Gear and Gear Unit Design: Theory and Practice
Prof. Rathindranath Maiti
Department of Mechanical Engineering
Indian Institute of Technology, Kharagpur

Lecture – 05
Tutorial

Now, this is the Tutorial part of the Module 1 that is on the introduction to Gear and Gear Unit Design. And this is lecture 5 and tutorial in nature.

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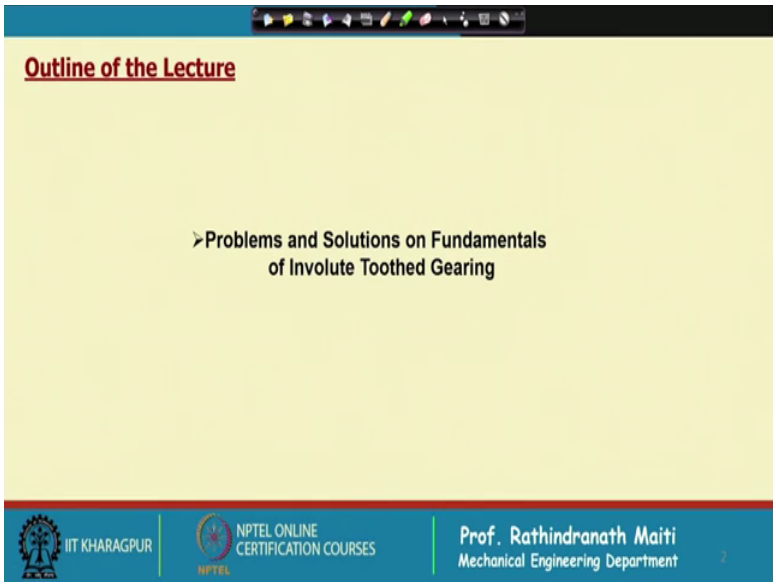

We have considered few problems and solutions on fundamentals of involute toothed gearing here of 40 teeth.

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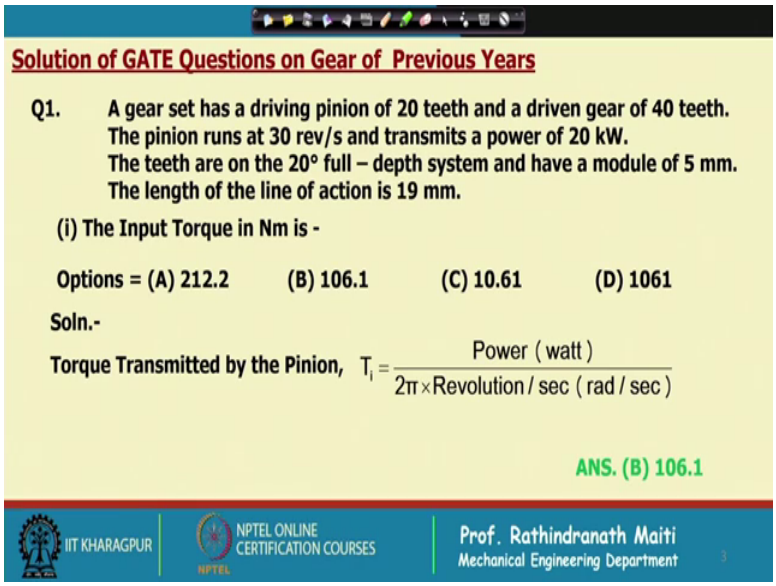

The pinion runs had thirty revolution per second and transmits a power of 20 kilowatt, the teeth are on the 20 degree full depth system and have a module of 5 millimeter the length of the line of action is 19 millimeter.

Now, on this question there are 3 4 sub questions. So, this has to answer the first one, which is not exactly from the gate one, but it is very relevant to the gear system this is to calculate the input torque. Now the input torque in newton meter each here this is very important that you should look into the dimensions what is given? And when you are entering the data, you need not enter this unit and perhaps it is not also possible. So, you have to enter only the numerical value.

Now, next this answer options are A is 2 1 to 0.2 and B is 1 0 6.1, C 10.6 1 1 and D 1 0 6 1 all this should be newton meter.

Now, the equation what we can consider that the torque transmitted by the pinion will be equal to T I, which is input then it is equal to power that we have to express in watt divided by revolution per second or the angular speed, which must be in radian per second. Now here it is given that revelation is 30 revolution per second that speed is 30 revolutions per second.

So, simply if we multiply it with 2 pi that will give the angular speed radian per second and substituting the values, if we calculate we will get the answer as 1 0 6.1 this is in Newton meter.

So, here we have to put the tick on B.

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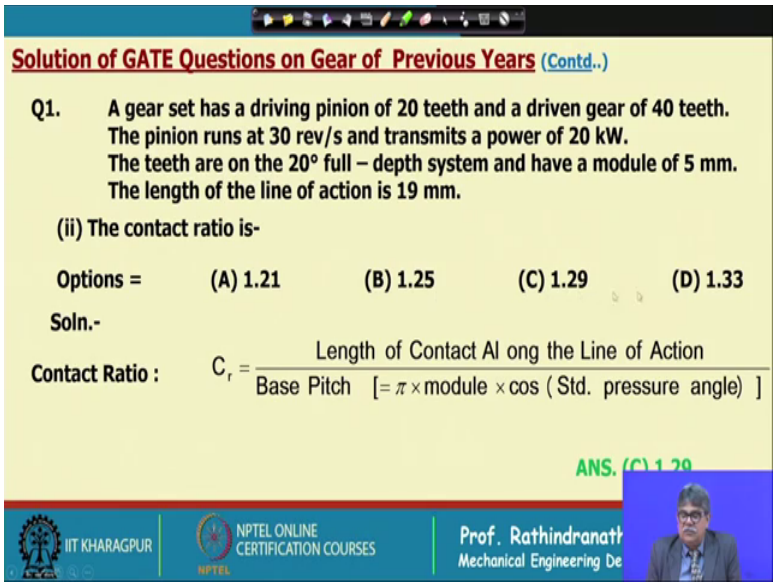

Next question is out of that what will be the contact ratio. Now first of all we should know what is the contact ratio? Contact ratio is length of contact along the line of action it is not a I go along the line of action and divided by the base pitch base pitch of the gear. So, which is equal to pi into module into cos of standard pressure angle?

