Lecture 28 –
Aircraft Maintenance
(Aircraft Performance Point of View)

Good morning friends. I'm Dr. A.K Ghosh so, far you are enjoying, wonderful knowledge sharing by Mr.Vipul Mathur, who is our chief engineer, it was agreed or we decided: that maintain this aspect will continue. But, at some point, we should also discuss, why this is important from, airplane performance point of view, as I understand? You are learning about, engines in terms of maintenance aspects, but, then why engine is so important, we will try to understand that, in a simpler language.

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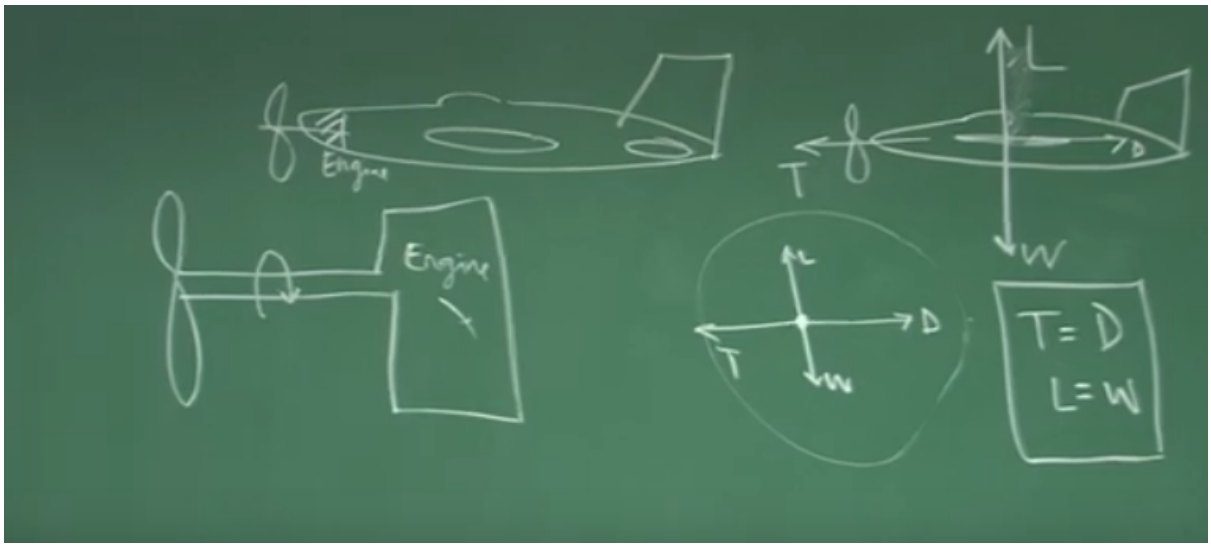

So, let us see, if I see an aircraft and let's say, this is the propeller and here there is the engine, what is the role of the propeller? If you see, this is the shaft and this is collected to engine,there is a combustion that goes on and there is some, horse power, some power, is delivered at the shaft. Now, the point is,how do I, extract, thrust out of this power or how do I convert, whatever power is available here? Into thrust using a propeller.Right? So, it is important, from the maintenance point of view, whatever is happening here it should go the way, it was designed and also, it's important that, when this power transmission is happening or thrust extraction is happening, the health of the propeller should be very good, as per the design and also, this interface. Right? And that is exactly what?A maintenance engineerwill ensure: that every time we go for a flying, in a she ruled manner, he's supposed to check and certify the airplane. But, if I go a little deep into it, I should also know, the importance of the thrust, which is coming out of this airplane, I will just take you to simple understanding, I do naught know, what is your background? But, they'll assume that, most of you are doing maintenance course, for licence, for disease exams and you are also, reading some material, on the aerodynamics and how, the lift is generated, how the drag is generated etc. Assuming that to be true, I write here: that this airplane is generating lift, there is a weight, this man is giving thrust and this airplane is experiencing drag. If I draw it in a neater fashion, I say this is the drag, acting this is the thrust acting, this is the lift and this is the weight. Right?Now, if I want this airplane, to move like this: that is Cruz, right, most of the time your airplane is cruising and let's say,I want the airplane to move, in a manner that, the speed is constant, it is moving in a straight line, without changing the altitude, in that case you see, my forces must be balanced, so I right, trust it all to, drag and lift it all to which, correct? When I talk about engine maintenance, you are actually; looking for this thrust, where from this thrust is coming? If I am talking about, IC engine with a propeller attached, I know that, I have to have an art, of converting the power available on the shaft, into thrust and that is this thrust, I'm talking about. So, if your engine is naught able to produce that thrust,what is designed for, it will

