Indian Institute of Technology Kanpur

National programme on technology enhanced learning (NPTEL)

Course title
Introduction to Experiments in flight

Lecture- 04
Drag Polar Estimation

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Hello and welcome to the next part of the lecture so today I will be talking about how to estimate the Drag Polar Parameters using aircraft data so we learn this experiment today right so the objective of that pyramid will be this drag solar parameter estimation.

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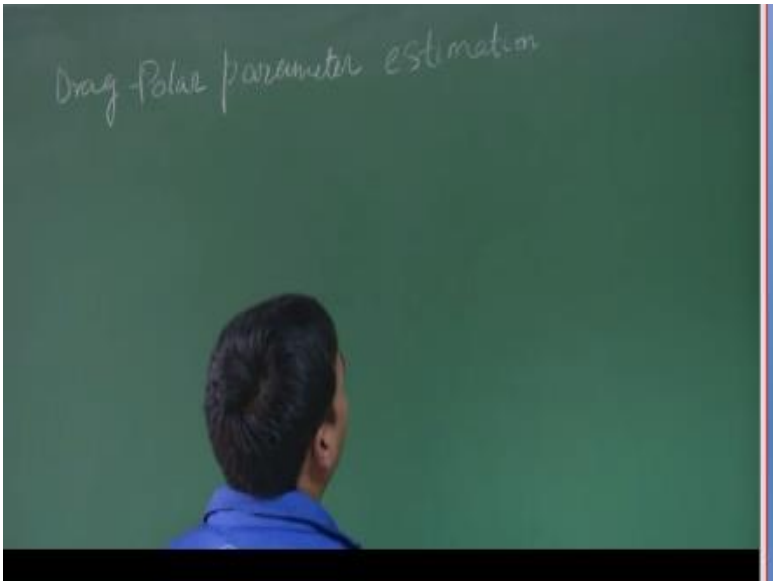

And for this experiment will be using this Cessna Aircraft data, so I should write tri-polar parameter estimation Eugene Cessna 206H and we should do this experimental cruise mode so at crude mode. So the objective of this experiment is to estimate the Dracula parameters. So from the drag polar equation we know if you see this equation dry polar equation which is

CD = CDo + kcl square so here you see beach to our terms CDo and k maybe CDo and k so to find CDo and k will be the objective of this experiment yeah.

So now it is clear to us like we want to find CDo and K from the flight data so the question arises now like how will you plan the experiment suppose you have aircraft now and you also have a pilot so how will you conduct this experiment, what should we have plan and how can you get these two numbers CDo and K right.

So I just quickly a review the theory of BHP which will relate this city not in case so, the background which already has been given by Professor Crucial and not go in detail so, PHP as we know is dragged into velocity right and you can write further like half Rho v square as CD yeah in two weeks and if you further expand then it will become half Rho V Cube s and I am replacing CD now with pd not + kcl square from the Dracula equation right.

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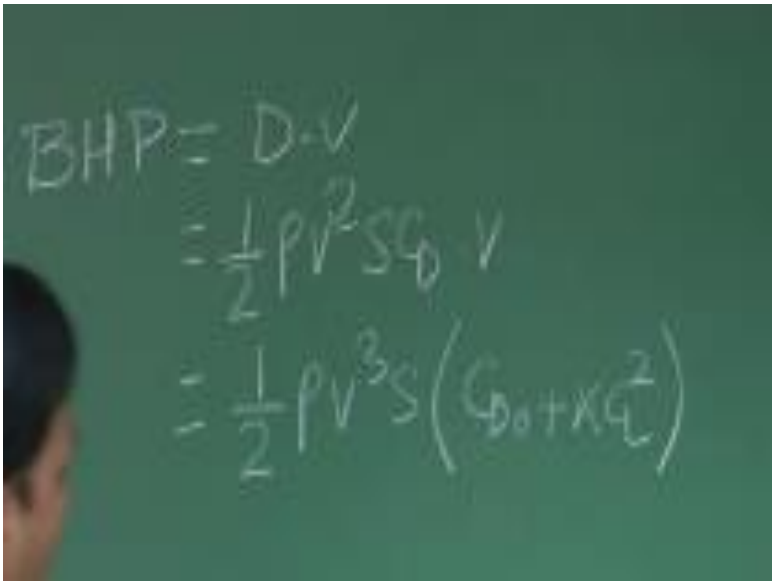

So if you break this again it will become half Rho V Cube as CDo right Plus and I want to right field in terms of velocity the what should I do so you know a CL equals to twice of wing loading divided by Rho v square so CL square is essentially for W square by S square rho square V to the power source so we have to plug this value here right so I will write half Rho V Cube f x ke ya in 24 w square by s square by 2 square 3 to the power 4.