Now, here the length of contact is usually calculated, but in this case length of contact is given 19 millimeter it is along the line of action. So, we can directly put that into numerator and then we can calculate that what is the base pitch and we can find out this one. And the answer will be 1.2 9. So, in numerator we will put 19 and here we will pi into module is given which is 5 module. So, this is 5 cos into 20 that will give us the value 1.2 9. Even if in calculation if it is close to that say if is 2 8 7 or 2 9 3 something like that you should select this 1 not this two.

So, calculation to be done very carefully.

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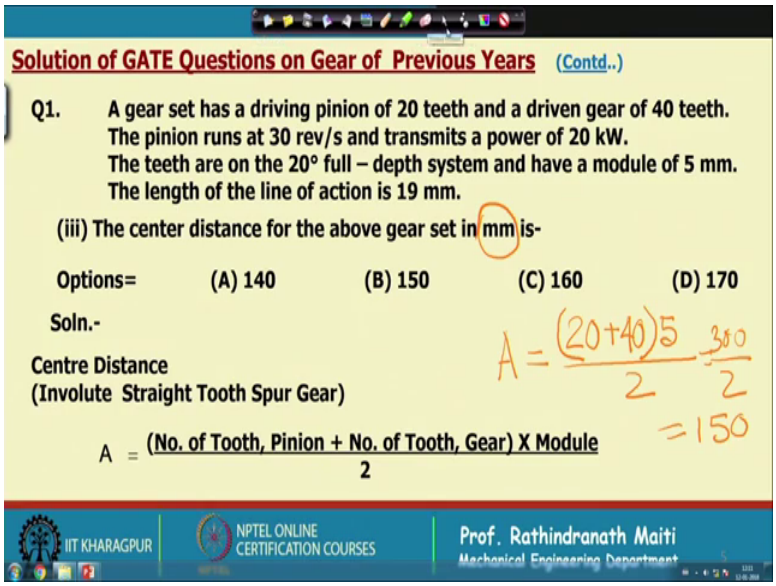

Now from the same problem we have to find out the center distance for above gear set, that is also look at this here this you should 1 should be very careful because only you have to click and where the range is given there you have to put the range value.

So, usually the dimension is kept outside in this case. So, it is given here in millimeter. So, we should calculate in millimeter and that value we should select from here ok.

Now, this is options are given 140 150 160 and 170. Now how to find out the center distance the center distance is equal to number of teeth in pinion plus, number of tooth in gear total multiplied by the module and divided by 2. This means that a the center distance is equal to hear the teeth number of pinion is 20, teeth number of gears is 40 and whole multiplied by module 5 divided by 2.

So, this becomes 300 divided by 2. So, directly we get 150 ok. Now so, answer is B 150.

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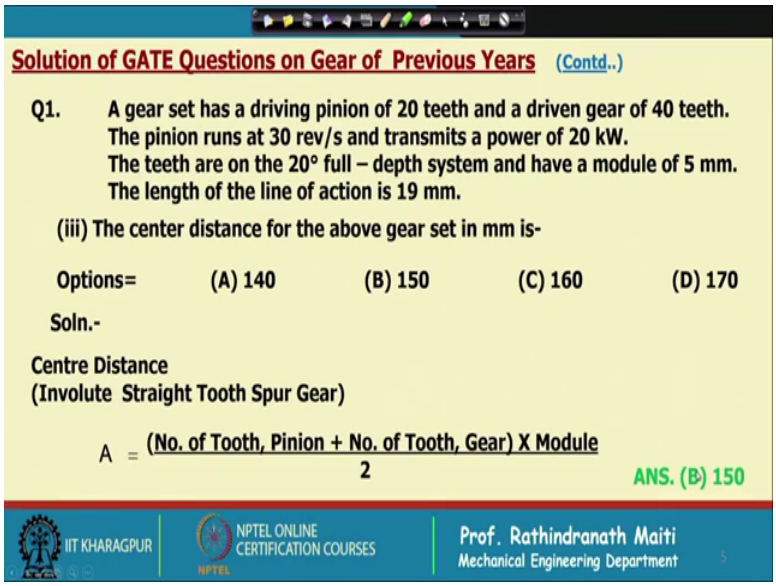

So, on B you have to click.