naught be able to balance this drag and the moment it doesn't balance this drag, it will lose the speed and you will naught have enough lift, to balance the weight, generally.Right?

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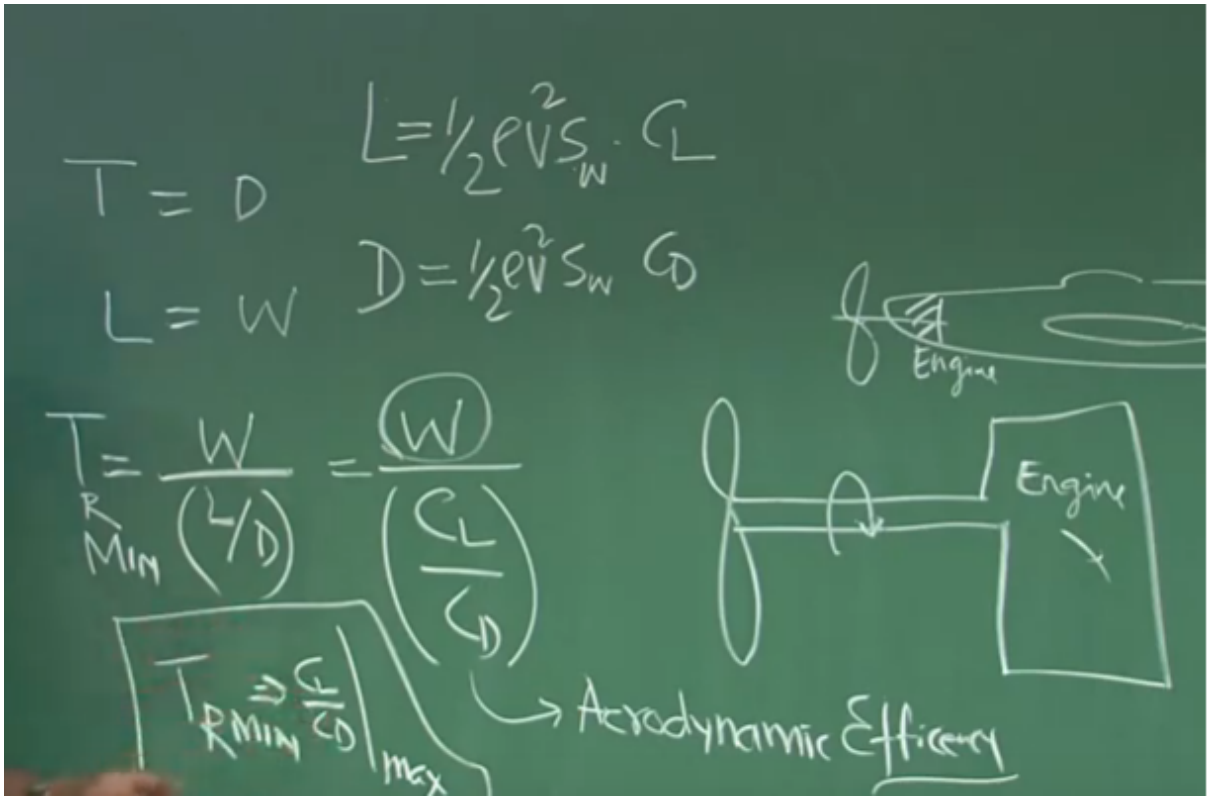

