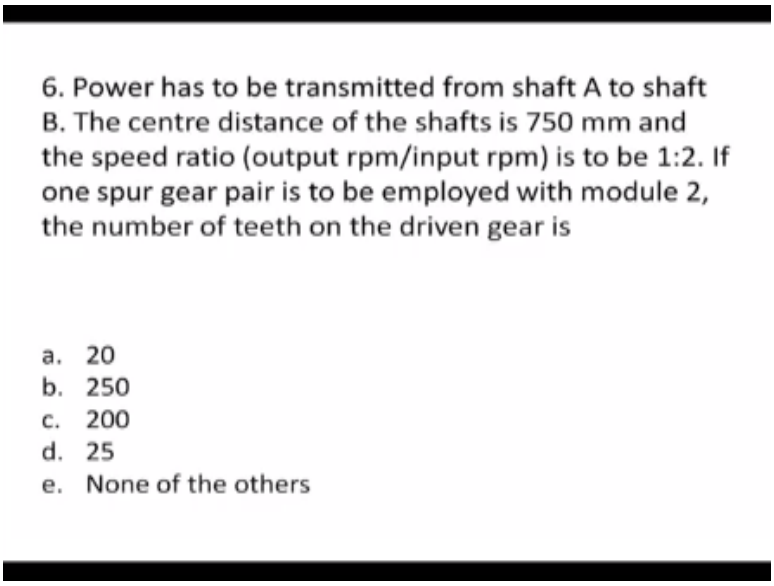

Let us look at the question, if one spur gear pair is to be employed with module 2, the number of teeth on the driven gear is this is the driven gear.

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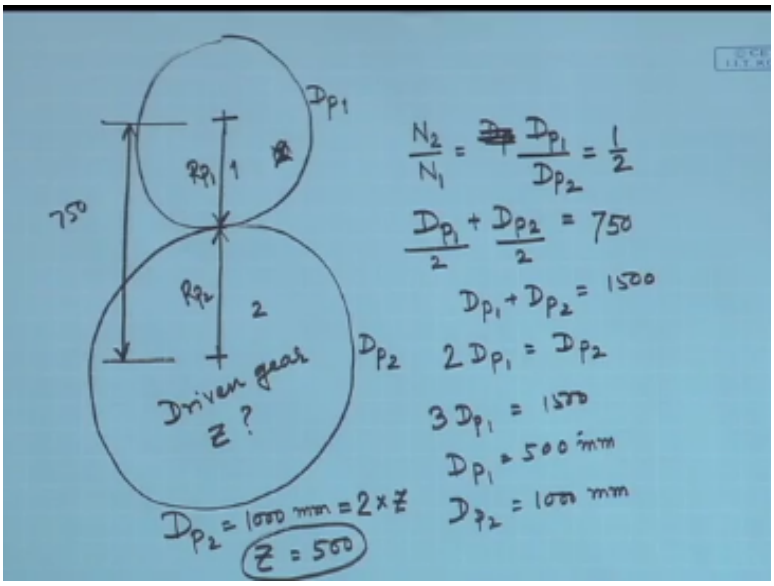

Driven gear each serving the purpose, yes as it is connected with the smaller gear if this has Rpm x this Rpm will be less than x, okay. So because it is larger in size and infact the node here diameter value the exactly the diameter will be brought down by a factor of half, okay. A factor of 2 the Rpm will be brought down by a factor of 2, so everything is satisfied now we have to find out the number of teeth on the driven gear, number of teeth.

So z has been asked for, so what we can say is that since Dp2 is known to be 1000 mm and module = 2 we can write this must be equal to module 2 x by the number of teeth, therefore z is equal to 500, answer is none of the above, why have we given a question in which none of the above is the answer the reason is this, very frequently students make a mistakes they put Dp1 that is Dp2 = 750. And immediately they will get an answer of 250 they will say Ha, ha 250 is there.