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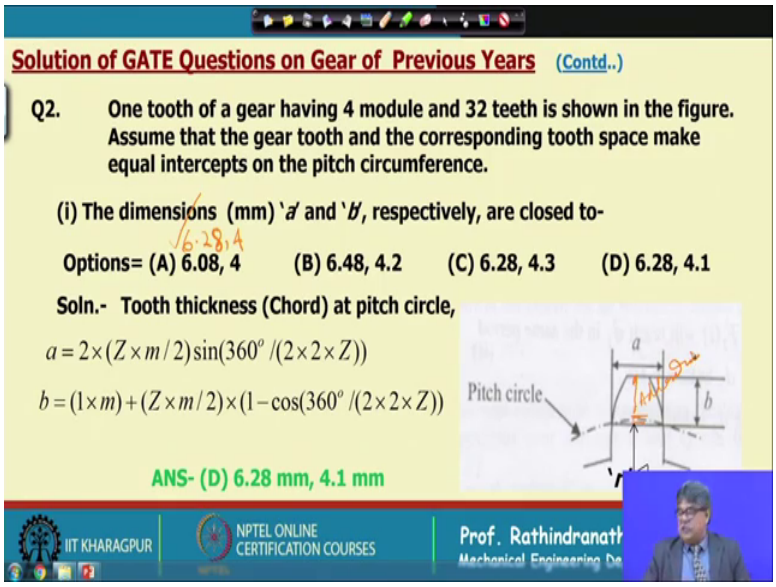

Now, next problem is it is different 1 tooth of a gear having 4 module and 32 teeth it is shown in this figure this is the figure. So, teeth is shown and this dimension is major this is chordal dimension you have to remember this is not the arc.

So, it is asked that we have to calculate these dimensions and also these dimensions. Now to calculate this width we can use this formula, this is the radius and this angle, if we consider half angle from if we join this point with the centers; that means, we will

joint this point with the centre here and we will consider this point with the centre. So, this angle this angle will be how much this will be 360 first of all we will divide by 360 in to divided by twice Z, that would give this distance this angle and again further if you divide by 2 we will get this angle.

So, what we have done we have taken this sign component of this radius, which is pitch circle radius with this angle. And that comes to close to a value that you can calculate yourself you will find a value, say it will match with someone of this or at least it will be close to this one of this. And next if we consider this b we know from this point from this steep point to top that is the 1 module, but we have to add also this portion that is nothing, but this radius minus the cost component of this radius with the same angle.

So, we have also calculated that one and finally, we get the result it is greater than 4.1, you see in this in these combinations more tricky way it could be put 1 option is that 6.2 8 and 4. And most of the students or who is writing we will make a mistake after calculating the first one now this is the addendum we will go into this 6.2 5 say 1 option could be like this 6.2 5.4 sorry not 2 5 2 8.

So, this calculation as it is close to 6.2 8 and then this is the addendum height 1 will be tempted to put on for this offset to select this offset, but this is wrong because we have to consider this distance along with the addendum this is the addendum this we should keep in mind. So, correct answer is 6.2 8 that is option D millimeter and 4.1 millimeter.

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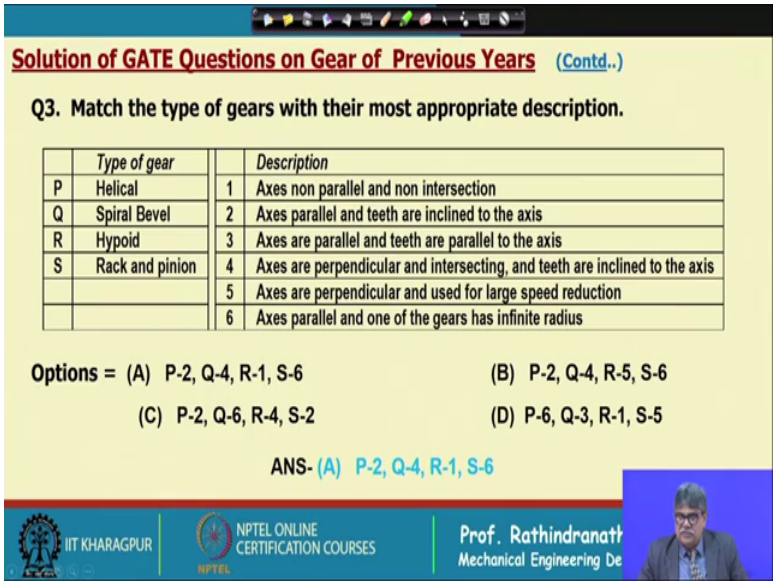

Now, this is another question match the type of gears with their most appropriate descriptions. So, in 1 column it has been given that P is equal to helical gear, Q is equal to spiral bevel, R is equal to hypoid gear, and S is rack and pinion.

Now in the description it is written the axes non-parallel and non-intersections ok. And for spiral bevel no sorry another description is even access parallel and teeth are inclined to the axes third is axes are parallel and teeth are parallel to this axes, number 4 each axes are perpendicular and intersecting and teeth are inclined to the axes axes are partners 5th 1 is that axes are perpendicular and used for large speed reduction and another is access parallel and 1 of the gears has infinite radius.

Now, let us consider first helical gear. Now helical gear, now try to match with the description helical gear axes non-parallel and non-intersections axes are in helical that non-parallel means it might be in the plane are parallel. So, in that way first one will not be there they will be always in the parallel plane. So, accept parallel and teeth inclined to axes; that means, we can write here that. So, probably this with 2 we will also can check the other one access parallel and teeth are parallel to the axes no axes are perpendicular and intersecting and teeth are inclined to the axes no, axes are perpendicular and used for large speed reductions this is also no for legal gear.

Axes parallel 1 of the gears has infinite radius that is also no. So, P is matching with 2. So, now, we will find that P 2 are there. So, in that way by no means; D will not be so, it will be mo A C and B. Now we shall consider the spiral bevel.

In case of spiral bevel it is not hypoid it is spiral bevel, spiral bevel means the axes will intersect. Access non-parallel and non-intersecting snow axes parallel and teeth are in client it is this 2 is with helical only axes are parallel and teeth are parallel to the axes axes are perpendicular and intersecting and deed are inclined to the axes.

