CAREER EPISODE 1

a) Introduction:

1.1 This career episode is based on the project which was presented in the technical seminar arranged by the IARE (Institute of Aeronautical Engineering) in collaboration with the Department of Aeronautical Engineering, Hyderabad, India. The project was entitled "Aircraft Thermal Analysis", and I worked on this project to fulfill the requirement of my bachelor's degree. The project was commenced in Month/Year and completed in Month/Year.

b) Background:

1.2 From the past few years,the thermal management of the aircraft has gained a lot of importance because of the following main reason:

1) To provide a comfortable ambient environment to crew and passengers
2) To allow airplane systems and cargo to operate in an acceptable operating environment
3) To protect aircraft structures from thermal threats.

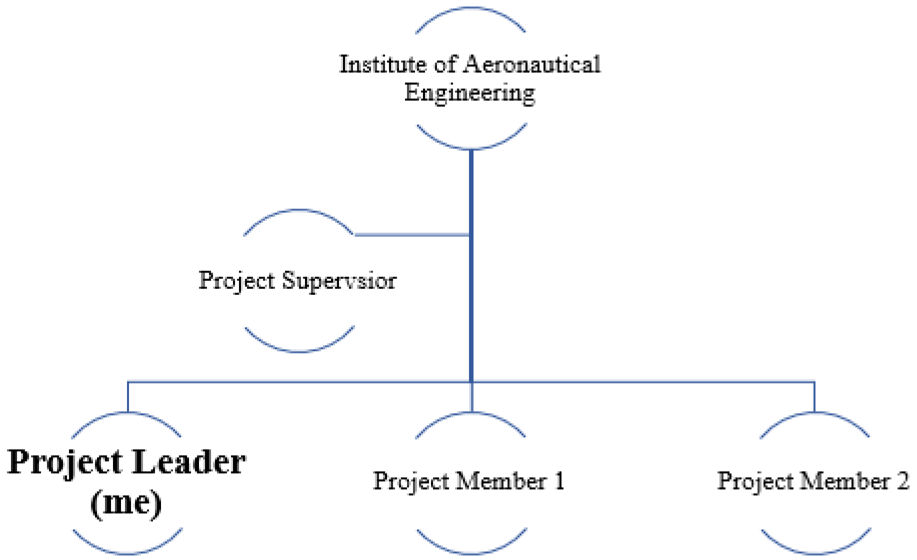
On top of that, the management is also required to ensure that both crew & passengers are neither too cold nor too hotirrespective of the OAT (Outdoor Ambient Temperature), which can beover 70°C throughout a flight. The extensive research on commercial aircraft showed that due to poor temperature control in the cabin a lot of issues have been encountering by the passengers and it eventually causing a loss of valuable customers and a drastic reduction in theannual revenue for an airline. In addition to this, in military aircraft, it has been found that the distressof pilotsbecause of extremely poor control of temperature can negatively impact crew performance.Therefore, based on these identified problems, it was decided to carry out an aircraft thermal management toensure the occupant's comfort plusthe safety of the structural operation and systems to gain longevity in normal operation, as well as survival during any failure. In this project, a thermal analysis was carried out to propose the economical and lesser weight thermal design of an aircraft.

1.3 I carried out a thermal analysis of the aircraft by performing the following main tasks:

- Analyzed the impact on aircraft due to differences in the outside and internal ambient environment.

- Studied the effects of solar heating and internal headloads on the aircraft.
- Proposed the modifications to reduce the impact of identified problems on the commercial aircraft i.e. development of the ECS (environment control system).
- Suggested the innovative solutions remove the excessive systemheat or structural temperatures by using a heat sinks mechanism.
- Developed the final report which showed the analysis in detail.
- Involved in the project meetings and managed the project work.

1.4 The following organizational structure indicates my position:



c) Personal Engineering Activities:

1.5 Being a research-based project it required a lot of researching and internet browsing to understand the fundamental concept of the electronic aircraft and their systems, wide temperature ranges, and large-magnitude, variable-orientation acceleration of aircraft in the form of shock, vibration, and sustained maneuvers, etc. Therefore, to enhance my project understanding, I first performed a literature survey and studied the procedures for the management of aircraft to enable both safe flights as well as landing at any nearest airport. Then, I prepared the "Project Plan", which showed the steps to conduct proper study and analysis of the aircraft system under different scenarios.

1.6 I studied the effects of the outside and internal ambient temperatures (−40 ◦C to 50 ◦C, respectively)on the commercial & military aircraft by first analyzing the pressurized volume of the aircraft according to the IATA and ICAO standards. I found out that during pressurized volume, the ambient environments of commercial airplanes become vary among the zones which are occupied mainly by persons, cargo, and electronics, and at this point, I suggested installing environmental control system (ECS) so that internal ambient air temperatures can attain a much narrower temperature band and provide the lowest heating&cooling to fulfill the temperature demand required for the separation zone. Afterward, I studied the effect of temperature on both the flight deck and passenger cabin. I came across that there's necessary to stringently maintain the temperature in the cabin and deck to provide complete comfort to the humanthan that ofthe cargo compartment and E/E (electrical/electronic) bays. So, I suggested maintaining the temperature nearly at 23◦C in an occupied cabin of passengersand deck to allow normal operation, which is usually get neglected to avoid increasing the size of the ECS or the cost. Also,to properly maintain the required temperature, I suggested calculating or determine the air velocity and relative humidity during the designing of ECS to maintain human thermal comfort.