So now you see this will get cancelled here and, then try to hear so furthers amplification will look like this. So half Rho V Cube s CD naught plus twice off k w square by i should write here s through x 3 so this is actually BHP now, so if you multiply with velocity both the side so it will look something like this so can I write like this BHP into V equals to half Rho v to the power 4 yeah s CD not Plus twice k w square by s into zone or we will get cancelled because we are multiplying this with v so this is the equation actually.

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So now you see our CD naught and Q both are appearing this equation and if you see this relation carefully then BHP into V this is linear with v to the power 4 so if you roughly see the curve so I will make it here, so that infinity we can have the reference so if i put BHP into V versus V to the power 4 so it is linear so it will look like this so from this curve if you get to know about intercept then that will be equivalent to twice of K W square byRho times s

and this slope will be equivalent to half Rho s CD not yeah so now it is very clear like if we want to get CD naught and k then we should have the reading for BHP and velocity right.

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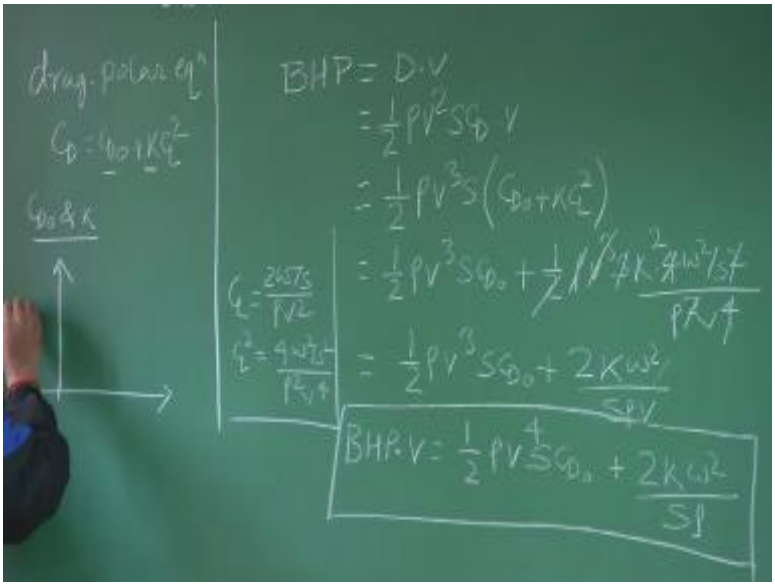

So once you plan this experiment, so what we need is falling bhp and V now do we have any instrument which directly can give you the bhp so no so to get bhp if you see bhp or the specification given by manufacturer so bhp basically or RP m/ rated RPM into manifold pressures x rated manifold pressure sea level temperature standard temperature / outside air temperature Oh 80 into rated HP.

So if we want to calculate the bhp then we need these variables so from the engine manufacturer you will get specified values for rated RP M rated manifold pressure and rated HP right so if you see here the data provided by manufacturer for specific 206 aircraft rated man RPM is 2700 rated manifold pressure is 29.92 inches of Hg and threaded HP is given 300 right HP.

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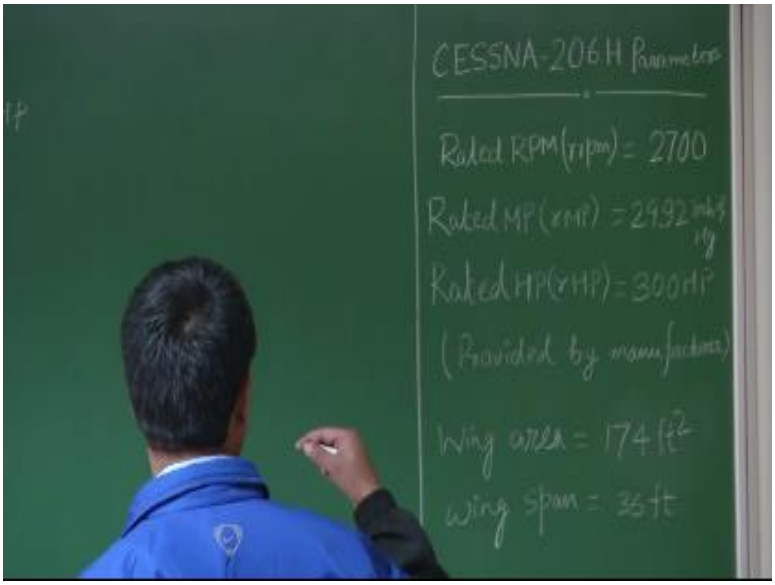

So or with those value we can calculate now from the flight can we measure RPM manifold pressures outside air temperature and yes can images yes we can measure so we have instrument to measure that so, once you plan your experiment then you should create a table in that of course you have the instrument to measure the velocity V and you also have to note down the reading for manifold places right and next is RPM 60 and next will be our bhp.