This is you can see this inclined means it is spiral as you know this is inclined. So, spiral bevel is matching with 4 ok. Axes and perpendicular and used for large speed directions axes are parallel and 1 of the gears has in fine radius that is also not matching. So, Q 4 now what we find Q 4 is here Q 4 as well as it is in A it is in B, but it is not in C. So, c is also cannot be answered ok.

Now, next we will come to the hypoid gear in case of hypoid. The axes non-parallel and non-intersecting probably it might be that 1 axes non-parallel and not intersecting and next the third is that axes are parallel and teeth are parallel to axes no this cannot be at all. So, now, axes are perpendicular used for large speed reductions this may be large, but this is not that appropriate axes is parallel and of gears of infinite radius this is also not matching. So, this hypoid will match with one.

So, this means that this is coming over here and this is R 1 it is not there. So, B each can only it is there, but we will check the last one also a rack and pinion for rack and pinion the axes. So, if we come to the third point axes are parallel and teeth are parallel to axes no it is not that axes are perpendicular and used for large speed reactions no this is not true axes parallel and one of the gears has infinite addressed rack is having infinite radius.

So, this is matching 6. So, this s is matching with 6; that means, we have up to analyzing this we have this could be the answer and we have also matched this is the answer. So, this will be the answer now let us see. So, answer is a ok. So, in that way you have to answer these questions now.

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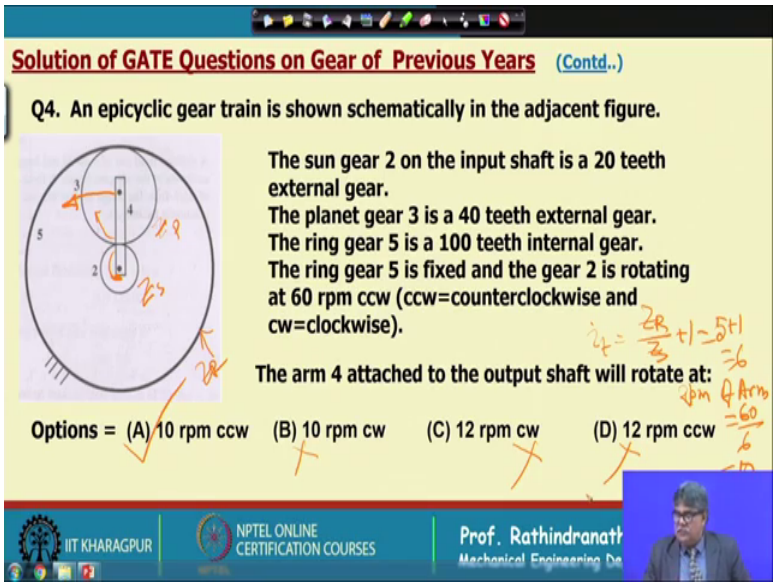

Next one is that an epicyclic gear train it is shown schematically in the adjacent figure this sun gear 2 on the input shaft is 20 teeth external gear.

The planet gear 3 is a 40 teeth external gear and the ring is 5 is having 100 teeth internal gear, the ring gear 5 is fixed and the gear 2 is rotated at 60 rpm clockwise this is sorry CCW means counterclockwise and CW means clockwise. So, it is being rotated in counter clockwise direction. So, if we consider; that means, the sun gear is rotated in this clockwise directions ok.

So, what the arm 4 attached to the output shaft will rotate at this we have to calculate the rpm, but first of all looking into the directions if it is rotating like this then this is rotating like this ok. So, this tip is being touched here this means that this point will move in this direction that is as this gear is fixed. So, from this means sun and this arm will have same direction of rotation and in this case we can find that this is this would not be because it is clockwise this would not be.

Now, we have to calculate the rpm, this is as you know that let us consider this is Z S and this is Z P and this is acting as idle and this is Z R. So, transmission ratio is I t is equal to Z R by jade s plus 1. This means that it comes to hundred divided by 20 5 plus 1. So, that is equal to 6 and our input rpm it is 60. So, this must be ten. So, rpm of arm must be is equal to 60 divided by 6 is equal to 10. So, the answer would be this 1 10 rpm counterclockwise this is 12. So, this is known all right and let us see the answer and cell is a right.

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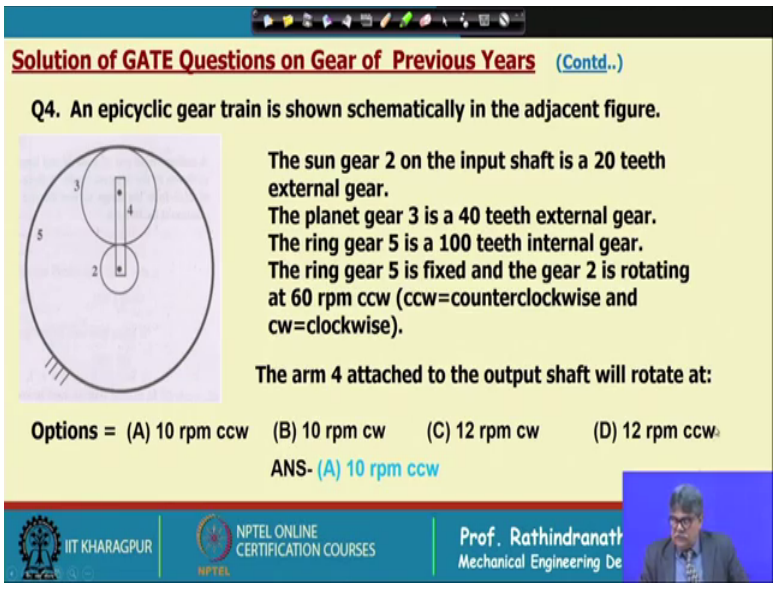

Now, we have considered another gear train.

