UAV Design - Part II
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Lecture - 08
Numericals

Hello friends, welcome back. In our previous lecture we discussed about static stability. We started with stability and then we continued to longitudinal static stability and we derived the conditions for an aircraft to be statically, to possess longitudinal static stability it has to satisfy the conditions that C m alpha has to be less than zero and C m naught has to be greater than zero, right.

So before we proceed to look at the contribution from various components of this of the UAV towards the static stability, let us solve few example problems, where you will be able to find out aerodynamic center of various configurations. Why we are doing this exercise is, so we will be considering aerodynamic center as one of the reference points in this entire calculation.

So that will be handy right once we solve this particular problems, say about 2 to 3 problems that we are going to solve that will help you to figure out how to find out aerodynamic center for various configurations. So once we find the aerodynamic center, then we will be able to talk about the stability of the system with respect to the C g or what will be the relative position between C g and the aerodynamic center of various components of the of a UAV, right. That helps the system to be stable.

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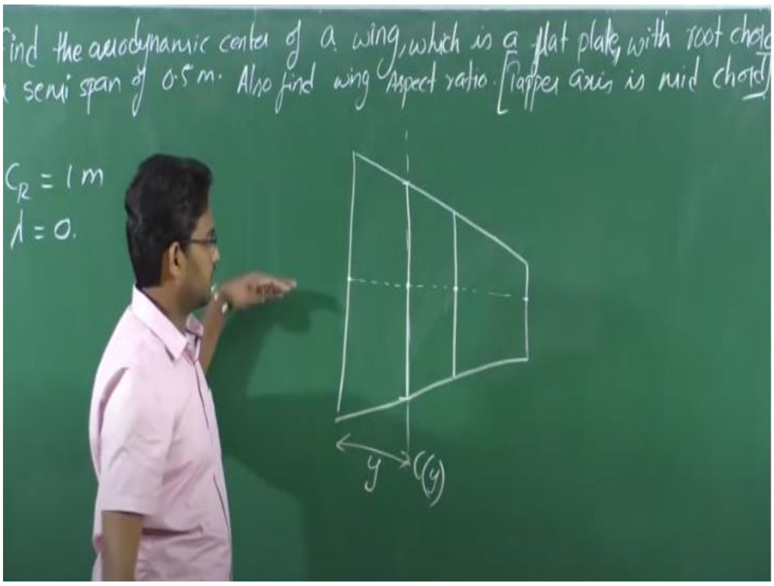

So let us take up the first example problem. So find the aerodynamic center of a wing which is a flat plate with root chord of 1 meter zero taper ratio and with semi span of 0.5 units, right. So this is the question. We are asked to find out the aerodynamic center. Also find, yeah let us add some more non-dimension parameters. Also find wing aspect ratio, right and also the aspect ratio.

Yes, okay. So we are asked to find the aerodynamic center of this flat plate and we were told that this flat plate has a root chord of 1 meter and taper ratio is zero and we were also given the information about it is tapered about, the wing is tapered about yeah, the taper ratio is zero. So add this one as well. So the taper axis taper axis is mid chord. So the taper axis is also given, right.

So it is tapered about mid chord. What do you mean by tapered about mid chord? So let us consider a wing, right a tapered wing. Now if you consider any span wise location, you have corresponding chord at that particular span wise location, right. Say if this is my span wise location and say this is my corresponding chord at that particular span wise location.

So now if you consider C by 2 of this, right. If you look at C by 2 and also at any other span wise location, locate C by 2. So all the C by twos will lie in particular straight line, right; lie on a particular straight line here. So this is the definition of taper axis, right. So now according to this question, so it is a flatbed configuration.

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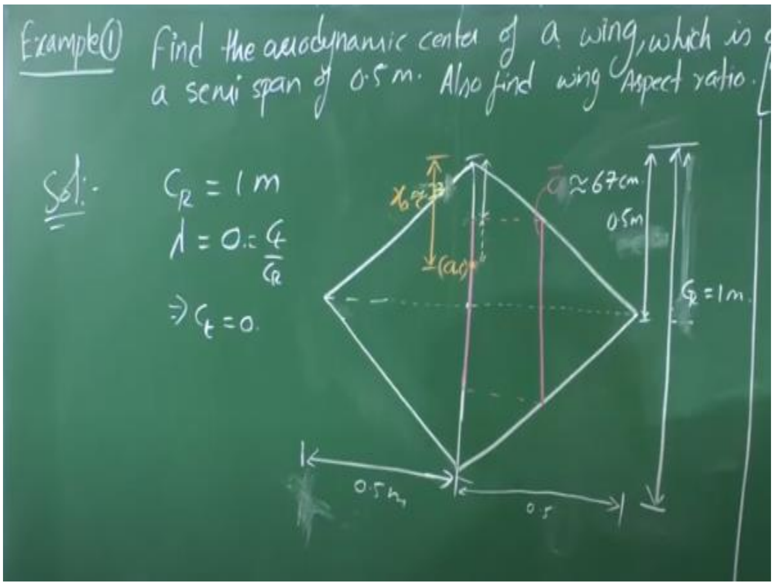

The wing is a flat plate. So from the question we can tentatively get some rough idea about the wing planform here. So we have root chord which is about 1 meter and the taper axis is so that is 0.5 meters. Am I correct or not? Say if this is my root chord, which is 1 meter and the midpoint should be 0.5, right. So and I was given the information about semi span, right.

