NOC: Introduction to Airplane Performance
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Lecture - 13
Review

As we promised before starting a new week lecture series, we will be again revisiting whatever we have presented to you and try to add some value to it.

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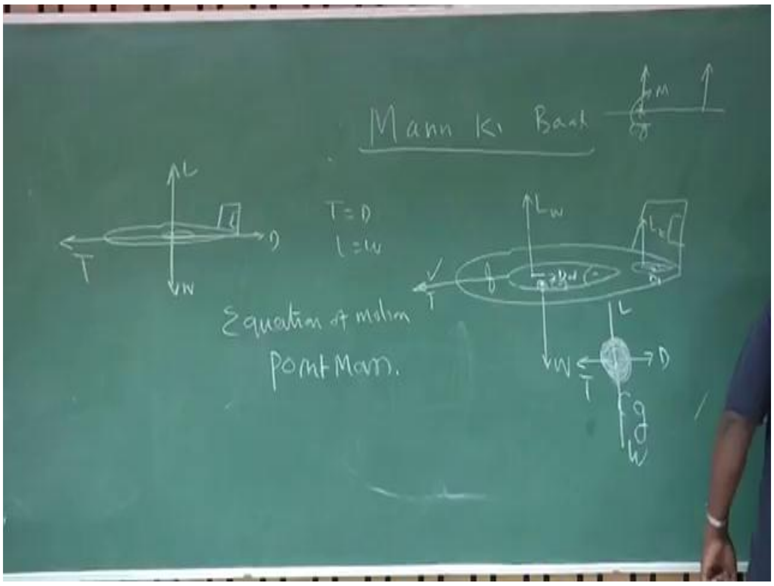

Please understand this whole module generally in a regular university you finish in 4 month or around a semester and we are trying to pump it very fast. So, it is an explicitly important that we must revisit and gradually add value to a basic concept. So, that is why I personally prefer this Mann Ki Baat session to be a one of the important session, where not only I improve myself also you get improved.

Let us go back what we were discussing on the second week lecture that was primarily thrust equal to drag, lift equal to weight. We are trying to do cruise and we drew an airplane, thrust, drag, then lift and then weight. I was discussing with one of my student and he was little disturb, he said sir you are too fast. I said why, you are drawing this diagram lift equal to weight, thrust equal to drag without measuring the point of application of this thrust, drag, lift and weight.

So, that will give you wrong picture to the students especially the newcomers. So, why do not you add little more and unfold, so that newcomer can understand what exactly it means, I agreed.

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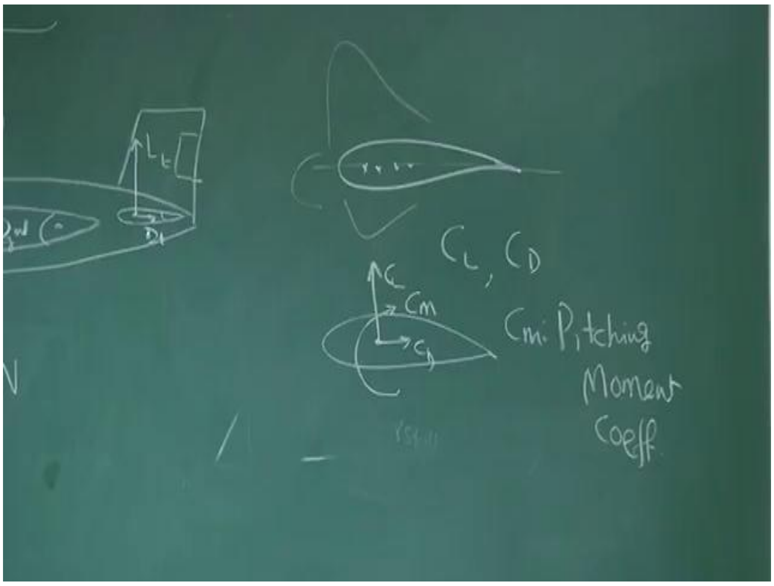

Now, let us see I think he raise a good point, let us see a typical airplane, this schematic of a typical airplane. And when it is flying actually what is happening, you see this portion gives the thrust, weight is here, then lift on the wing will be some point, let us say here I will explain you what exactly this point will be. Similarly, lift on the tail will be somehow here I say lift on the tail, lift on the wing, then drag on the tail, drag on the wing and drag on the tail let me repeat.