1.7 Next, I analyzed the effects of unpressurized volumes in the commercial airplane by using the following figure, which represented the A/C pack bay present below the center of the wing fuel tank, airplane tail, and the main wing

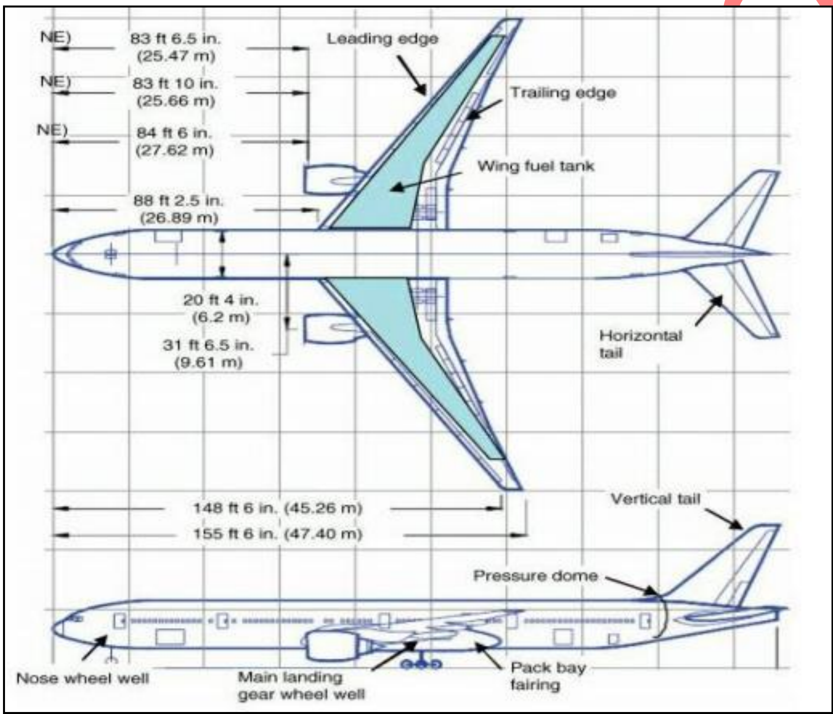


Figure 1 Unpressurized Volume

Also, I observed from the figure that the wing comprisesof fuel tank &aft leading-edge compartmentson the forward side, whereas the tail compriseshorizontal &vertical volume aft and stabilizers in the pressure dome. So, the presence of unpressurized volumes over aircraft can open areas to allow water drainage and pressures equalization during variations in altitude. However, during this time, it is a chance of occurrence of the pressure differentials in between the manifold openingsof unpressurized volume which can generate ambient airflow to ventilates all compartments, and subsequently, it might cause the equipment placed in the unpressurized compartment to generateenormously lowest or minimum air temperatures throughout the flight, impendingan ambientrecovery temperature. At this point, it is necessary to ensure optimization of recovery temperature so that air can reachitdecelerates as soon as it comes in contact with an aircraft by converting themotion energy into the heat.

1.8 Next, I examined the solar heating effects on the airplane. I noticed that during the time of[3] flight, solar heating produces minor effects on the structure because of themaximum convective cooling rates as compared to ground conditions. However, I observed that solar heating can be caused a significant escalationin structure temperatures (50°C or more than OAT) for few aircraft surfaces which have optical properties and such properties encourage the rise in temperatures. This condition mostlyoccurredwhen the aircraft are flying in the desert environment near to the solar noon in summer months where calm air reducesconvective cooling. Further, during this condition, there's a chance of occurrence of calm winds from the commercial airplane standing next to the terminal during loading passengers. During this period,I recommended that temperature should not increase to avoid loss of material strength and degradation.

1.9 Then, I examined the effects of solar heat on flight deck crew passengers, and I noticed that the larger surface area of the window in both commercial planes and military aircraft enables direct solar radiation's impingement on the crew. However, the A/C system of the aircraft must provide an adequate capacity to maintain airflow rate and temperature to keep all crew members comfortable.Therefore, I suggested installing an ECS system that must havenozzles for direct spraying of conditioned air on the crew on military or commercial aircraft.