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6. Power has to be transmitted from shaft A to shaft B. The centre distance of the shafts is 750 mm and the speed ratio (output rpm/input rpm) is to be 1:2. If one spur gear pair is to be employed with module 2, the number of teeth on the driven gear is

a. 20
b. 250
c. 200
d. 25
e. None of the others

And they will pick on 250, okay. This is a tricky part of the question, you have to be extremely alert, so answer is none of the others.

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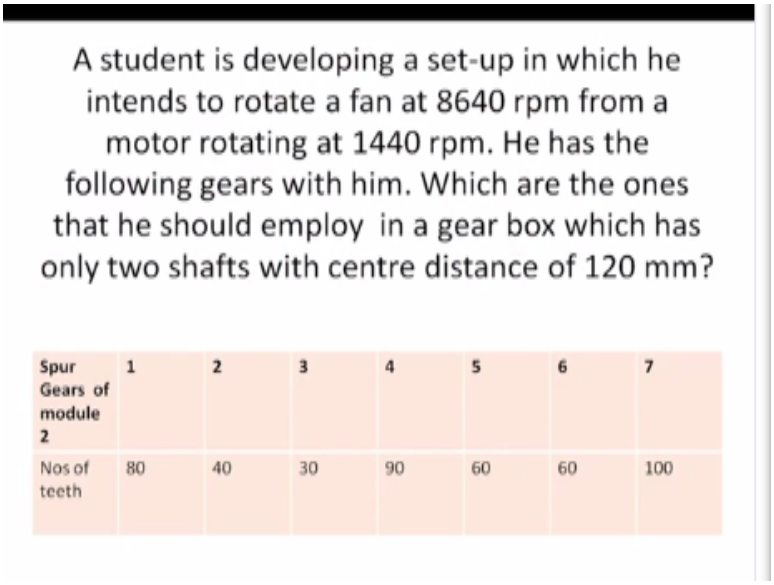

I think we have just a one or two minutes so that I will just introduce this problem and ask you to solve yourselves and I will provide the answer in one of the subsequent lectures and if tiny z I will discuss it as well, a student is developing a set up in which he intends to rotate a fan at 8640 Rpm from a motor rotating at 1440 Rpm, Okay. So almost 6 times the Rpm has to be increased he has the following years that have which are the one that he should employ in a gear box which have only two shafts. With centered distance of 240 mm, so let us have a look at the figure.

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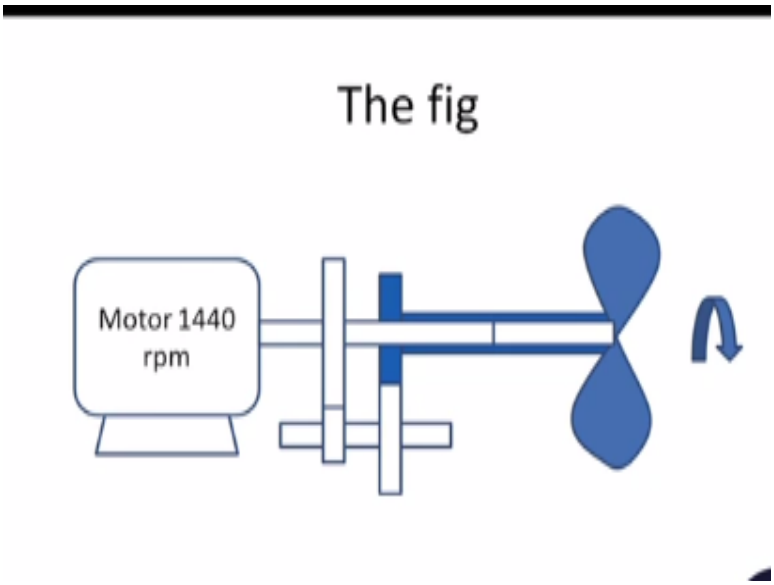

This is the proposed figure motor 140 Rpm give with it, gear to you know alterably we shaft and this one sharing Rpm giving it to another gear which is loosely fitted on the first gear not forgetting not having any rotational illusion with the first gear, first shaft and this one is connected with the fan, so with only two shafts we are able to bring down Rpm once here and once there so what should be the answer, okay. You can think about this we will discuss the answer in one of the subsequent lectures, thank you very much