So we can calculate the HC with the help of these readings and specified data, so now you can further create one more column the HP in two weeks later actually so we will talk about this later yeah, so to conduct this experiment is we have already talked like we have to perform this experiment at cruise mode then we should also note down what is Altitude to that what altitude we are going to fly the aircraft.

So you should know about the altitudes so usually we fly at 300 meters or roughly thousand feet so, you can write thousand fifty thousand Smith and then you can note down the outside air temperature, so whatever it is so just to give the reference i will show you one of the experiment done in this aircraft so one of the group of student actually they have performed and then they have noted on the velocity like this one not three yeah, we have to be very careful about the unit.

So here in the aircraft you will get velocity in terms of not k and OT not yeah so all right here not and management my default manifold pressure will come in inches of edgy, so i should

write inches of SG and now crematorium yeah, so yes so if you see here you will get for one not three manifold pressure words 21.4 and RPM wash to 250 okay.

So with that oh bhp will come around 12758 2.77 yeah okay, and next column H bhp into V right if you see this equation here I wouldn't be H P into V equals to this so the velocity which is being used by this equation here so it's a match what is being read in the dialogue aircraft? It did same so no it is not sale.

So usually in the aircraft you see this velocity reading this is called indicated air speed so indicated air speed is not a true speed here in this equation it is true speed so, you can also write V T so this V is nothing but true speed so now a question arises again like to how will you convert this indicated air speed to speed right so first of all for different kind of aircraft you will get the calibration chart.

So with the help of that you can convert your indicated air speed to the equivalent air speed right so, if you see I will give you a small example through this container and support for this it is flaps of configuration so, here if you got the readings for indicated air speed not then you can have the corresponding calibrated air speed.

So CAF or not so if you have number 60, 70, 80, 90 HP and so on actually I am not writing all the number so just to show you so small 60 it will become 63 as per the specification 70 corrected value will be 71 and for ATT79 and for 92-89 39 so, now further we need to convert in terms of to speed so we will use the sum pollination actually so half Rho v t square Rho altitude I should write here so to half Rho three naval into V equivalent square so, deep it is actually a VQ late after the correction once you correct your indicated air speed.

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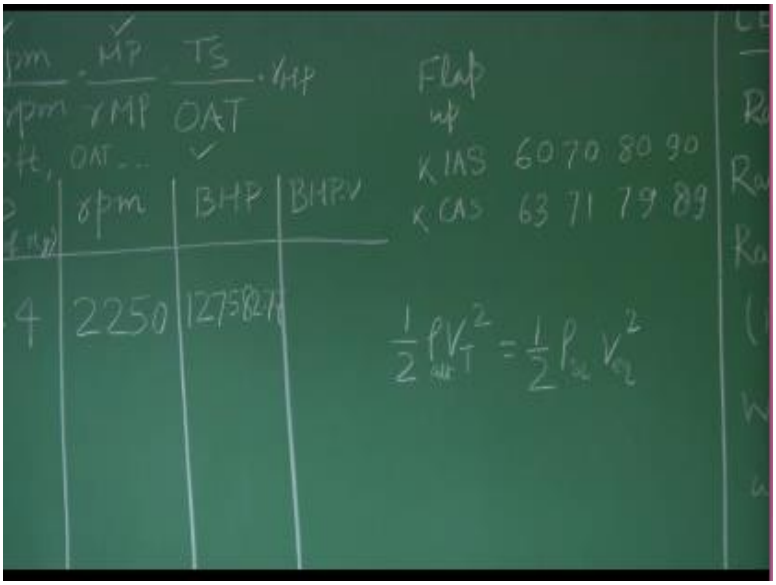

So that will become a V equivalent and from that you can calculate your feet are true air speed which will be square root of L divided by Rho all teacher yeah, times V equivalent so that is how you get are two aspects so now you can plug in the equations or in your reading, but again yeah.

So we also have to see here it is a row altitude so it means that we need to correct the density also the density correction can be done through this relation so density altitude you can write Rho naught yes so PS sea level temperature which you can take 15 degree Celsius and 80 e to the power minus EG not provided by a r plus so, here is lapse rate you all know so just I'll write the value equals to minus 6.5 can we per kilometre and RG specific a constant so you know about that so once you correct at your density.