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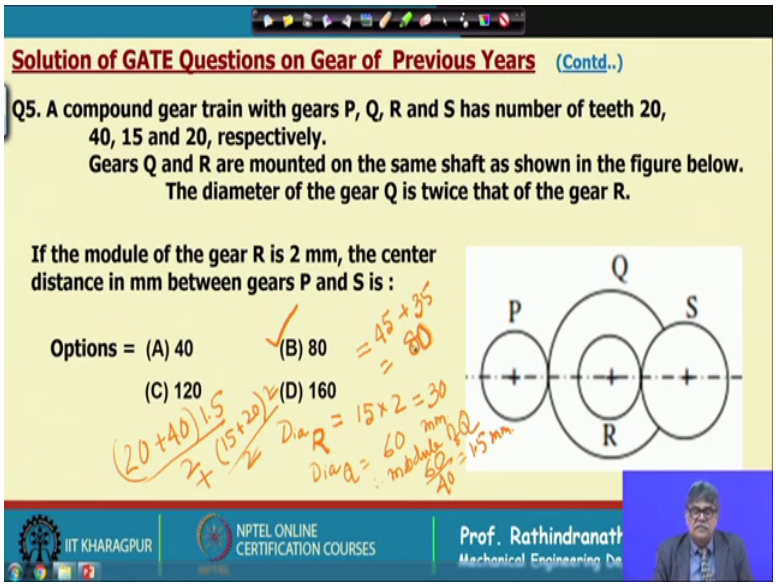

A compound gear train with gears P Q P Q R S has number of teeth 20 40 15 20 respectively so; that means, this is P is having 4 20 this is having 40 and this is having 15 and this is having 20. Q and R Q and R mounted on the same shaft as shown in the figure below ok, the diameter of the gear Q is twice that of the gear R let us see the tip number.

Now, this is 15 whereas, this is 14, but it is in the twice the size. So, module if the module of the gear R is 2 millimeter, the center distance in millimeter between year P and S between P and each 40 120 80 160, now this is a little tricky because the R is having. So, this we can do in that way this if the module of gear r is 2 millimeter; that means, dia R will be must be equal to teeth number of R is 15 and module is 2 that is equal to 30 and what also given that the Q is twice of the R; that means, dia Q is equal to 60 millimeter.

Now, it is having forty teeth. So, module of Q must be equal to 60 divided by 40 that is 1.5 millimeter right. So, this means that if we would like to find out the center distance this means that center distance will be fast matching 20 plus 40 into 1.5 divided by 2 and plus we will have 15 plus S is equal to 20 20 that into 2 divided by 2.

So, this becomes if you write it. So, this is 60 to 30 into 1.5. So, that becomes forty 5 and this part becomes canceled 2 cancels 15 plus 20 this is 35. So, this becomes totally 80 millimeter and our answer could be b ok. So, answer would be let us check that what is there. So, answer is B ok.

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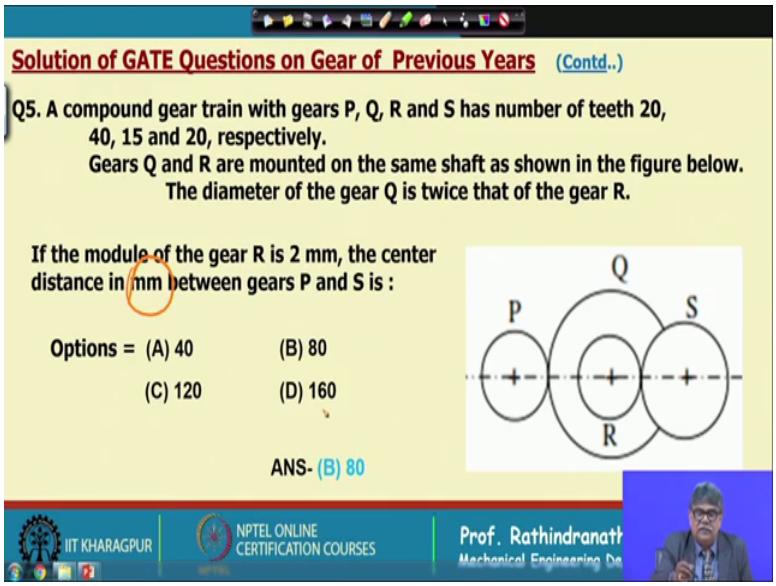

And you here also you should notice that this millimeter here it is mentioned that in millimeter.

So, you have to calculate in millimeters right.

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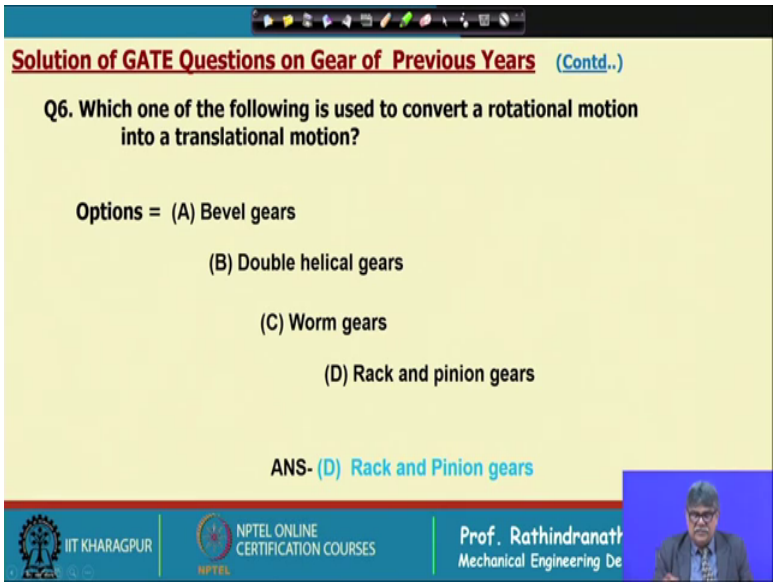

Now next question is that, which 1 of the following is used to convert a rotational motion into a translation motion bevel gear no it is not is it the answer is bevel knows, double helical gear this is also no 1 gear, this is also no no translation motion. So, translation motion is only available with the rack and pinion ok. So, answer is d the rack and pinion.