1.10 Hereafter, I performed heat loads analysis and came across that increased electronics in the military and commercial aircraft causes decrease in the power dissipation of avionics. So, in commercial airplanes, the presence of increased IFE (in-flight entertainment) systems, as well as avionics,frequentlyintensifying the need for aircraft cooling. Therefore, for the thermal management of maximum power density, I identified increasing the avionics and use of advanced weapon systems as a critical factor in the future military program. After this, I checked the heat load that occurred during the brakes applied by the aircraft and studied that during the application of brakes, a great of energy is dissipated which can cause aircraft to move through the rotor's frictional heating, eventually contacting stators (brake pads), alike to the car brake. During this tenure, the stator temperatures also got increased up to 400 ◦C because a large amount of energy is dissipated while stoppingthe large aircraft by applyingthe lightest brake. Here, I calculated the energy needed to stop the commercial airplane with the equation:

$E = MV^2$

Where M = mass of airplane(kg),E = energy (J), and V= wheel's velocity when the aircraft hit arunway (m/s)

I noticed that in the larger commercial aircraft there's a thrust reverser, which can cause diversion in the exhaust of the aircraft's enginein such a way that produced thrust will be directed forward, instead of aft at landing, which can be observed from the following figure:

Figure 2Fokker70 Thrust Reverser

The thrust reverser decreaseshowever it will not remove the required amount of energy required by the brakesto stop an aircraft during a landing time.

1.11 I also studied the effects of aero heating and then, I proposed the solution of installing ECS (Environmental Control System)to maintain asuitable ambient environment throughout the aircraft structure. The proposed system comprised of turbo-compressor or bleed air system to generate air to pressurize a cabin, an air distribution system (ADS) to supply direct conditioned air into the flight deck and cabin, and A/C pack for cooling of pressurized air, and lastly, cooling systems for eradicatingthe generated heat by avionics equipment.

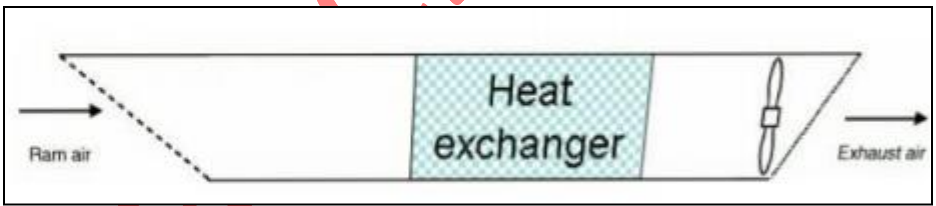


Figure 3RAM air system

The bleed air system comprised of the turbofan engine to producemaximum pressure air and temperaturethat bled from the bleed ports in order to pressurize a cabin and it will also provideair source to all air-conditioning packs, anti-ice protection through heating of wing leading edge and engine cowl, and also provide heat inthe cargo compartment.

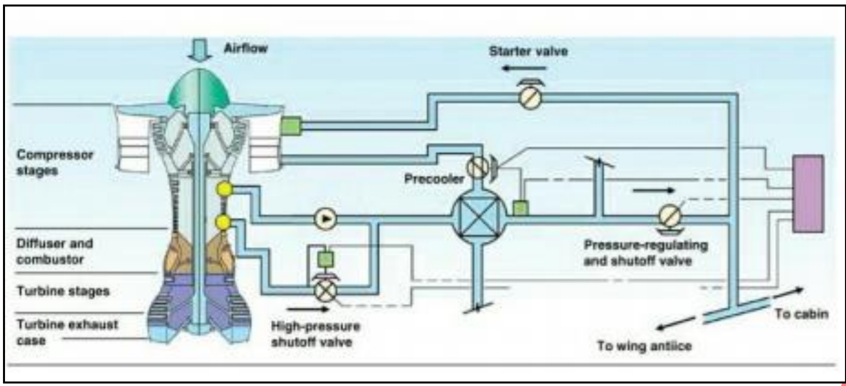


Figure 4multiple compressor stages

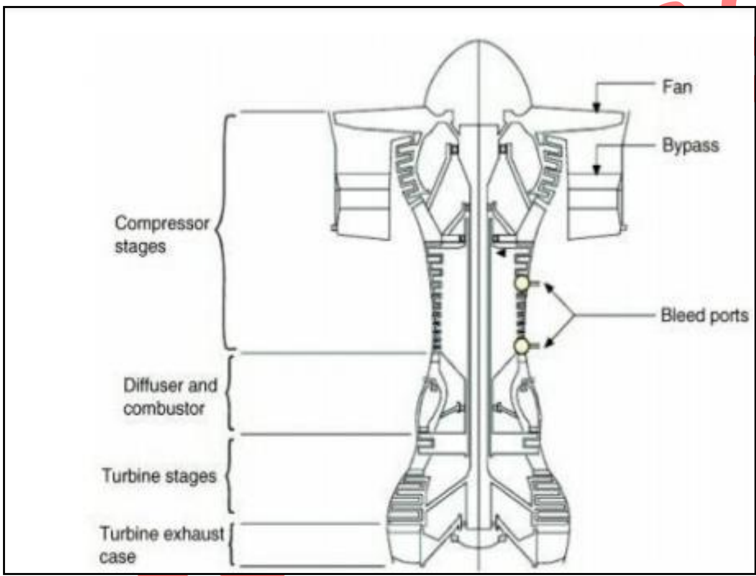


Figure 5Typical Turbojet

At lower engine power settings, I noticed that air usually gets extracted at the maximum compressor stage so as to confirm adequate pressure to meet the system's requirement. So, using it, I suggested that the bleed air must first be cool enough so that it can exit the compressor stage bypassing it via an air-to-air HX (cooled) precooler by outside air.

