Indian Institute of Technology Kanpur National Programme on Technology Enhanced Learning (NPTEL)

Course Title Introduction to Experiments in Flight

Lecture03 Weighment Experiment and Cockpit Panel Demonstration

By Prof A.K. Ghosh Dept of Aerospace Engineering IIT Kanpur

Good morning today, we are here in flight lavatory and I am fortunate to be surrounded by students of MIT Chennai and you all know Dr. Kalam was a student of MIT and they are here the part of their course on introduction to airplane experiments in flight. Today we on to demonstrate you how we can take the measurement of weight of an airplane you could see before I go for women experiment let's briefly see what is an aircraft.

It could see the CS lew is large, this is a flap this is a Laran the similar there Ellen on and rudder now the question is why weight is important? Now after all aircraft has to fly inhere there should be some force who should balance the weight and how much about force is required will be decided by how much weight of the airplane ease so basically the performance of the airplane is decided primarily by the weight of the airplane. For example what will be the range or out of the endurance, how much rate of climb is, how much take off distance landing distance are primarily governed by the weight of the airplane.

Hence it is extremely important to know correctly what is the weight of the airplane, when I say what of the airplane it means the air frame weight, the structure weight. We will weight along with the passenger weight right. So now today, as soon as we realize that weight is so important we should not forget from the stability and control point of view center of gravity of the airplane in configuration is equally important.

So we will use this experiment we try to understand the procedure to know how to find out weight as well as center of gravity of an airplane. For any measurement you need a balance we have a balance there you could see that side there are three balances will be soon focusing you there before you focus there will request our student to drag this airplane to the balance. Let's drag this airplane all together okay thank you.

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Now you see that these are the balance is one balance here and that is I had rather in the node landing gear. Now we have to somehow measure the reactions happening at these three balances. So how do I measure the weight or measure the reaction at the three point thing? We need to measure it by a scale; we need to know what is the least count of the scale. What is the least count of this scale?

Its 200 grams right. So now you see how to measure the weight will demonstrate it. Can you demonstrate how to take the weight? Slide slightly off take it back yes okay thank you! Mind your head. What she has done if you see this is a scale here right and you have to make the scale horizontal the first is you adjust from this liver and for the final connection you do from the

small right here once this is done it is like a one-year caliber you read the scale main scale and the venire scale and you note down what is the weight.

Can you note down how much is the weight here and somebody should write here the back 220 to 243 watt. 443 no decimal we get three how will be 3, 200 is the list down low post for the three point four kilograms okay for 43 points four kilograms for 43.4 and go for 43 points 44 on the 440 okay. What about the nose somebody measure the nose come on what is the problem come to measure will help you out come front, this of the balance see that this scale is down we have to somehow make it parallel.

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So he will try to use the one year to do it yeah it is valid can you read the scale now 680 4.2. So the nose wheel reaction is 680 4.2 Reggie. Whatever the left or right landing hear 400, 400 a mannequin. You could see that the 400 is the main scale here right and one here is how much 40 + 2 that means it is 144 40.6.

So now this landing gear is measuring is action of 440.6 kg right okay what is your name? So Sangeetha will help us now how to get the total reaction? Let me repeat the left landing gear was

weighing for 43.4 kg and the nose landing gear here was showing a measurement of 6804.20 kg and the right landing gear was showing for 440.60 kg.

So what will be the total is it okay everybody says yes, so what is the weight of the airplane 1568.2kg for these fuel configuration, this aircraft is not fully loaded with the frills so it you can further add frill but the point is the moment you want to fly this airplane the passenger will sit here. So their word has to be added when you are doing the experimental analysis.

Right now tell me one thing now see we have we now know that weight is equal to 1568.2 kg now we want to know under this configuration where is the city location how should you find out? How to find it out? Anyone who can come boys or girls anybody get some gum that's like graham yes we want to know find out what is the CG location right center of gravity location what data we have got?

We have got one location here one location here and the location here and we know these distances like this distance is A this distance is V and this distance is C. These are known because landing air is fixed there is a geometric location you can check the manual you will find this lengths are given left there A B and C and this is a nose landing gear right. So what is the reaction here we are finding it is around 684.20 kg and hear how much left is for 443.4 kg and hear how much for 440.60 kg. One thing you can clearly see that this left and right landing gear they're almost measuring equal weight, which shows what they're sure there will be hardly any lateral shift in the city.

If some of this weight was much more than this weight, that CG would not be in the center line feed you with me some of this weight is much more than this way that we CG will be little towards this weight but we want as a designer the CG should be on the central axis. So this number when you see within these 3kg difference there may be so many other multiple accessories here. So you know one thing that they act out this beautiful design and CG will be in the center line this is one of the question.

Now if I want to find out where is that CG of this configuration it is very simple you know how to find CG suppose this is the reference axis and there are 3 m1, m2 and m3 and you know their location a1 a2 and a3. How to find CG along X axis like this that will be what XCG will be will be what m1 a1 + m 2 a2 + m 3 a $3/\Sigma$ m. The CG is that point about which net moment because of all mass distribution should vanish here we have got three forces this one, this one, and this one.

You take any reference, you take therefore this line you can as well take a reference line from lets say I am taking a reference line here that depends upon you, you can take a reference line here also then this product will be 0 from here you know what is this distance. So what is this distance and what is this distance. They say a1, they say a2, this is a3 and you know this forces you find m1 * a1 + m2 * a2 + m3 * a3 / \sum m that will give you a piggy location and you've already seen leather shift is not there so you can fairly assume that it is on the center line is this concept clear.