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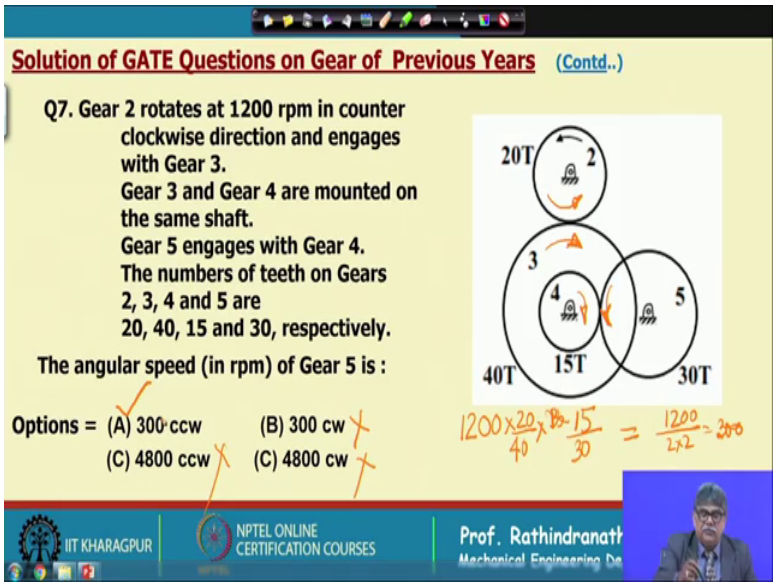

Now, next another question is that gear 2 rotates at 1200 rpm in counter clockwise direction. So, gear 2 this is the gear 2 this gear 2 rotates in flounder clockwise directions, which is having 20 teeth and engages with gear 3. So, this means that gear 3 will rotate in this directions as well as, gear 4 also rotate in this directions. Gear 3 and gear 4 are mounted on the same shaft, gear 5 engages with gear 4 the number of teeth on gear 2 3 4 and 5 are 20 40 50 13 which is given and this gear is rotating anti clockwise directions.

So, therefore, the angular speed in rpm of gear 5 we have to find out the gear 5. And this gear 5 what will you find this is in anti-clockwise directions. So, these 2 is automatically canceled out now among A and C this answer will be there. Now it is written this is in 1200 2 is rotating 1200 rpm 2 is rotating rpm. So, what will find that 3 will rotate into 3 we will rotate 20 by 40. So, this will be half of that and then the gear 5 will rotate is further into sir sorry 15 15 divided by 30 ok.

So, gradually this is clearly the reduction gear unit. So, we can find out 1200 divided by 2 into 2 that is 300 ok. So, answer would be a this is also not true this is from the direction point of view and this is from the ratio point of view I mean speed point of view.

So, let us see this, what is the answer?

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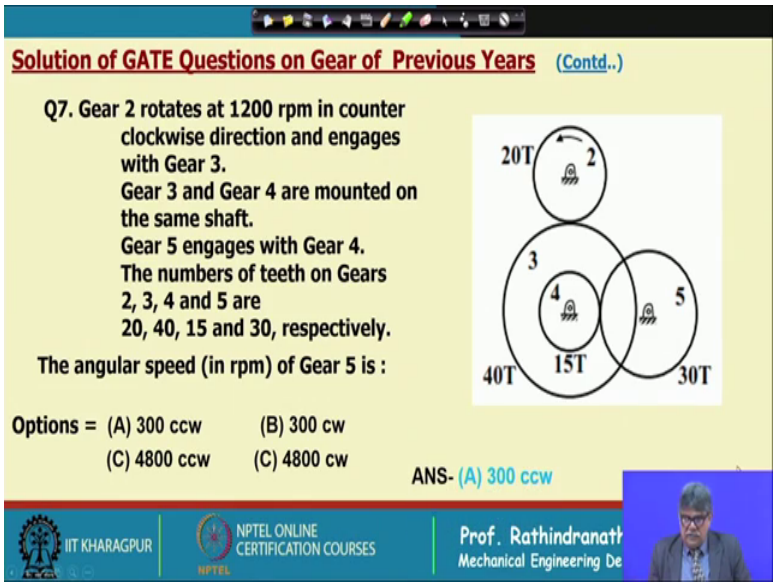

Answer is a 300 counter clockwise.