So one side of the wing is about 0.5 meters. Let us say this is my 0.5 meters, right. So we can so root chord is a mirror image of this, like is a plane of symmetry, is it not? So let us say this is the other half of the wing, which is again 0.5 meters and zero taper ratio. What do you mean by that? C t upon C R, which implies C t is 0, right. So we have point at tip. At 0. 5 meters, we have a point and then now joining this will give us a wing planform, right.

So let me redraw it a bit better. Yeah, more or less it looks like this is 1 meter and this is 1 meter, right? So what we have is the total span as 1 meter here and then the root chord is also 1 meter. 1 meter C R is equals to 1 meter C t is 0. And then the taper axis. So up to this point it is 0.5 meters. This is 0.5 meters or C R by 2. This is your C R, which is 1 meter.

This is C R by 2. Now we need to find out the mean aerodynamic chord, right. So let us say this is, if this is my mean aerodynamic chord C bar, right. So we know how to find the aerodynamic center. First we need to find out what is the corresponding mean aerodynamic chord here, right. So once you find this mean aerodynamic chord, let us project this mean aerodynamic chord onto the root chord.

So this will be my projection of mean aerodynamic chord on the root chord and one fourth of this because we are talking about a lower subsonic speed UAV. So one fourth of this C bar is generally considered as aerodynamic center here, right. So let us say this is my corresponding C by 4 of this C bar, right. So and this will be my aerodynamic center. So let this be denoted by x a.c, right.

So this is measured with respect to leading edge of the root chord, right. Let us say this is my x aerodynamic center fine. Now how can I find this x aerodynamic center?

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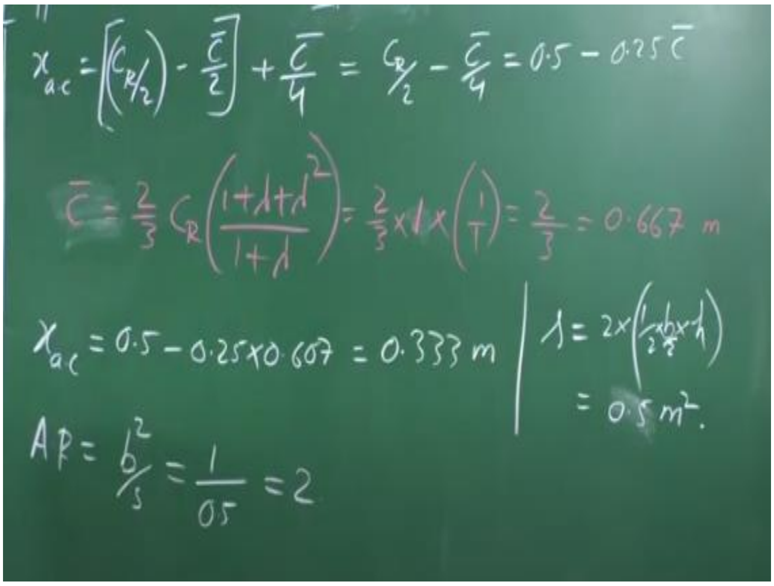

So x aerodynamic center is equals to, so this I know C R by 2 because it is tapered about yeah, tapered about mid chord, right. So what I can what I know is this particular distance which is C R by 2. So C R by 2. So minus, see this mean aerodynamic chord is also tapered about the same axis, right. So when you project this C bar onto the root chord, so the axis the taper axis will still remain same and this particular distance will be C bar by 2, right, is it not?

This particular distance will be C bar by 2. So if I subtract this particular C bar by 2 from the C R, what I have is this particular distance, right? So minus C bar by 2, right. So I know what is this. So from that particular expression, I will be able to find out what is this particular distance. Now I need to add this distance, right in order to find out. So I know what is the leading edge of this C bar right now, right.

From this expression I have arrived at leading edge of the C bar and then C bar by 4 from there is my aerodynamic center, right. Plus C bar by 4. So this equals to C R by 2 minus C bar by 4. Am I correct? What is C bar by C R by 2, which is 0.5 meters, right? C R by 2 is 0.5 meters minus 0.25 of C bar. So I will be able to find out this location of aerodynamic center given C bar here, right.

So how should I find C bar? So C bar is equals to C bar is equals to two third C R times 1 plus lambda plus lambda square upon 1 plus lambda. That is equals to two third. C R is 1 meter times, so lambda is zero. This will be 1 upon 1. This is simply 2 by 3, which is 0.667 meters, right? C bar is nothing but two third of the root chord for a complete tapered wing, right.

So it is tapered till the tip, right. So for a complete and the tip is a point here. So for a complete tapered wing what we have is two third of C R as lambda is zero in this particular case. So I know what is C bar. If I substitute C bar in this equation, what I am going to get? x a.c is equals to 0.5 minus 0.25 times 0.667 is equals to that is approximately 0.333 meters, right.

So this is the C bar. This x a.c is approximately 33 centimeters or 0.3 meters or 33 centimeters from the leading edge of the root chord. So if you measure 33 centimeters from here with a scale, you will be able to find out the corresponding aerodynamic center here, right. And let us also complete the rest of this question. Let us find the aspect ratio here. So aspect ratio of this wing is b square upon s.

So what is b here? Half a meter plus half a meter is 1 meter. 1 upon the total area of this particular planform is, what is the area of this planform? So s is equals to twice half base into height, right. It is a triangle and twice the area of and you have a mirror image this side as well. So twice the area of this particular triangle. So what you have is 1 time.