1.12 To further reduce the temperature, I recommend usingan air distribution system (A/C) in commercial air flights. Because the air-cooled by the A/C packs is mixed with recirculated air drawn from the pressurized volume and supplied to risers going up the sidewalls. The risers supply overhead nozzles running the length of the passenger cabin. This system will also provide air to the flight deck nozzles, which makes the cabin produce exhaust airflows to the lower lobe where the air is either picked up by the recirculation system and mixed with the air coming from the A/C packs or flows out of the airplane through the outflow valve or airplane leakages paths, such as cargo compartment or main cabin door seals and this cabin exhaust air is mixed with air supplied by the packs to reduce the amount of bleed air or engine power required to compress ambient air in providing cabin cooling.

1.13 Next, I studied the effects of the fire thermal threats on the cargo compartment,6 engine/APU, and then provided thermal management for the military aircraft which have similar ECS as their civilian counterparts and must operate in nearly identical outside ambient environments.Lastly, I observed the heat sinks effects on the aircraft and suggested the removal of the generated heat to avoid excessive system or structural temperatures. Thus, I recommended two primary heat sinks methods for a commercial airplane are the outside ambient air and fuel, i.e. ambient air and fuel. Because, the ambient air cools aircraft structures heated above ambient and removes waste heat by flowing over a skin heat exchanger (HX), whereas fuel also acts as a primary heat sink on both commercial and military aircraft to cool engine systems, hydraulics systems, and electronics.

1.14 After analyzing the effects on the aircraft and recommended modifications, I arranged a meeting with the project supervisor to explain my work to him. This was done by developing the presentation in the PowerPoint software. I illustrated a detail of different factors which need to be considering while designing the aircraft, ambient air temperature requirement, and their effects, generation of heating loads in the aircraft, etc. I suggested proper thermal management of the aircraft to avoid accidents and installation of the ECS which will help to maintain the temperature and reduce the effects of excessive heat.

1.15 Moreover, I also developed the report and comprehensively explained each step i.e. project background, literature review, study of different effects, recommendations, etc. This report was made in the MS Word software and I submitted it to the head of the department and the supervisor.

1.16 During the project, I also called frequent team meetings to create a friendly and coordinated environment. I always discussed the project's important points with them and carefully listen to the suggestions given by them. Moreover, we worked as one team and followed all the instructions of the supervisor to complete the work ontime.

d) Summary:

`1.17 By working on this project, I came to know different factors or requirements must be considered to increase the safety of the aircraft crew and passengers, and most importantly, I suggested the thermal management andECS design ensure thesuitable ambient temperatures of pressurized volumes aircraft to maintain passenger and crew safety.

CAREER EPISODE 2

a) Introduction:

2.1 The second career episode is the description of the major project which was conducted to fulfill the requirement of my Bachelor of Technology in Aeronautical Engineering which was completed from the Institute of Aeronautical Engineering, Dundigal, Hyderabad. The project was under the name of "Airfoil Stall delay using Synthetic Jets" and it was **performed within the time frame of Month/Year and Month/Year.**

b) Background:

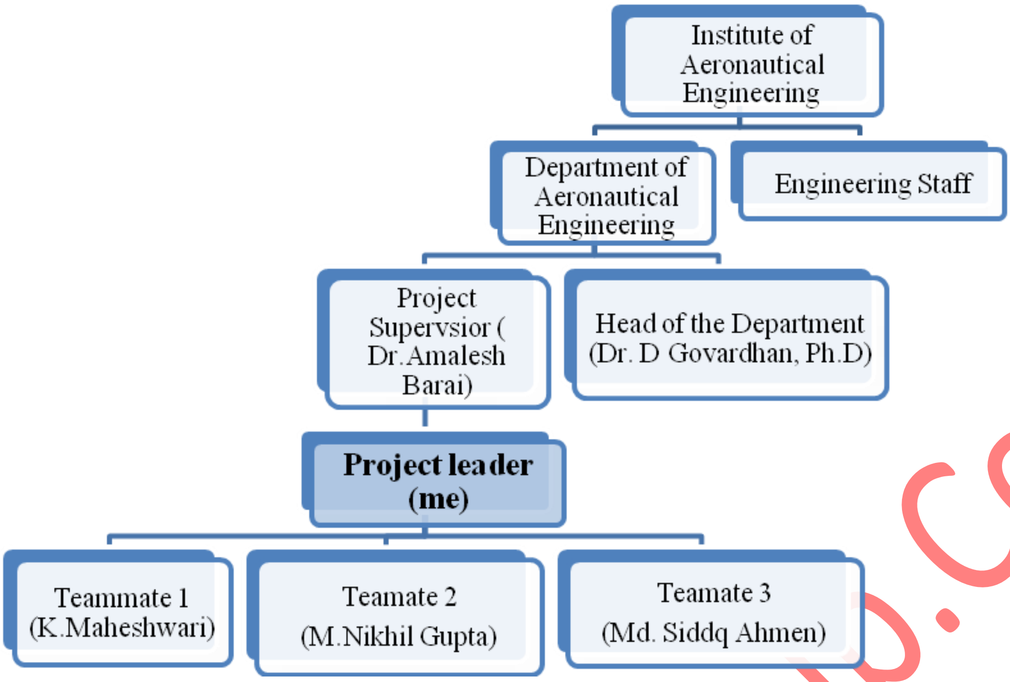
2.2From the past few decades, a lot of research has been done on synthetic jets and currently used in a wide range of applications, i.e. ranging from separation & turbulence control to cooling of electronic and propulsion. Also, such jets are characterized by the fact that they are synthesized entirelyfrom surrounding fluid as well as produce no net mass into an external flow. Fortunately, all these facts haveeradicated the requirementfor fluid circuitry as well as allows compact, self-containeddesigns that integrate both actuation and power and the control electronics. Therefore, in this major project, we have decided to study the behavior of a wing with & without a synthetic jet in the wind tunnel to ensure that a wing made by using synthetic jets will surely have a higher stall angle as compared to the normal wing. Similarly, it would produce delays in the separation of the boundary layer.

2.3 The project aimed to explain the fundamental role of synthetic jets when used in the wing by experimenting on the NACA 0015 wing having a chord-wise length of 25cmand a span of 25cm. Hence, the main objective of the aforementioned experiment was to examine the NACA0015 airfoil behavior during the installation of synthetic jets at 12% of chord length from the leading edge. At the same time, the lift, drag, and pitching forces were measured with the six-component force balance. The forces were then compared with the same airfoil forces without synthetic jets.

2.4 The following duties were assigned to me:

- Performed a literature survey to study the previous researches conducted on the synthetic jet, NACA0015 airfoil, actuators, optimum location of the synthetic jet on the airfoil to control stall, etc.
- Involved in the fabrication and testing of the wing with & without synthetic jet.
- Used the wind tunnel made of teak wood and waterproof plywood to test the developed wing.
- Performed the testing on the wing in the wind tunnel and observed its performance.
- Discussed the experimental results in detail.
- Called frequent team meetings to brainstorm over the complex issues and also discussed the work status.
- Designed the working schedule and also responsible to create the final thesis document.

2.5 The below organizational chart is the representation of my position:



c) Personal Engineering Activities:

2.6Before commencing this major project, I first called a meeting with my intellectual team members to discuss our roles and responsibilities, strategies to commence and complete the work cost-effectively and sustainably, standards that need to be followed, reference books name/research articles which should be studied to gain maximum knowledge, and also, we shared our fundamental knowledge & understanding with synthetic jets and wings. During the meeting, I made a rough sketch of our idea and techniques to start the project. Afterward, I underwent a literature review and studied maximum research articles and journals related to my project to get the idea to experiment on the physical model of the wing. Also, I developed the project proposal report, including literature review, objectives, risk analysis, and predicted experimental results, and submitted it to the supervisor.

2.7 After getting approval of my idea from my supervisor, I commenced the fabrication work of the NACA0015wing by using laser-cut airfoils, hard foam sheets, 9 volts battery, and coin vibration motors. First, I cut the two sheets of wooden material into the desirable NACA0015 by keeping the thickness of the sheet as 140% using a Laser cutting machine. Then, I attached these sheets at the ends of a hard foam sheet, as well as I used the hot wire to extract the exact shape of the wing so that there is no vacillating on the surface. Next, I fixed the 'L' clamp (with two holes of diameter about 5mm separated by 20mm) at the bottom of the surface and now by considering the center of gravity, I fixed the wing to the 6-component force balance in the subsonic wind tunnel. Here, I once again used the hot wire to make a cavity on 12% of the chord on the upper surface, a square hole was also extracted to accommodate the vibration mechanism.