This is the point of application of lift, wing, drag wing, lift tail, drag tail and this is the weight of the overall airplane, this is the thrust. So, immediately a question came, where should I represent this lift acting on the wing as well as of the tail. In a quick and in a short explanation or a more of information, let us see this aerofoil a general aerofoil, because of the pressure differences, you know there is a lift and we try to talk in terms of C L.

And if you take different point this net force will generate different type of moment, it nose up, up, nose down whatever it is depending upon where is the resultant and where is the C G. Now, what we do? We want to represent this C L and C D at a particular point, fixed point and we ask a question is there such point which does not change with angle of attack. So, that I can simply write draw an aerofoil and I write this is the point, this is C L, this is C D and whatever moment is there I write C M, I will have not discussed about C M, but you take C M as pitching moment coefficient.

It is so happens for general aerofoil, there is a point along the chord of thin aerofoil. At that point the pitching moment is independent of angle of attack, that even if the angle of attack changes, the pitching moment above that point does not change. I will repeat again, see this is the force out of this pressure distribution. So, if I take pitching moment a moment of that force about any point on the chord they will vary, they vary with angle of attack also.

For example, if I choose one point here resulting will give some pitching moment, if I change the angle of attack the lift distribution will increase, lift will change, the pitching moment also will change. However, there is a point which is we call quarter chord point typically for low speed which is also called aerodynamic centre in general. It so happen for low speed, the aerodynamic centre is that quarter chord 25 percent of the chord.

What is this aerodynamic centre? It so happens, the pitching moment is independent of angle of attack at the aerodynamic centre. So, that is why we always represent C L, C D, C M all these coefficients at aerodynamic centre. So, now if I come back I know this is the wing, so I find the chord and this point will be 25 percent of the chord, so I know this point. Similarly, I know this point for tail, I know thrust where it is located, I know why the C G and the weight.

But, when I am writing this equation of motion, remember equation of motion from there we got thrust equal to drag and lift equal to weight for an unaccelerated flight. They were using point mass model I mention that point mass assumption that is, I am not bothered about mass distribution, because I am only bothered about rectilinear motion. So, I am assuming the whole mass is concentrated at the C G and whatever we are writing lift, weight, thrust, drag all are assuming that these forces are being applied on that point mass.

But, I know in reality, lift is not acting at C G, this lift is not acting at C G, this thrust is not passing through C G. So, what is done? Very simple, if I have a force here, if I know this is the C G or any other point, I can transfer this force here and the moment of course, I have seen the moment side as a positive way convention, if it is negative the value will be negative. So, I can transfer a force from one location to another location using force and the moment.

So, what is done is all these forces lift, tail, lift wing all drag, etcetera are transferred to C G here, also the thrust force and whatever moments are there, they are also transferred. But, in this analysis it is assumed that all those moments are balanced by elevator, trimmer or whatever it is. When I am writing this equation of motion, it is a point mass model and the assumption is all the moments are balanced and it is a stable flight, so this clarity must be there.

Then, we were also discussing about rate of climb and we have seen that rate of climb is related to excess power. But, one thing I must tell you, for this sort of unpressurized airplane aerodynamically they are ceiling or service ceiling, altitude will be much higher than actually you can fly this machine for other conditions. For example, if you are going above around 9,10,000 feet, the oxygen level is reduced. So, you need to carry oxygen cylinders, it is very uncomfortable for pilots and beyond that if you go, there are naturally problems which are more specific to a case where the airplane is unpressurized.

So, for all practical purpose this service ceiling and absolute ceiling whatever aerodynamically being predicted and operationally what we do they are being limited, because of these primary reasons. So, that is what I need to mention you on that.