So this is like why because area of this particular triangle is b by 2 times h here, right. Half b by 2 times h. So b by 2 will should come into the picture which is 0.5 meter square right. So now this is 0.5 meter square, which is equals to 2, right. So this particular wing has a very low aspect ratio which is 2, right. Please note it down. So let us move on to the second question, okay. Is it clear?

So we have to find the aerodynamic center of the wing given the root chord, taper axis and the span here. Semi span was given. So we can figure out span easily. So we have root chord, taper axis which is C by 2 or mid chord at each and every location. So if you find midpoints of chords at each and every y location, span wise location, so they all lie in a same straight line, right.

Lie on a same straight line and then from there, from this data you can figure out that C bar as 0.667, which is approximately 67 centimeters right. So this is 67 centimeters and this is 1 meter, right. When you project this C bar onto the root chord and C by 4 of the C bar will be or C bar by 4, one fourth of the C bar will be the corresponding aerodynamic center.

So from this particular relation that aerodynamic center can be figured out, once we know what is the corresponding aerodynamic center, sorry mean aerodynamic chord. Fine. Let us move on to the second question. So let us solve a similar question to find out what is the aerodynamic center and the mean aerodynamic chord, right of a delta wing configuration.

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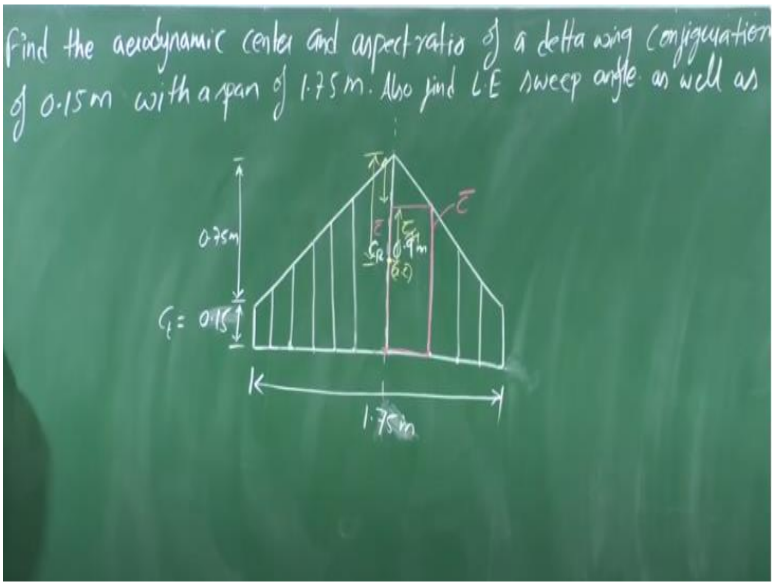

So find the aerodynamic center and aspect ratio of a delta wing configuration with a root chord of 0.9 meters and tip chord of 0.15 meters with a span of 1.75 meters. So this is what we have. So we were asked to find the mean aerodynamic center, location of aerodynamic center, mean aerodynamic chord. Yeah of course, to find out aerodynamic center we need mean aerodynamic chord and the aspect ratio of a delta wing right.

So as soon as we remember about delta wing. So we can imagine a triangle, right is it not? So for a pure delta wing it will there will not be any tip chord, taper ratio will be zero. But here we were given certain tip chord, right. So we have the information about this root chord and tip chord. So the tip chord is 0.15 meters and the root chord is 0.9 meters, right C R and C t.

So this is 0.75 meters, right. Also find leading edge sweep angle okay. So this is how the geometry of a delta wing, yeah it is more or less symmetric. Assume that this is symmetric, right. And you are given the span of this configuration, which is 1.5 meters. So we have root chord, tip chord and 1.5 meters. And we know delta wing is tapered about, the taper axis of delta wing is trailing edge, right.

So at each and every span wise location if you look at the chord, right so all the tips trailing edges of this chords right will lie on a same straight line here, right. So this is on either sides, right. At each and every span wise location the trailing edge of the chord will lie on the same straight line here. Oh, okay. I am sorry. Please make a correction here. It is 1.75 meters, right. Thank you Prabhijit.

So first thing I need to find out is again the same procedure, let us figure out where is this mean aerodynamic chord, right. So what is this C bar? Also find we will add some more part to this question. Leading edge as well as y mac. See it is location, span wise location of mean aerodynamic chord, right? So this is your C bar. And so for this, it is bit simpler to find out the aerodynamic center.

Why because we know the trailing edge is same here, right. Is it not? So when you project this we have C bar on the root chord. So C x a.c aerodynamic center will be definitely C bar by 4, right. So this particular distance is C bar upon 4, right. If this is my a.c aerodynamic center, so this total distance will be sum of C R minus C bar.

See this is the total C R, root chord minus this mean aerodynamic chord what we have is this particular portion, right added by C bar by 4. What you get is a distance location of this aerodynamic center with respect to the leading edge of the root chord, okay.