Figure 6Cavity to accommodate the synthetic jet mechanism

2.8 Afterward, I made a vibration mechanism with the help of 2 Galvanized Iron metal strips, a thin rubber sheet, and coin vibration motors because these materials can easily withstand the produced vibrations by the vibration motors. I kept the metal strips parallel to each other and connected them with the rubber sheet attached to the edges of the strips. After the attachment of the sheet, I attached the coin vibration motors parallel to the 9v battery. Then, I attached these vibration motors to the rubber sheet from the inside of the strips and the sheet. The whole mechanism was then inserted into the square hole which was made throughout the wing. The following figure shows the final product with the following specifications:

1) The width of the rubber sheet = 17.5mm
2) The distance between the GI sheets = 17.5mm
3) Diameter of single vibration motor = 9mm
4) No.of vibration motors used = 10
5) Width of the cavity on upper surface = 4-5mm

Figure 7Synthetic Jet mechanism inside

2.9 Next, I used the following wind tunnel to test the wing to determine its characteristics.

Figure 8 Wind Tunnel

The selected wind tunnel was comprised of the following main parts i.e. bell mouthed segment, screen sections and setting chamber, honeycomb, test section, contraction cone, transition (circular or square), fan duct, diffuser, stand, and motor, with the cross-section of 600mm x 600mm and length of 2000mm. Now, I'll illustrate the system of the wind tunnel. Its test section consisted of four Perspex windows for viewing inside the test section, and its top was made open for easy access to the test section so that it becomes convenient to set up experiments. The aforementioned tunnel was fabricated by using the waterproof plywood and teak wood with the diffuser having bothcircular outlet and square inlet, and its angle was kept lesser than 9^{o} to avoid separation in a diffuser. Furthermore, I found that the speed of this tunnel was varied from 3m/sec- 45 m/sec. Though, it can provide a continuous running from 3m/sec to 45m/sec. Furthermore, this tunnel can run for a very shortest duration at the speed lower than 3m/sec, and I noticed that these short durations were important should be intermittent to allow enough time for the motor to cool in between.

Furthermore, I also noticed that there's anchored attached to the ground to provide support to the anchor and the inclined manometer was also fixed with the assembly of the tunnel. In addition to this, I studied the working of fan in the tunnel which has designed wind speed of 45m/sec and it is coupled directly to the AC motor and its speed can be varied by motor controller (AC).

2.10 After analyzing and understanding the system, my next significant task was to calculate its performance efficiency. I came across that during the period of commissioning, the fan was the run-up to a maximum RPM of 1450 RPM, and I knew that RPM indicated on the controller will normally be more than the RPM of the motor because of the slip at higher power consumption at a higher velocity in the tunnel. Therefore, I measured the dynamic head using the inclined manometer attached to the tunnel and found a notable increase in the RPM from 100 RPM to 1450 RPM. Next, I calculated the tunnel's wind speed by applying Bernoulli's Law, such as:

$Po - P = 1/2\rho V^2$

Where Po is the settling chamber'sstatic pressure, P is thestatic pressure ofthe test section, V = air velocity, and ρ is the air density.

2.11 I measured the (Po - P) by using the equation: ρwgh.

Where ρw is the density of the liquid used in the manometer (methyl alcohol is used at present), 'g' is the acceleration due to gravity and 'h' is the vertical length of the liquid column sustaining the pressure. In this project, the density of air at Hyderabad was taken as 1.2, and the density of alcohol was 0.8. if 'h' is measured in mm of alcohol column, so, I obtained the velocity by the following relationship. V (m/s) = 3.68 √h(mm).

Next, I determined the measured liquid column length on the inclined manometer which was "hm" so h = (hm - hm (initial))/2 because the inclination was 30° to the horizontal. Hence, I measured the tunnel performance by varying the RPM of the rotor using the controller and measuring tunnel wind speed using the inclined manometer. I developed the following table which shows the measured performance of the tunnel.

Table 1Calibrated velocities for increasing RPM

Courtesy: Sunshine Measurements)

RPM (controller)	Inclined manometer Reading (mm) h_m	Inclined manometer reading (mm) $(h_m - h_i)/2$	Velocity (m/s) in the test section
0	$H_i = 7$	0	0
100	08	1	3.68
200	13	3	6.37
300	22	7.5	10.0
400	35	14	13.7
500	52	22.5	17.4
600	74	33.5	21.2
700	100.5	46.7	25.1
800	130	61.5	28.8
900	165	79	32.7
1000	202	97.5	36.3
1100	244	118.5	40.05
1200	289.5	141.2	43.7
1300	337	165	47.2
1400	389	191	50.8

2.12 I obtained the satisfactory performance efficiency ratio as per the requirement and design and noticed that the relationship between wind speed in the tunnel and RPM of the motor was very nearly linear as expected. However, at very low RPM it was very difficult for me to read accurately the manometer reading, and hence there can be scattered in the reading. At this point, I needed to obtain an accurate wind speed measurement i.e. less than 4 m/s wind speed for accurate calibration at low speeds. To overcome this problem, I decided to use vane anemometer wind speed for this measurement which provided accurate measurements up to as low as about 0.3m/sec wind speed.