Now, the question comes, is thrust equal to drag and lift it all to weight, then as a designer,I would like to Cruz in such a manner,if possible: that first required is minimum. Right? So that, the effort here and here are less, so that, the weight of the engine goes, to at the lower side, if I write like this, then I can as well write it like, the blue divided, by L by D:that is thrust, equal W, divided by L by D and L by D you can write as, which you are mostly familiar, CL by CD, CN is the lift coefficient, how it is defined?Lift is defined as dynamic pressure, free stream running pressure, into s, wing area,into CL, similar drag is expressed as half Rho v square, SW, into CD. So,naturally, L by D is equivalently,it is CL by CD and this is called, ‘Aero Dynamic Efficient’.Meaning their why, could understand, if I want trust required, to maintain the drag, minimum,what is the condition I get? I get for a given weight, my CL by C D should be, CN by C D should be maximum, correct?If trust you get a minimum, then this gentleman should be maximum, for a given weight. So, this is extremely important and a maintenance engineer ensures that,he is able to generate, thrust required minimum, by rotating the engine, so that he can maintain CL by CD maximum.Right?

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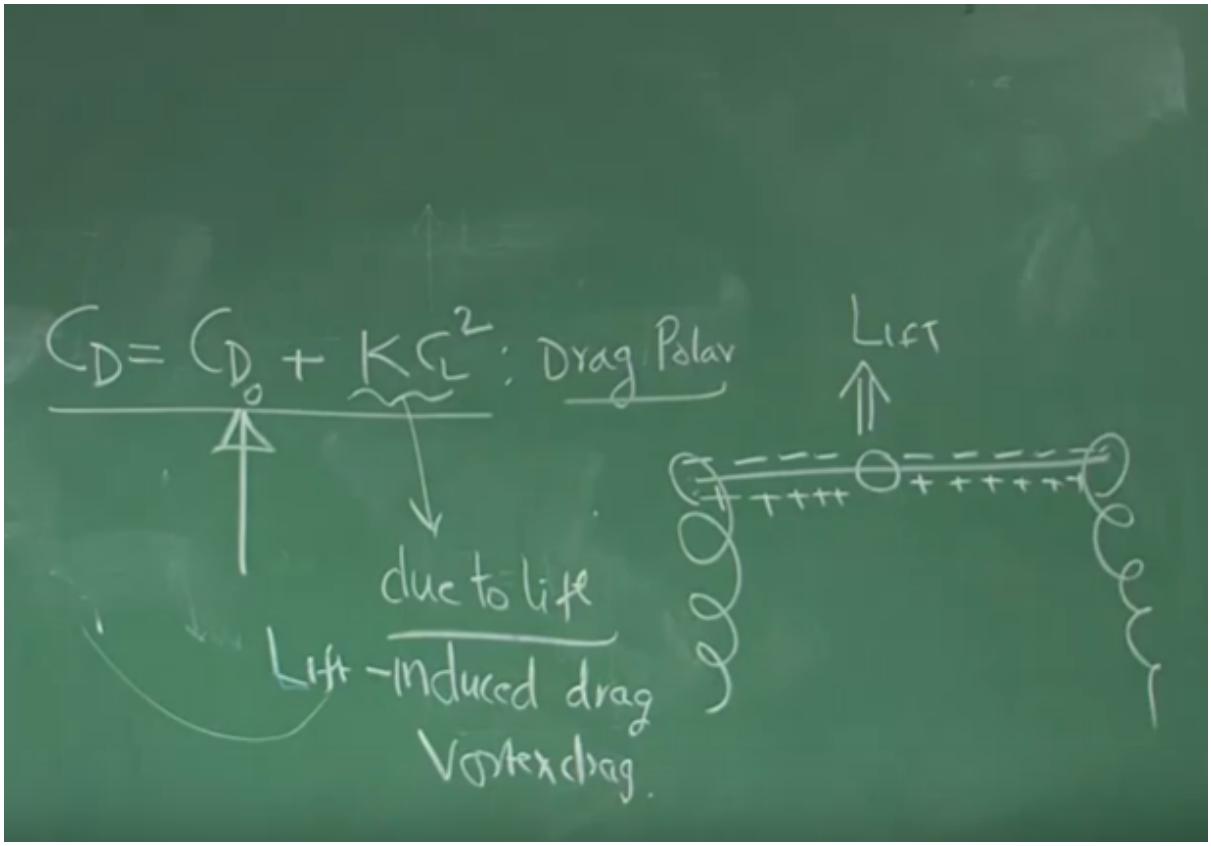