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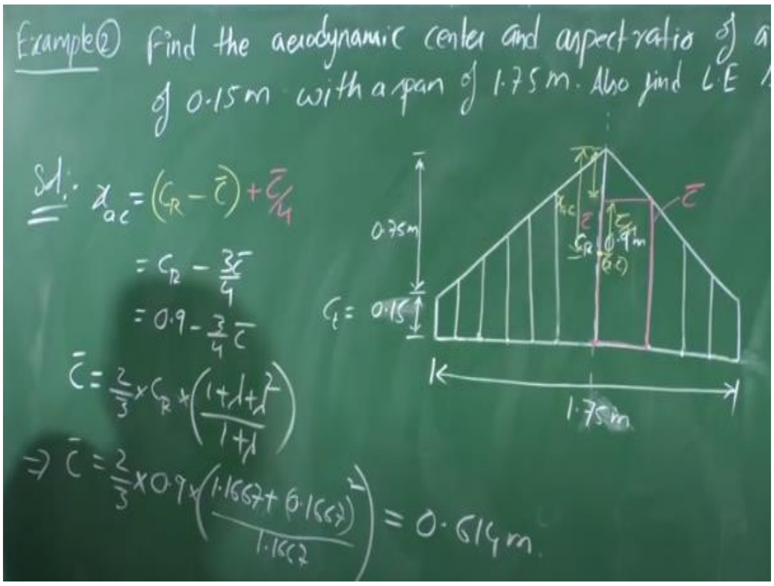

So again, what we have is x aerodynamic center, which is equals to this is say this is x a.c, right. So this particular portion from the leading edge of the root chord till the leading edge of the mean aerodynamic chord. So how do you get? Since the root chord, tip chords lie on the same straight line C R minus C bar right is this particular distance, C R minus C bar. And plus C bar by 4.

So that is this additional portion which is the C bar by 4 is the aerodynamic center, location of aerodynamic center for this configuration and with respect to root chord, we need to like leading edge of the root chord we need to add the portion right, which is in between the leading edge of the root chord and the leading edge of the mean aerodynamic chord.

So we need to find out C R minus 3C R by 4, right. So which is what is C R we know 0.9 meters minus 3 by 4 of C bar. So again we need to find what is C bar, right. C bar is two third of C R times 1 plus lambda plus lambda square upon 1 plus lambda. What we have is two third C R is 0.9. So in order to find this we need to know what is lambda here, right. Is it not? So how do you find lambda?

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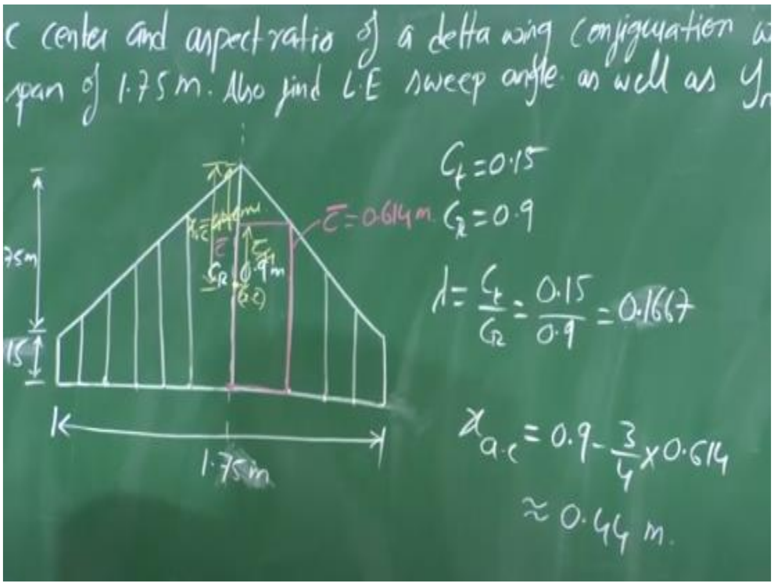

So we know C t is equals to 0.15.We have C R is 0.9. So lambda is straightforward C t upon C R, which is 0.15 over 0.9, which is approximately 0.1667, yeah. That is taper ratio. So if I substitute that is 1.1667 plus 0.1667 square upon 1.1667, right. So if we solve this so this is equals to 0.614 meters, okay. This is the mean aerodynamic chord.

So this particular length of this mean aerodynamic chord is 0.614 meters, okay where the root chord is 0.9 meters, right. Okay? So since we have root chord and we also know what is the mean aerodynamic chord now. So we will be able to calculate what is the corresponding x a.c with respect to the leading edge of root chord here, right. So see there is a reason for me to repeat this leading edge of root chord repeatedly, right.

So later when we talk about stability right so this concept will be useful. So x aerodynamic center is equals 0.9 minus 3 by 4 multiplied by three fourth of 0.614 meters. So this is approximately 0.44 meters, right. So this is approximately 44 centimeters from the leading edge. So this is approximately 44 centimeters. So this particular distance is 44 centimeters from the leading edge of the root chord, right.

So we have now figured out what is the location of aerodynamic center with respect to leading edge of root chord. Now we have to proceed to figure out what is the aspect ratio here.

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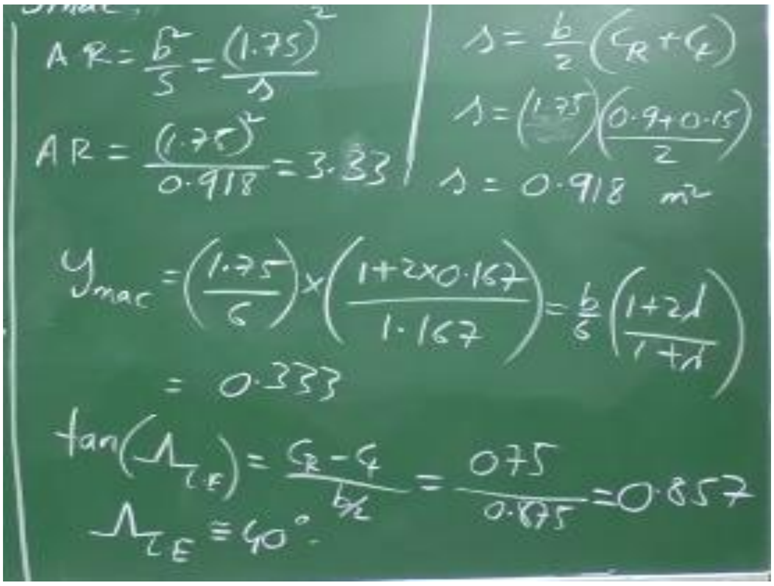