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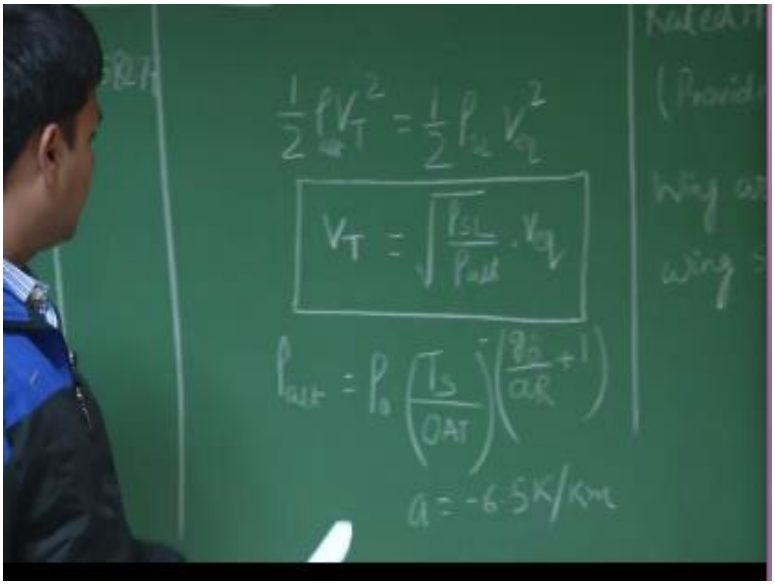

So you will get that to speed from the true speed we should multiply this so I should write wait so you will get your number now yeah so for each readings like students they have performed four different speeds so just I'll write down the number so that you can appreciate the readings so one not 31not six and crippled one and has taken the editor for 114 so 21.4, 22 2.1, 22.4and 22.8 right and RPM heading for like20 1.1 so 22.4 and 22.8 and corresponding bhp 132927.20 point 2013 4731.64 and 118 296 89.12 so, now with these ratings actually.

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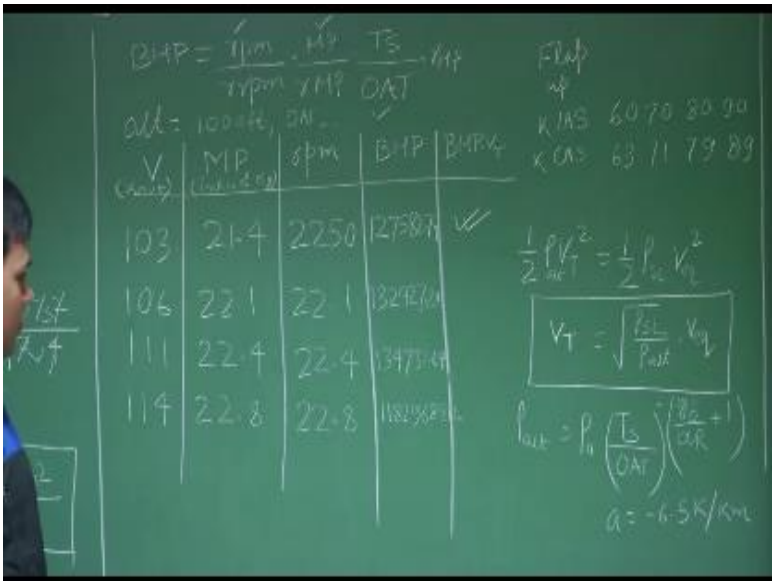

So God with all of the flighty attack during the flying condition students they have noted down those values right so, now you will have this column bhp to VT and then you can also have this weighty power force right so now coming to this if you see here you got this reading here from that table and then you also have corresponding to speed to the power 4right so for this corresponding for reading so you will have you should get a linear.

So here also to be read them reasonably linear right and with that the value obtained for CD not and K are this so from this slope you will get ready not which is here zero point those three two and k k zero point one five so, as per these ratings right now the number which you got CD not and K how will you know like these are accurate or what is the confidence interval for those numbers how will you judge the numbers right.

So what we should do if you want to evaluate your k which is here of 155 all of us know of k can be written like the disc k equals 1by phi aspect ratio and Oh spoil diversity factor e right so fall Cessna aircraft if you calculate K so it will be 1 by phi x.

So the values are on 17.448 s the pressure you can get the staff pressure from here d square bear drink span square by this area and if you take a value as 0.85 yeah so this number will0.05 here now from the calculation from the geometrical details of the aircraft for e being 0 point eight five you got k 0.05 but you see the number here it is point one five so it means like this is not in agreement right so oh and the CD naught looks to be okay.

Because use a range of CD not usually will be your cleaner 0.022 0.04 for this kind of aircraft so looks very reasonable but we did not or we could not get a value correctly I will not say like a very bad but yeah we definitely need some collection on the value it means we have to look back for to the readings like maybe because of some instrument error we could not load the reading properly and it may have a certain other human error in that liquor which did not go well.

But the whole idea is like that once you have their craft and you want to estimate CD naught and K so these are the values or these are the variables we need to note while the flying condition and with that you will get bhp brake horsepower and true airspeed you will convert your indicator speed and you will be able to estimate City Norton okay, so Thank you so much.

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