2.13 To perform the testing in the wind tunnel facility, I used the 6-component force balance to measure the forces i.e., lift, drag, pitching moment, and yawing moment for pitching moment, rolling moment, and yawing moment. During the experiment, I first fixed the wing into the 6-component force balance with the clamp beneath the wing, and then performed the analysis before the installation of the synthetic jets and measured the lift, drag, and pitching moment forces for two different angles of attacks i.e., 0^0 and 3^0. After the installation of the synthetic jets into the wing, I measured the forces for the same angle of attacks and compared the results of both situations. Further to this, I also carried out a smoke visualization to observe the vortex rings formed by the actuation of the Synthetic Jets mechanism

2.14 After experimenting, I observed its results i.e. I noticed a gradual increase in the velocity at an angle of attack 0^0, whereas the lift was decreasing, with the simultaneous increase in drag and pitching moment forces.

Table 2 NACA0015 wing at angle of 0º

Velocity (m/s)	Lift (Kg)	Drag (Kg)	Pitching Moment (Kg-cm)
5	-0.279	-2.601	+67.603
10	-0.006	+0.002	+0.047
15	-0.031	+0.001	+0.252
20	-0.072	+0.001	+0.435
25	-0.086	0	+0.614

However, I found out that at 3^0 angles of attack, the lift was increased till 20m/s, and then I noticed its sudden drop to a negative value. I considered it a fault reading since no wing produces a negative lift at such a small angle. Then, I observed the perfect results of increasing lift and pitching moment forces and decreasing drag force with an increase in velocities. Moreover, I also observed a rapid increase in the lift compared to the wing without synthetic jet, due to the presence of synthetic jet and their jet formation over the upper surface.

Table 3 NACA0015 wing with a synthetic jet at 0 attack angle

Velocity (m/s)	Lift (Kg)	Drag (Kg)	Pitching Moment (Kg-cm)
5	+0.041	-0.009	+0.381
10	+0.053	-0.011	+0.389
15	+0.059	-0.013	+0.443
20	+0.068	-0.015	+0.523
25	+0.072	-0.017	+0.586

I then detected the wing to an angle of 3^0 and results were showing a positive sign of increasing lift and pitching moment, decreasing drag. I concluded that the lift and pitching moments values had doubled comparing the previous results at 0 0 angles of attack.

Table 4 NACA0015 wing with a synthetic jet at 3⁰ attack angles

Velocity (m/s)	Lift (Kg)	Drag (Kg)	Pitching Moment (Kg-cm)
5	+0.086	-0.018	+0.610
10	+0.09	-0.019	+0.652
15	+0.094	-0.020	+0.661
20	+0.099	-0.021	+0.724
25	+0.101	-0.023	+0.758

So, I concluded that the obtained results varied with the increase in the angle of attack and also the inclusion of the synthetic jet, the lift and pitching moment increased with the above conditions, whereas the drag increased for the normal wing with the increase in the angle of attack and the drag decreased for the wing with synthetic jet for the increase in the angle of attacks.

2.15 I proved myself a careful and vigilant person by working in compliance with the safety standards, for instance, as soon as, I noticed that the wind tunnel facility was an open circuit tunnel, so at large speeds, there will be a considerable noise from the fan. Therefore, I advised my teammates to work with earplugs if the facility will be working continuously at large speeds. I also developed the list of mitigation measures with the help of a co-guide (Mr. U. Shiva Prasad) and made it compulsory for the team to implement those precautionary measures whenever necessary.

2.16 I had a great passion for my work, therefore, I always remained active and worked enthusiastically to present the best outcomes of my project. To observe the status of ongoing activities, I chose a systemic approach i.e. I developed the working schedule which included the daily and weekly tasks with their deadlines and all team members were assigned to specific tasks. I also supervised their work with respect to working schedule and then reported to the supervisor about the performance of each member. Then the team member who performed the best and efficiently carried out all tasks was complimented in the weekly meetings to encouraged other members to work harder.

2.17 I always took help from the co-guide whenever I faced a problem in performing any task and also showed my leadership skills by working in collaboration with my team and provided them a friendly and pressure-free environment. I also advised using the project resourcesefficiently to avoid its wastage and increase in the cost.

2.18 Apart from meeting arrangements, I was also responsible for weekly reports and it included the weekly progress of tasks, milestones, issues with their solutions, achievements, etc. Also, I made the final document in MS-Word software to pen down all the project findings. Hence, I did all my work by following engineering ethics and international aeronautical standards.

d) Summary:

2.19In this project, I computed the effects of synthetic jet used in a wing to increase lift at low angle of attacks, which indirectly means that the wing can withstand higher angle of attacks compared to the ones without synthetic jets and recommended that synthetic jets can be best applied in UAVs and MAVs with low velocities up to a certain limit

CAREER EPISODE 3

a) Introduction:

3.1 The last career episode is based on my eighth-semester mini-project "Aircraft Anti-Hijacking System Using RFIDs" which was conducted to complete the key requirement of my bachelor of technology degree in Aeronautical Engineering from the Institute of Aeronautical Engineering Dundigal, Hyderabad, Telangana. I started working on this project in Month/Year and completed it in Month/Year.

b) Background:

3.2 Nowadays, many types of research have been conducted to develop a system which will prevent the aircraft's hijacking attempts, and in this need of the hour, we also decided to propose a secure system which will be comprised of Raspberry Pi PC & control program coding written in the Python's scripting language.With the help of this system, an aircraft's manual control will get disabled immediately whenever any unusual condition occurred persistently beyond a pre-defined limit. Generally, thiscondition will occur above the predefined time of 10s, and at this point, it will immediately turn on the2 authorized RFID tags and takes the aircraft's control by triggering an autopilot beyond 10 seconds. Furthermore, this system will also not permit any kind of manual input i.e. disabling ofthe system because this can cause vulnerability.