So the aspect ratio here, so the aspect ratio is b square upon s. So b here is 1.75 square upon s. What is s? So what is the area of this particular delta wing? So we can consider this as a trapezium, right. Am I correct? So high times the average of these two perpendicular distance, right. Am I correct or not? So this is b by 2 times C R plus C t by 2. That is b by 4 multiplied by C R plus C t.

So we have to consider twice of that. It becomes b by 2 C R plus C t, right. So s is equals to so s where s is equals to b by 2 multiplied by C R plus C t, right. This equals to 1.75 upon 2 and C R plus C t. Average of R we can say this is average of root and tip chords, right. So this is 0.15. So now the area turns out to be 0.9 approximately 0.9 meter square, 0.918 meter square, right.

So aspect ratio is 1.75 square upon 0.918 which is close to 3.2 yeah sorry 3.33. So that is close to 3.33, right? That is aspect ratio of this wing. And then y mac is b by 6, which is 1.75 upon 6 multiplied by 1 plus 2 times lambda is 0.167 upon 1.167. So this is equals to 0.333, right. So close to 33 centimeter. So if you move 33 centimeters from here, you will be able to find out the corresponding mean aerodynamic chord on either sides.

So if you move 33 centimeters, right. So 0.333 meters then you will be able to figure out the corresponding location of span wise location of this aerodynamic center. So what will be the leading edge angle? Can you solve this?

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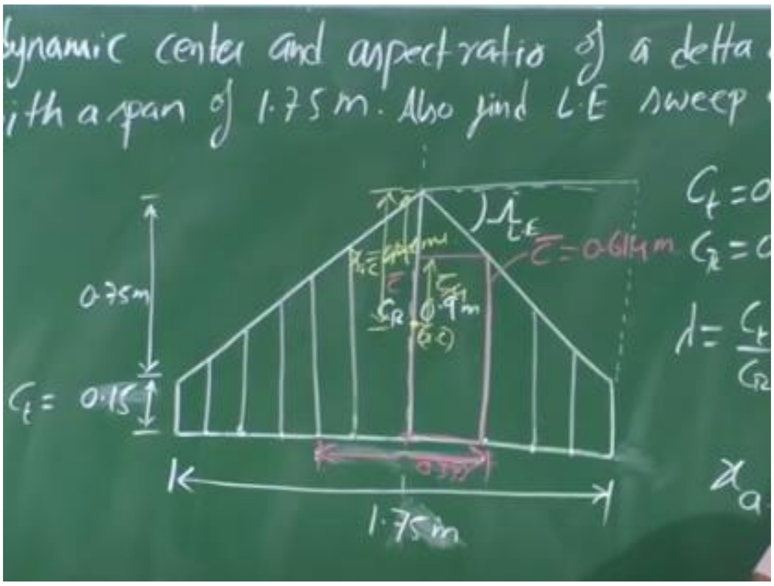

So let us say gamma leading edge. Let us say this is the leading edge angle right. So how can we find? We know this distance right, which is yeah which is close to this. So if you know this particular value you will be able to figure out what is this leading edge angle, right. So what is that leading edge angle? Tan over, leading edge angle is equals to this particular C R minus C t upon b by 2.

So what is the value? C R is 0.9 minus 1.5 it is 0.75 upon b by 2 is 0.875. This is 0.857. So leading edge angle is close to 40 degrees, right. So that is close to 40 degrees. So this particular angle is close to 40 degrees, right. So this is how we solved the, we were given a delta V and we need to figure out what is the corresponding aerodynamic center. We have root chord. We have the information about root chord which is 0.9 meters.

And the tip chord which is 0.15 meter and the span of the configuration is 1.75 meters, right. So based upon this information, we figured out what is the corresponding mean aerodynamic chord, which turned out to be approximately 60, 61 centimeters, right. So since it is a delta wing, it is tapered about trailing edge.

We can project this particular C bar onto the root chord and can easily figure out what is the corresponding aerodynamic center by just adding the distance between the leading root leading edge of the root chord and leading edge of the mean aerodynamic chord and then one fourth of this mean aerodynamic chord, right.

So by adding that, we will be able to figure out yeah, we have figured out what is the mean aerodynamic chord and as well as yeah, aerodynamic center. So once we figured out this location of aerodynamic center, we then proceeded to find the aspect ratio which turned out to be 3.33 right for this particular configuration. And then the leading edge angle was figured out to be 40 degrees here, right.

So you can simply calculate the y mac by using the standard expression that we have arrived at. So which is b by 2 upon b by 6 multiplied by 1 plus lambda plus lambda square 1 plus sorry 1 plus 2 lambda upon 1 plus lambda, right. So by using this, you will be able to be we figured out that span wise location of this mean aerodynamic chord is about 33 centimeters from the root, right. Okay.