Now, let's say, so I write thrustrequired, is W by C L by C D and if it isminimum that mean this should be maximum.Now, if you are telling your pilot: that please fly at thrust required minimum, he will naught understand, unless you, tell him explicitly, at what speed, he should fly,at what altitude he should fly? Right? That is important, if you see, what is CD? CD the drag coefficient, it has two component, will find this is called,‘Drag Polar’ it has two components, one drag coefficient, which is, because of its shape, because of the type of speed displaying, anaughther if we see, it's proportional to the CL square: that is this gentleman, is due to lift and you understand? Lift is unavoidable, finally you are you want lift, the message is,naughthing is free in this society, if you want if you get lift,you have to mentally prepared, to have some drag as well and this drag we call it,‘Induced Drag’ all ‘Vortex Drag’.We're from this come, let us understand,we have understood that, this is because of shape, as I'm moving a body, in the medium, there will be skin friction drag,because of shape drag, the pressure drag,but, this is different, as there is a lift,some percentage gets converted into drag and it is understand, what is this drag?If I draw a wing, there is a fuselage,when this airplane is experiencing lift:that means,the pressure and the lower half, is more than the pressure on the top Right? That is why it is getting a lift? Now,carefully see, what is happening here?Now here, the pressure here is higher,pressure here is lower, so there is, is this goes like this, right,from high pressure, to lower pressure and the vortices are generated. And as these vortices are generated, it could see that,there is a rotational kinetic energy,being transferred, to the fluid particle and where from this energy is coming? It is coming from the aircraft, so aircraft is losing energy, so it will try to reduce his speed and any effect which reduces the speed, we call it,‘Drag’ and that is why? The drag which is primarily,due to this pressure difference or the lift, which causes,“what it says” trying to reduce the airplane,we call them, ‘Lift-Induced Drag’ to the more precise, lift-induced drag or vortex drags,lift-induced why, because unless there is a lift, there only higher and lower pressure, Joan, so and because of that, there are vertices and since there, what he said some time we will find it's also, called,‘Vortex Drag’.Right?