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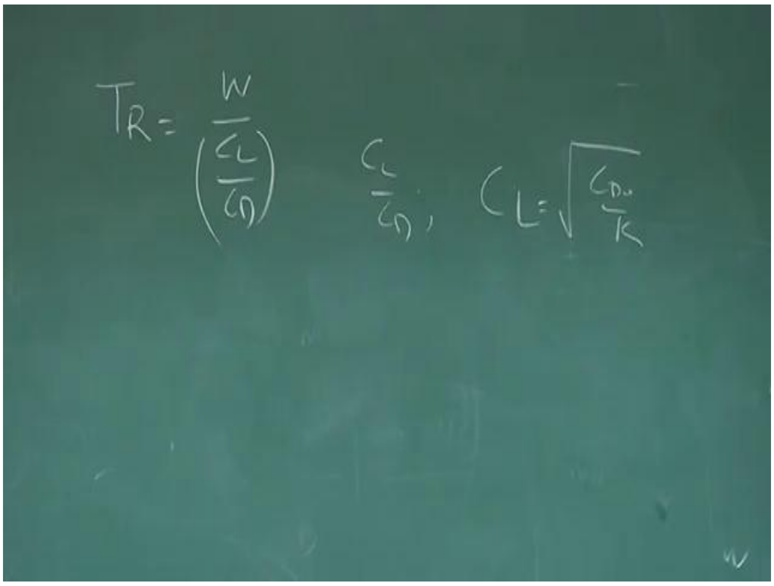

And then we also very explicitly talk about thrust required and we are talking about C L by C D and we gave a statement that it means C L is under root C D naught by K and we will try to add more values on this C D and not on K and we try to see, how can I get this values even through flight experiment, that is the final thing. Getting from wing tunnel do a flight test, then see they are closed or not then you say yes this is the value. So, these are the things we will be doing.

Thank you.

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Cessna 206 fully glass purple 300 BHP Brake Holds Power, this we called is PFD, MFD Primary Features, Main Features called arm standby battery, master, avionics that is called throttle, mixture, propeller pitch, control column, pitch. The aircraft is moved backward crasher, aircraft goes up, down aircraft goes down that is ailerons left or right. You can turn left, you can turn left wing below the horizon, right wing if you press right then right wing below the horizon left wing up the horizon called two rudders jointly.

Then, we can start press arm then battery and that is a standby instrument in case main primary and main field that is called standby, altimeter artificial horizon airspeed indicator or a artificial horizon altimeter that is called PFD that is manifold pressure RPM all readings your engines, oil pressure, temperatures, CST, EGT airspeed altimeter. Now, mixture in throttle half inch in fuel pump on, then fuel pump off, mixture out, then crank ignition right, left both then start.

Now, engine start and now alternator on avionics frequent never stop. So, today we will experience a flight of Cessna 206 that is restoration is VT, IIT the aircraft has been visually checked with the go round in it is fiction. And now we are going for the ground run after which we will experience the climb, takeoff climb and the landing of the aircraft. Pilot is checking all the readings for the inside the instrument panel, you can see he is checking for the flaps, the different positions of the flaps, the various readings on PFT's and MFT's.

The aircraft is being warmed up and is being ready for taxiing ((Refer Time: 14:37)). It is the RT voice for clearance. You can see the various engine readings on the PFT's, the oil pressure, the oil temperature, the CHT, EGT and the readings on MFT the multifunctional display, all controls are checked for field correct moment, cowl flaps are open, flaps are being sent at 10 degree position for takeoff ((Refer Time: 15:52)), elevator trim and ((Refer Time: 16:00)) is being set for takeoff.

Fuels electro is on both, fuel is being taken out from both the tanks, just keep a watch on an ASI and an altimeter as we climb. Aircraft be the two magneto should be within the limit. Now, we can increase our throttle air speed align after the airspeed maintaining aircraft 60, then slightly backward pressure, the nose gone the up, there is a climbing ((Refer Time: 16:49)), this is the airspeed ((Refer Time: 17:08)) aircraft on a artificial arising also can be seen aircraft is the stable, so the miniature aircraft is also a stable on the gauge on artificial arising.

The aircraft is engage fully on autopilot, the controls can be left free when the aircraft is left on autopilot. This is the airspeed of the aircraft frequency, you can see ((Refer Time: 17:42)), the airspeed is given in knots, you can see the variable RPM of the engine. The oil pressure will range the oil temperature between the minimum and the maximum limit, this is the miniature aircraft and the artificial horizon as the aircraft is banking towards right. Just keep a watch on the airspeed of the aircraft CR 23, 100 RPM we have a manifold of 21.6 inches.

We are getting an approach for landing ((Refer Time: 19:22)) flaps are full down for 80 degree, airspeed is 72 to 75, pilot pitch in ((Refer Time: 19:40)). Functional RT has been taken clearance of the landing for landing approach adding towards a runway. See the altimeter airspeed reduced, power is reduced and here is the touchdown of the aircraft lights off ((Refer Time: 22:11)).