So we will solve another example problem for this to find the aerodynamic center. So let us complicate this a bit further. Let us take another example problem where we have a wing with multiple sections, right. So the wing planform can be something like this, right. So we have a rectangular planform and then the tapered planform as well. So in that case, how do we find out the mean aerodynamic?

So in this particular case, so what can you notice? So the taper is about, so we have a rectangular section here. So we are not much worried about the mean aerodynamic chord or the taper axis. Of course, there is no taper here, right. But for this particular yeah portion what can what can you infer? So see the trailing edge of this rectangular wing as well as the second portion which is here are same, right or on the straight line.

That means, we can assume that this particular taper of this wing is about this. Yeah, wing portion is about the trailing edge here, right. So we will consider a similar problem, but not exactly this, the same what we are seeing here.

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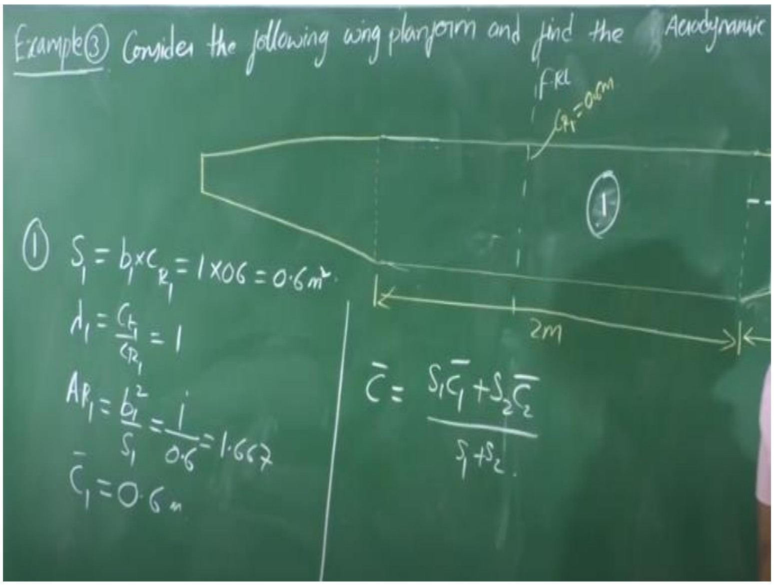

Consider the following wing planform right and find the aerodynamic center. Yeah, find the aerodynamic center. That is good enough, all right? So this is what the planform is. We have a rectangular portion of this wing, right in the center. Let us say this is my f RL, fuselage reference line that we discussed earlier. So let us consider a rectangular wing. So have a rectangular wing portion in between.

Followed by it this is my tapered wing right, okay. So assume that this is symmetric. So we have a rectangular portion in between and the span of this rectangular portion is 2 meters, is 2 meters and then the semi span of this particular portion is about 1 meter, okay. And we have information about this root chord. So this is your C R 1, which is 0.6 meters, okay. So we have the information about root chord.

This is 0.6 meters, right. And the leading edge sweep of this is about 4.3 degrees, right. So do we require any other information here? So we have 4.3 degrees sweep of this and you have and yes this so the entire taper, so the taper of this particular portion is about C by 4. So this taper axis is about quarter chord. So what is quarter chord taper?

So if you consider any section, span wise section and the corresponding chord, if you find the corresponding quarter chord of that particular span wise section, right. So if you join all these quarter chords, they will all lie on a same straight line, right. So that is the definition of this taper about quarter chord, taper axis is quarter chord, okay. So how to find the aerodynamic center?

So to find the aerodynamic center, first we need to find out the mean aerodynamic chord, right. So let us now divide this particular wing as section 1 and section 2. So section 1 is a rectangular wing, it is a straightforward. I do not have, so for section 1, let us say for section 1, what is the area? Area of S 1 is equals to b into c, it is a rectangle wing, right; b into C R I can say.

So b is 1 meter times C R is 0.6 meters, which is 0.6 meter square is the area of this cross section, right. And what is the lambda of this first section? C t upon C R 1, b 1 C R 1. Let us say 1 subscript here stands for the section 1, two stands for the second section, right. C t 1 upon C R 1, which are equal right because it is a rectangular wing and we have lambda 1 is lambda of this first section is 1, correct?

And then aspect ratio of this first section is b 1 square upon S 1. So b 1 is 1 meter square upon 0.6, which is approximately 1.667 as the aspect ratio. So what will be the C bar of first portion? Nothing but 0.6 meters, right. Two third C R, 1 plus lambda plus lambda square upon 1 plus lambda. And it is a rectangular wing that is straightforward, right. So and if we substitute lambda 1, so what we have is C R directly.

C bar is equals to C R, right. So this is 6.6 meters, okay. So if we say let us say C bar of section 2 is at a given location. So what will be the mean aerodynamic chord of the center configuration? It will be the weighted average of S 1 times C 1 bar plus S 2 times C 2 bar upon S 1 plus S 2, okay. Am I correct? So it is a weighted average of S 1 C 1 + S 2 C 2 bar upon S 1 + S 2.

So if I want to find the mean aerodynamic chord in the first place, so I need to know what is the corresponding C 1 bar and C 2 bar. So we have information about S 1C 1. Now we need to find out what is what are these S 2 and C 2, right. So can we find out for section 2? So I will just erase this particular portion.