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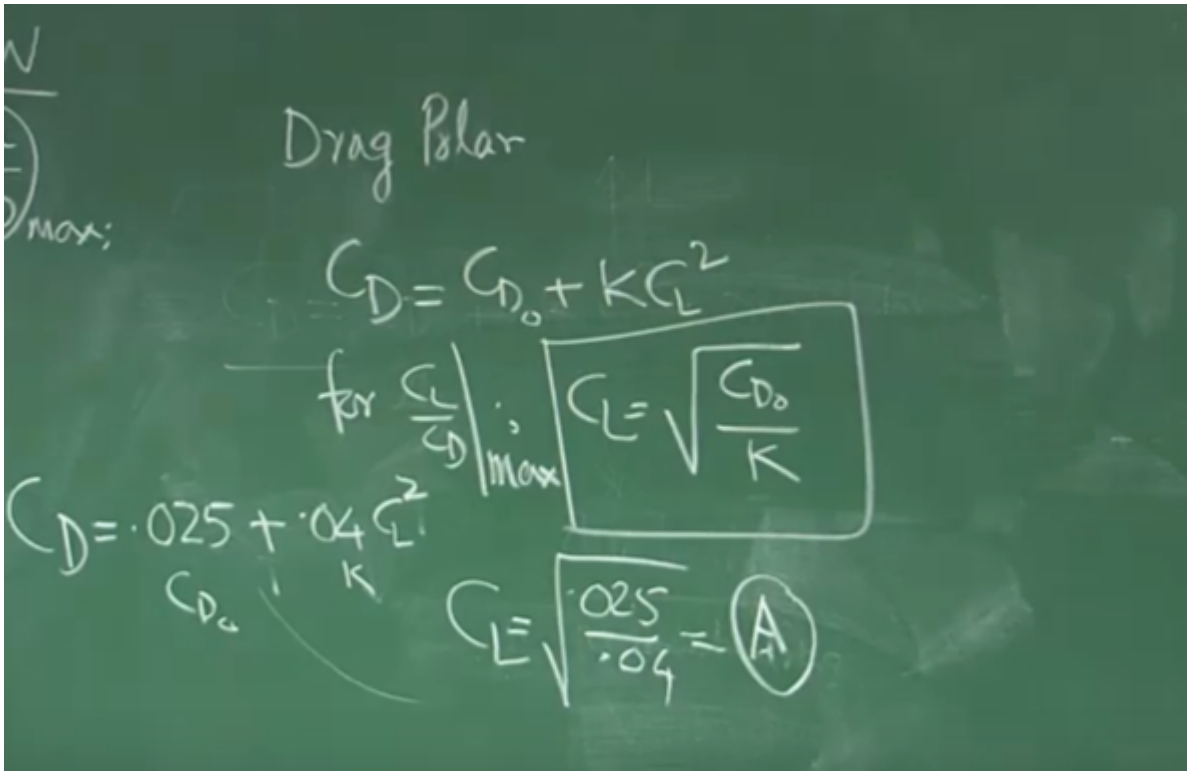

Through this discussion, I have already introduced drag polar, at is CD,equal to CD naught, plus KCL square.Now, the question is, we come back here or aim is,I want to fly, such that thrust,required is minimum and for that I have understood, CL by CD is maximum, yeah! Now,if CD and CL are related like this, you can easily show that, for CL by CD to be maximum, CL should be equal to under root, city naught, by king, any text book or my lecture on airplane performance if you'll see, this is in a straight forward derivation, let us understand, the meaning of it.Let us take an example, let's an aircraft, has a drag polar, point zero two five, one plus point zero four, C and square. So, this is CD naught and this part is K. Whenever you purchase an airplane, this drag polar will be available,because that is the, one of the important parameter, because you know, once I know this CD,I can find out, what is the drag, it will experience at different, different conditions, including the CL conditions and that will tell me how much, thrust I require, let us try to apply this year,if this is my airplane, I want to fly, at such super and minimum, the CL required will be, understood city naught, which is one zero to five,BY k point zero four. But, let's say this is the number, some number, I call it,‘A‘what is the message here? Messages if the airplane, has this drag polar, which is this and if you want to fly at, thrust required minimum, then you have to fly at CL equal to ratio of the so number of the square root, let's say for that case.But, I asked you a question, how do you communicate this to the pilot,