You know how to find CG and how to find the center of gravity right okay thank you! If this is this aircraft is a typosaratoga, this is the cockpit where I am sitting, this is the instrument panel you can see these are the control stick every excerpts has got dual control sticks. This stick you can compare it with your with the handle of your car or your cycle if you do it like this the aircraft banks to the left , if you do it like this a curve banks to right, if you pull the stick the aircraft node goes up, if you push the stick the craft node goes down.



Here you have a few instruments you can see this is the altimeter, which indicates the Alta to that which you are flying, this is your air speed indicator which indicates the indicated air speed, and this is your vertical speed indicator which give you the rate of ascent and descent of the aircraft. There you can see there are 3 gauges and 1 this is the engine instrument you can see the oil temperature, cylinder temperature and oil pressure.

Oil pressure is the most critical parameter which is to be observed when you start an engine. The very first thing which you have to observe us the oil pressure should register within 30 seconds of your starting the engine in case if your oil pressure doesn't register then you have to switch off and look for the reason. This is your fuel quantity gauge, this gauge on the left is for the left tank and this gauge on the right is for the right tank.

Thus a plane has got few tanks in the Wings one in the leftwing one in the right wing. The total capacity of this aircraft fuel capacity is 107 US gallons out of which 102 US gallons are usable and 5 US gallons are unusable. This gauge you can see this is, there are 2 gauges and 1. 1 is the manifold pressure gauge on the top and on the bottom is the fuel flow gauge. The manifold pressure gauge this indicates the power being generated by the engine.

This particular gauge this is your RPM gauge we also call it a tachometer. This indicates the revolutions per minute of the propeller this particular plane the maximum RPM is 2700. This cage this is your exhaust gas temperature gauge, this indicates the temperature of the exhaust gases, this is your artificial horizon's or you can say flight command indicator, this indicates the attitude of the aircraft whether your aircraft of is flying in a straight and level board or it is flying on a bank angle you can find it out from this particular gauge.

Then these are your navigational instruments, this is your turn coordinator or you can see there is a bank indicator also there you can see a black ball in the center in case that the aircraft is flying in the straight and level mode the ball will be centered and if it is flying at a bank angle you can see the ball will go either to left or right. Then you have this particular panel this is your radio panel where you have the radio sets through which you are in contact with the control tower and other aircrafts.

This particular airplane also has a as an auto pilot, then this is your switch panel you have switches for different, different circuits this is your master Becky master switch. Then this panel on the right side is your circuit breaker panel. These are the circuit breakers for different circuits here. On the instrument panel, you can see these few lights, these is the insulated panels you have lights for different circuit, these are the warning lights in case if there is any malfunction in any circuit if during the flight this light will glow.

This will indicate that you have a problem in this system and the pilot can take a call whether to make an emergency landing or to continue with the flight. This is the landing gear selection labor these are the 3green lights for the landing gears. This is for the left main landing gear, this is for the right main landing gear and this is for the nose landing gear.

Three lights 3 green lights glowing indicates that your landing gear is in the down and locked position after taking off once the pilot selects the sliver up then these 3 lights will go out that indicates now your landing gear is not in the down and locked position. Once these lights go out

you can see there here a red light gear, warning light this light will glow this indicates that now your landing gear is neither down and locked nor up and locked and is in the transit mode.

Once the landing gear is up and locked this red light will also go out similarly, before landing the pilot will put the selection lever down again the red light will come on this gear warning red light will glow. This indicates now again your landing gear is neither up and locked nor down end locked and it is in the transit mode.

Once the eight landing gears are down and locked this red light will go out and this these three green lights will go then you can safely land .There may be a possibility in flight that you have selected by landing gear lever down but your lights have not come on, now you are not sure whether you're landing gear is down and locked or not and you need to land in that case in these kind of situations you have a this you can see this red knob this is the emergency lever.

In this the emergency lever if you pull this liver, the landing gears will make a freefall and we get down and locked. How this was done? In the landing gear circuit which is a hydraulic circuit there is a shuttle wall which feeds the hydraulic pressure trap once you pull this lever that hydraulic that shuttle wall moves to one side, the hydraulic pressure is released, the landing is makeup free fall and gets down and dropped mechanical.

Then here you can see this is your fuel tank selection. As I have earlier told that there are 2 fuel tanks in those aircraft one in the left wing one in the right wing. This is the selection for the fuel tanks, this selection in is for the right tank that means the fuel supplier will come from the right tank and if I do it like this on the left the fuel supplier will go from the left tank and there is an off position also if I have to switch shut off the complete fuel now it is in the off bone.

So you have two-three selections of left and right in this particular plane. You can see here this is your parking brake, you can see here this instrument this is the direct reading, magnetic compass then this is your outside air temperature gauge which gives you the temperature of the outside air. Acknowledgement Ministry of Human Resource & Development

> Prof Satyaki Roy Co-ordinator, NPTEL IIT Kanpur

> > **NPTEL Team** Sanjay Pal **Ashish Singh Badal Pradhan Tapobrata Das Ram Chandra Dilip Tripathi** Manoj Shrivastava **Padam Shukla** Sanjay Mishra **Shubham Rawat** Shikha Gupta K K Mishra **Aradhan Singh** Shweta **Ashutosh Gairola Dilip Katiyar** Sharwan Hari Ram **Bhadra Rao** Puneet Kumar Bajpai Lalty Dutta Ajay Kanaujia Shivendra Kumar Tiwari **An IIT Kanpur Production**