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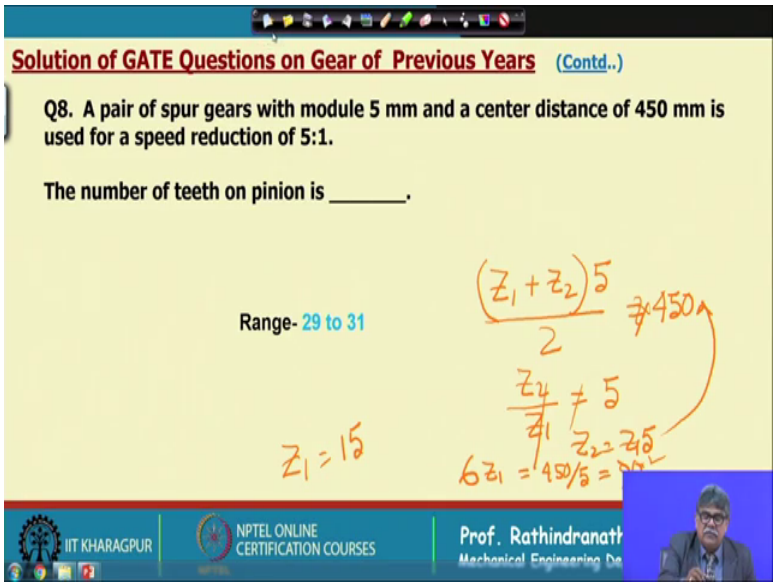

Now, next another question a pair of such gears with 5 module, 5 millimeter module and the center distance of 450 millimeter is used for a speed reaction of 5 is to 1 the number of teeth on pinion is then hyphen is there and actually this range will not be given, I mean 1 cannot see this range this range will be hide, but if you put answer anything between that 29 to 3 1 within this range it will be corrected.

So, even if 1 can put the teeth number is 30.5 that will be corrected, but actually actual answers should be an integer how that the pair of gears. So, let us consider this pair of gears each is Z 1 plus Z 2 and this module is 5 given and the center distance is 450 millimeter means this is equal to 450 and another ratio is given let us consider the Z 1 is the pinion and Z 2 is the gear.

So, Z 2 divided by Z 1 is equal to 5 it is given this means that Z 2 is equal to Z 1 into 5. So, if we substitute this here then we will have 6 Z 1 must be equal to 450 divided by 5. So, this is 90 this means that Z 1 must be equal to ninety divided by 6 how much 15 sorry I have made a mistake.

So, this is age 42 into 450 sake sorry the seeds in the distance and a center distant for 50 millimeter is used for a speed reduction this will be 2 into 4 450. So, this will be sorry this will be 2 this is not for 50 if we correct if we make it calculate correctly, Z 1 plus Z 2 to 5 divided by 2 is equal to 450 in millimeter.

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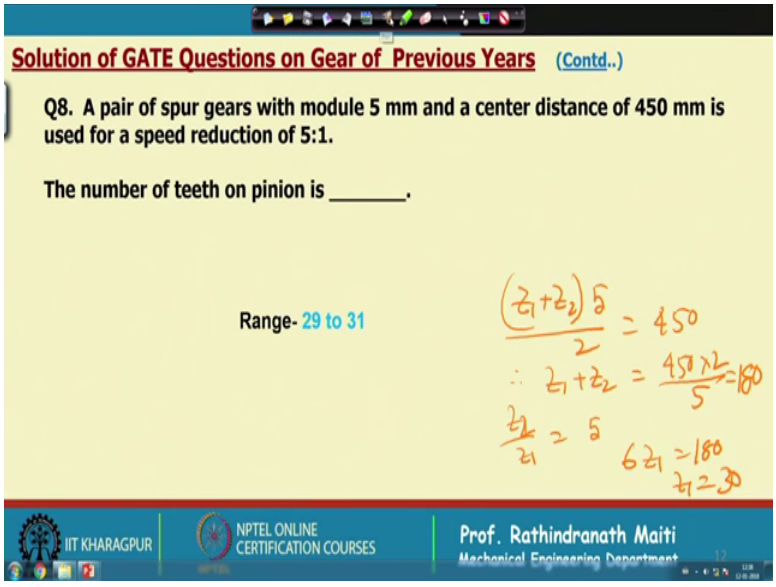

So, this means that Z 1 plus Z 2 is equal to 450 into 2 divided by 5 which comes to 180 is not it. And Z 1 Z 2 by Z 2 1 is equal to 5. So, 6 Z 1 is equal to 180. So, Z 1 is equal to 30. So, 1 will answer thirty and you will get the correct mass, but you even if for this type of question if you put 30.5 you will score the full marks answer is answer is 30.

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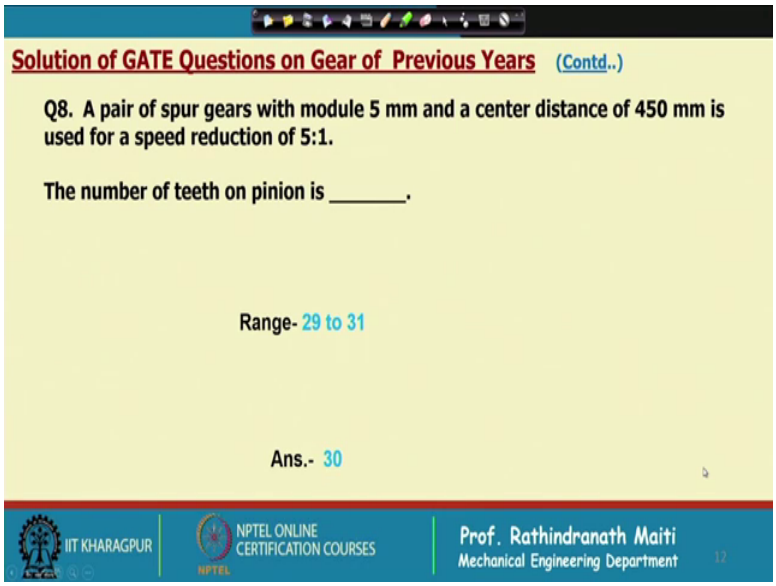

Next another question.