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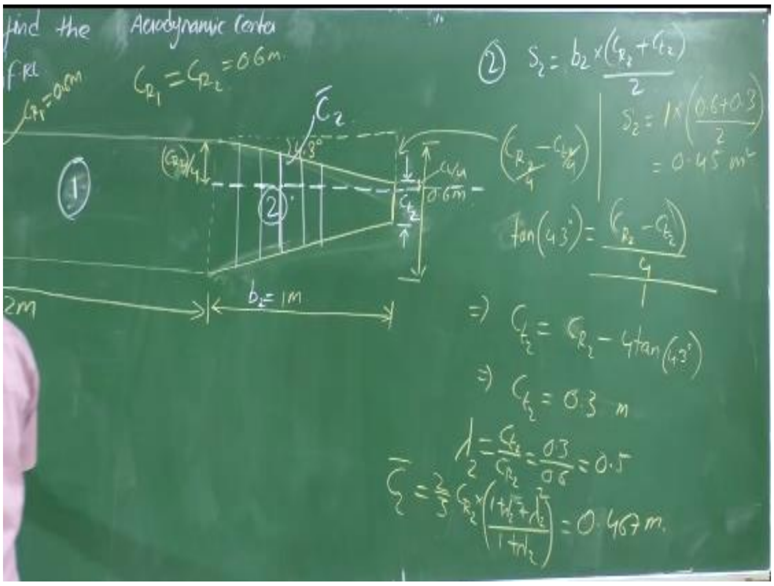

So for section 2, what I have is S 2 is equals to so the span here is b 2 by 2 right or say yeah, or say this is b 2. So b 2 times C R 2 plus C t 2 upon 2, right. That is the area of this particular trapezium. Am I correct or not? So this C R 2 is nothing but C R 1 here, right. What I need to find is what is C t 2. Do I have that information? What is C t 2? How can I find? So I so we are given about the leading, information about the leading edge sweep which is 4.3 degrees.

So say if I extend this right so we know this axis is up to here what we know is C R 2 by 4, sorry C R 2 upon 4 right is it not? It is a quarter chord point of this particular yeah particular chord, which is the root chord of this second section, right. We have information about it C R 2 upon 4. Because C R 2 is nothing but C R 1 in this case. So because C R 1 is equals to C R 2, right which is equal to 0.6 meters.

So now the question is we have these points on the straight line which is the base of this particular triangle. Am I correct or not? Now let us say how can I get what is C t? I have this angle, right. So what I can do is this particular distance so this particular distance is nothing but C t by 4, C t 2 by 4, right. Am I correct or not? So what is this particular distance/ This distance so from here to here, so this particular distance is C t upon 2, right.

So what is this particular distance then it will be so this is C R 2. So sorry C t upon 4. This particular distance is C t upon 4, right. This is C R 2 by 4 minus C t upon 4. So this is the corresponding distance. Say this overall length has to be same, is it not? C t by C R 2 by 4, right. So this is also C R 2 by 4. But we also know that this wing is tapered about C by 4, right.

So what we have is C t 2 by 4 will be this particular distance and then C R 2 minus C t 2 by 4 or C R 2 by 4 minus C t 2 by 4 what you have is the corresponding yeah opposite side of this particular triangle, right. Okay. So C t 2, so tan of 4.3 degrees is equals to C R 2 minus C t 2 upon 4 right divided by what is the span here which is 1 meter, correct? So this equals to C t 2 is equals to C R 2 minus 4 tan 4.3 degrees.

So this equals to C t 2 is equals to 0.33 or 3? So C t 2 is equals to 0.3 meters, right. So C R 2 is 0.6 meters and C t 2 is 0.3 meter. So what is lambda? Lambda 2 is equals to C t 2 upon C R 2, which is 0.3 upon 0.6, which is half right, which is 0.5. So we have lambda 2. What we can now find out is what is C bar 2, right which is equals to two third C R 2 times 1 plus lambda 2 plus lambda 2 square upon 1 plus lambda 2.

So this turns out to be 0.467 meters. So now what we have is C 2 and we know what is S 2. S 2 you can find it from here, right which is equals to so from here we can say S 2 is equals to b 2 is 1 meter right multiplied by 0.6 + 0.3 upon 2.45 right meter square. So S 2 is 0.45 meter square.

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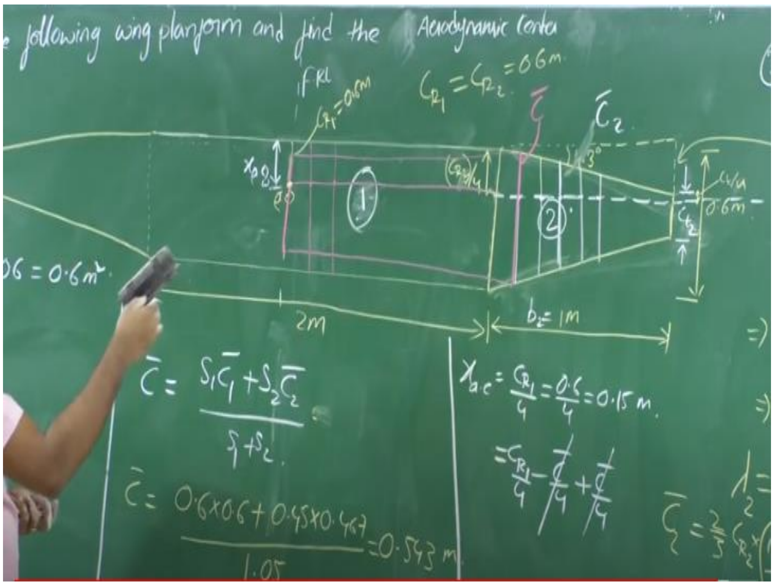

So if you substitute that what we have is C bar is equals to 0.6 times 0.6 plus 0.45 multiplied by 0.467, right upon 1.05. So what you have is C bar is equals to 0.543, 0.543 meters approximately. So 54 centimeters is the mean aerodynamic chord. So here we have 60 centimeter. So this mean aerodynamic chord will be somewhere here right, which is 54 centimeters, right.