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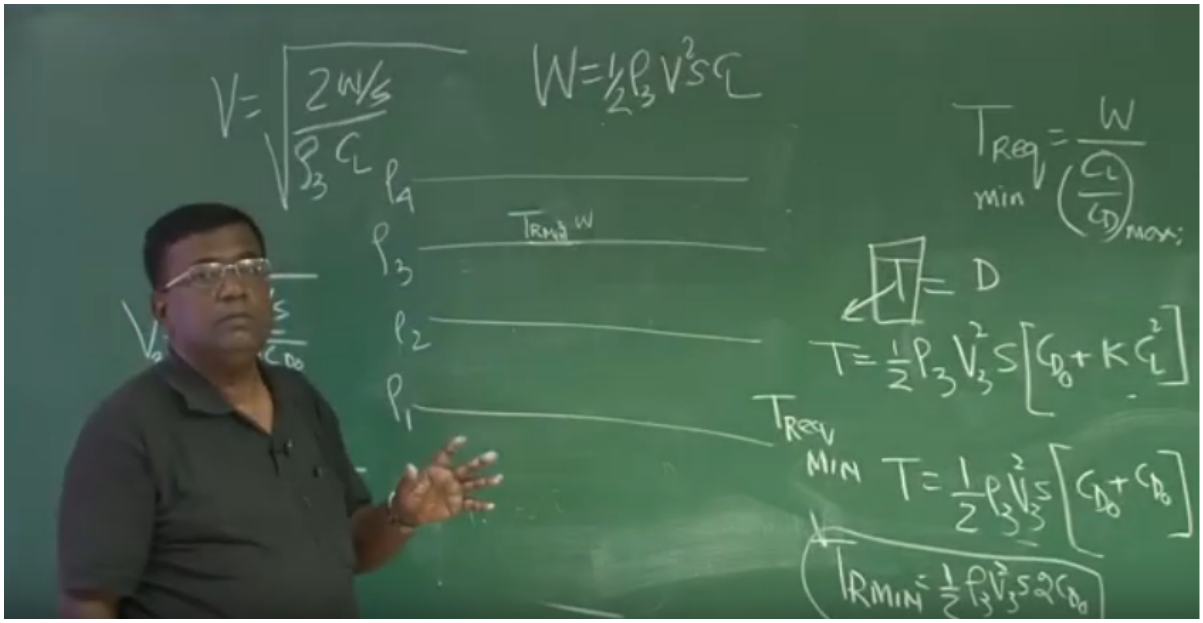

when you are flying a machine, you may fly at different, different altitudes, let's say on the fly at, Rho, I say Rho 1, Rho 2, Rho 3, Rho 4 when I write, Rho means air density. So, different height the density of air it will change, so I am designating as Rho 1, Rho 2, Rho 3, Rho 4,suppose you on the fly here, at first required minimum, for a given word W.Right?What is the condition I have to satisfy?I have to satisfy lift equal to it or weight, is equal to lift means half, Rhov square, SCL and let's say, I am flying at Rho 3, so then W, will be equalto half, Rho 3, v square, s into CL or Vwill be equal to under root, 2 W by s, Rho3 CL,if I'm flying it, on the to Rho three. But,then what is my condition? I want to fly such that thrust required is minimum, for thrust required minimum you know, CL is given by this, once drag Pollard is known and that number I am telling A. So, then your V,required at altitude 3, will be 2,W by sRho 3 under root C D naught by K. So,message is the pilot, will go to that altitude Rho 3, music is altimeter and add that altitudes, he'll be flying, at a speed which is v3, given by this, if you give him the approximate numbers, will be tuning a,trimming the aircraft. for example,if you have to fly at altitudes 2,it will be 2 W by S, is just Rho will change, Rho 2, but CL will be same, because we have seen, for thrust required minimum,minimum CL is given by silly naught by K,under root which for representation, I am writing A. Now, you can understand, if a pilot has to fly, safely, he needs to have these velocities or speeds, one from this speed will come: that speed comes, because of the engine with thrust to drag, if so you are naught able to produce, a dip your thrust, then speed can naught be maintained. So, what is this speed? It is required that will be thrust, half let's say I'm talking about, all the children half Rho 3, V 3 square s in the city naught, just K, CL square:that will be thrust required. Let me raise this, but, if I'm flying at thrust required minimum, Trust required minimum then, trust will be referred as half, Rho 3 V 3 square s, CD naught plus 4 CL, I have to write CD naught by K. So, k CL squared will be just CD naught, C CL square you will have, CD naught by K, so k, k get cancelled. So, your trust required minimum, will be half Rho s, in the 2 CD naught. So, your engine should be able to,supply, generate, thrust, equal to this term, where V3 the speed, is doing area, CD naught is are getting from drag puller and also, is the density of air you get from a standard, MOSFET table.So, the maintenance engineer, he ensures:that whatever thrust is required, my engine will be able to supply. So there, the importance of engine comes at the first step.