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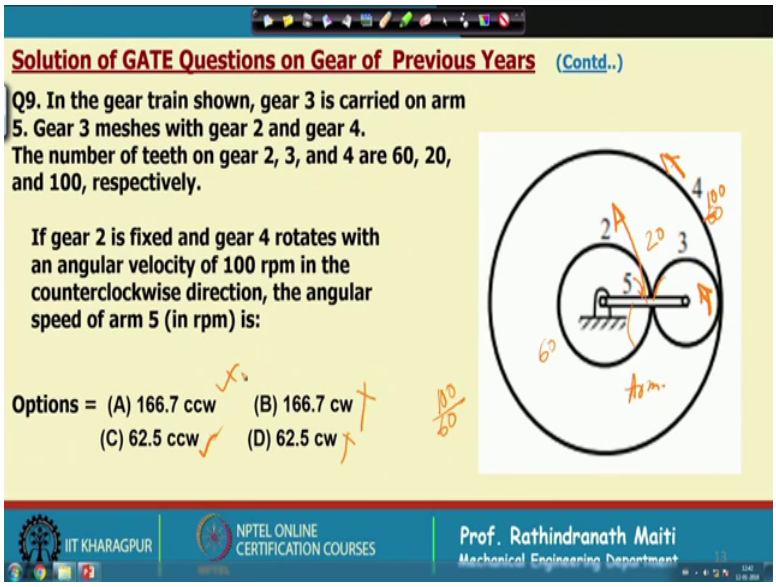

On in the gear trains shown gear 3 is carried on arm 5 this is the R 5 this is arm, gear 3 meshes with gear 2 and gear 4. So, this is the ring here the number of teeth on gear 2 3 4 is this is 60 and this is 20 and this is 60 no no no no 60 20 and 100 this is 100 60 20 100 right.

Now in gear if gear 2 is fixed right and gear 4 rotates with an angular velocity of 100 rpm in the counterclockwise direction.

So, this gear is rotating in counterclockwise directions the angular speed of arm 5 is then 6 166.7 counterclockwise, 62.5 clockwise and such and such values 4 options are gear. Now first of all we will analyze the, what will be the directions of here the gear 1 is fixed now if this gear rotates in this directions, this also will try to rotate in this direction and if it rotates in this directions counterclockwise. So, this gear will try to rotate also in clockwise direction, but this is stopped.

Now, this means that if it is rotating like that arm is rotating in this directions. So, the angular speed of arm. So, arm is rotating in the counter clockwise. So, either answer will be these or this, but definitely not this 1 not this one. Now this ratio we can find out in this way. So, this will become 100 60. So, this is 1.6 7 1.6 7 plus 2. So, this would be the answer let us see.

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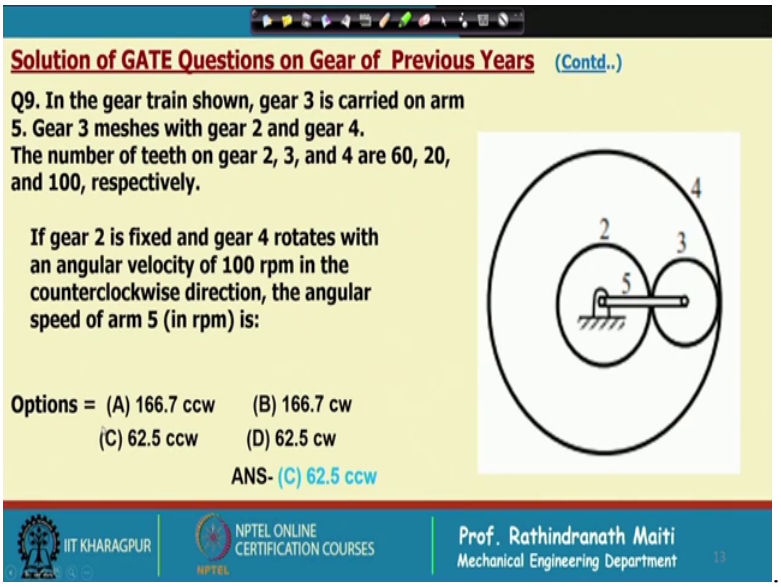

So, this is the answer is this one already we have found out now for this one can follow any theory of machines books, because there is no tooth strength calculation is here.

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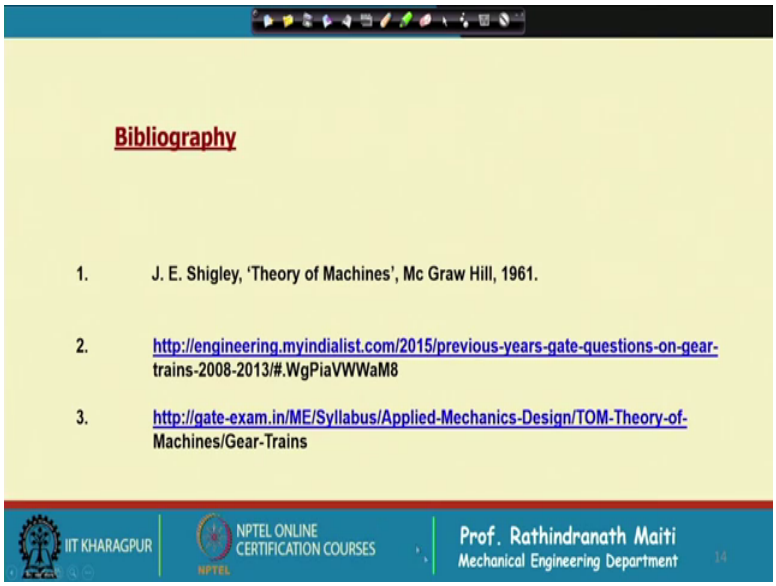

So, probably the theory of machines book will do as well as in machine design books in fundamentals, where the kinematics have discussed that book also would do and these questions are chosen from this websites. So, one can look into these websites also so.

Thank you.