So this is your yeah this can be C 2 yeah. This is your C bar, right. Now you can project this C bar onto the root chord and find out the corresponding location of the aerodynamic center. Is it necessary to do that? Why because see, this is tapered about C by 4. So for a rectangular wing there is no taper right, is it not?

So if you join C by 4 of this root chord, the C by 4 or any other C R by 4 or CT by 4 of this rectangular wing should lie on the C by 4 axis here, is it not? So without even solving this, we can tell that the aerodynamic center once you have that quarter chord taper, the aerodynamic center is nothing but C R 1 by 4 at a distance of, am I correct or not? Even if you solve this that is how it is going to turn out to be.

For example, let us solve this. So first figure out what is, what I say is x a.c is nothing but C R 1 upon 4, which is 0.6 upon 4, which is 0.15, right 15 meter. So 15 centimeters from the leading edge of the root chord is my aerodynamic center x a.c. Aerodynamic center of this wing is 15 centimeters from here. So if you do not believe me, then what you can solve it in the conventional way what we are doing right now.

We have the taper axis is C by 4, is it not? So x a.c will be like C by 4 of this, right? Yeah. Taper axis is C by 4. So we say it is C by 4 of this particular mean aerodynamic chord, right. So our aerodynamics enter if you project, if you project this aerodynamic mean aerodynamic chord on to the root chord, so when we take C we considered the aerodynamic center lies at quarter chord of this mean aerodynamic chord.

Say this is my aerodynamic center a.c right, which is at C bar by 4, right. What I am now claiming is that is equals to C R 1 by 4. That is what I am claiming, right for this particular case, okay. So now this particular distance is nothing but this distance plus this distance, is it not? So what is this distance? C R 1 upon 4, right.

So this is equals to, this is equals to C R 1 upon 4, which is this distance minus this distance will get the distance between the leading edges of root chord of first section as well as mean aerodynamic chord, right minus C bar by 4. So this is again this distance is nothing but C bar by 4. So you got this distance plus C bar by 4, right. So that is the mean. So once you subtract this what you arrived at?

Leading edge of the root chord and then C bar by 4 from the leading edge of the root chord is your aerodynamic center. So this is nothing but C R 1 upon 4. So which is 15 meter 15 centimeters from the leading edge of the root chord of this first section, right. So what is the aspect ratio of the second section?

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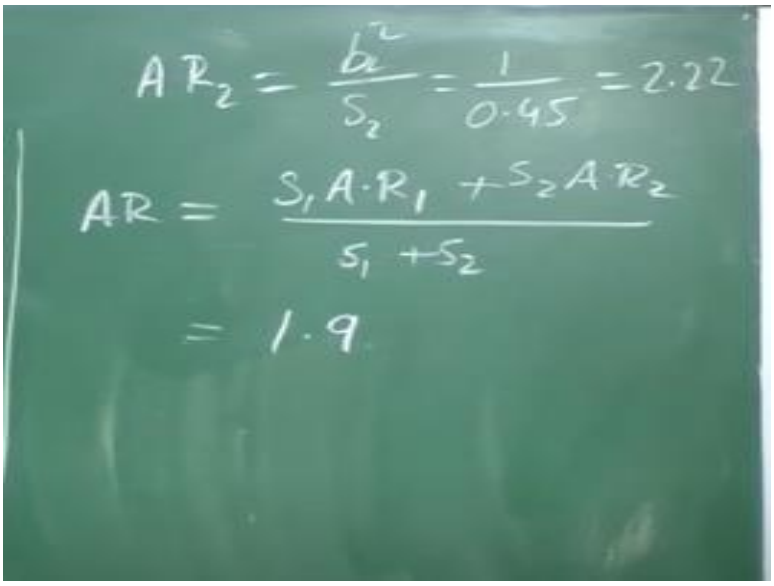

So aspect ratio of the section 2 is equals to b 2 square upon S 2, right. What is b 2 square here? 1 upon S 2 is 0.467. What is S 2? 0.45 right. So what is the aspect ratio? 2.22 is the aspect ratio of this second section. Now what is the total aspect ratio of this wing? We again can be found out from this weighted average. S 1 A.R 1 + S 2 A.R 2 upon S 1 + S 2. So what is the value? Approximately 1.9 right.

So this is the aspect ratio of this enter wing and again it is also a low aspect ratio wing. Yeah it is quite evident right? This is almost 0.6 meter chord right? And it is yeah it is spanned over 2 meters. So that itself so your chord length is very high here. So the area will be very high for a given span. When the chord length is high for a rectangular wing area will be high, right.

So aspect ratio automatically drops, okay. Okay, then we will yeah too many problems. We are now in a comfortable position to figure out what is the location of this aerodynamic center, right. So we will try to use this concept when we are dealing with the stability issues, right. How to find out say that stability criteria of, static stability criteria for wing and for wing and tail combination or wing and canard combination right or two wings combination.

So how to figure out the aerodynamic center for such configuration. And this location of this aerodynamic center is considered as a reference and the location of C g with respect to that will define the stability criteria, right? That we are going to see in the coming lectures. Thank you.