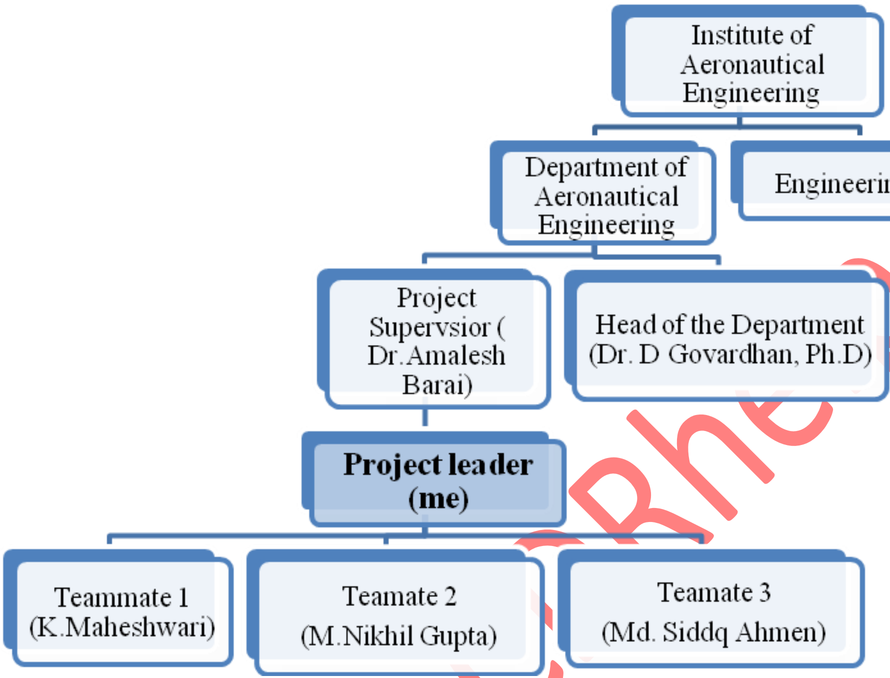
3.3 The project's foremost objectives were to prevent all attempts of hijacking by using the RFID detectors. Whenever a hijacking attempt is raised, the authorized crew can trigger a system that disables manual control as well as takes full aircraft's control by itself in such a way that the attempts of hijacking can be rejected.

3.4 I was responsible to perform the following main tasks:

- Studied the techniques previously implemented to eradicate the hijacking problems and how effective they were in terms of preventing the attempts.
- Developed the flowchart which showed the working of the system.
- Selected the components and then assembled them to develop the hijacking system.
- Prepared the required setup and then checked the working of a system by using python codes.
- Tested the system and discussed its results.
- Monitored the activities of my teammates and lend a hand to complete the tasks on time.

- Documented the project details and gave presentations to the supervisor.
- Scheduled the project meetings and also encouraged my team to participate in all meetings discussions.

3.5 My position is shown by the following hierarchy:



c) Personal Engineering Activities:

3.6 I first conducted a literature survey to collect maximum details ofdesigning of the past anti-aircraft hijacking systems and came across that all the suggested or proposed mechanism had few drawbacks, i.e. systems can be operating only from a cabin, sometimes it became very difficult to manually disable the system, etc. By considering these drawbacks, I decided to use RFID sensorstags, 1 joystick, and 2 servos to create the new and efficient system based on their performances and specifications.

3.7 First, I chose the Raspberry pi component because of its significance in the aircraft hijacking system, and most importantly, it is compact, cheap, and provides desired results. Then, I opted for RFID (wireless communication) and it integrates a use of both electrostatic coupling into a RF (radio frequency) portion of an electromagnetic spectrum intending to identify uniquely an animal, person, or object.During the selection of RFID, I also studied its applications, tag types, etc. The following is the list of RFID applications.

1) Traceability and Management of the GSE (Ground Supportive Equipment)
2) Both Tracking &Management of the containers.
3) Raw material's monitoring (rolls Carbone)

After this, I selected the servo motor which is the linear actuator or rotary actuator and it enables precise control over linear position or angular, acceleration, and velocity. It comprises the adequate motor coupled with the sensor for the position feedback. In addition to this, I studied that its mechanism and types i.e. it consists of the following main types, such as DC servo motor, AC servo motor, position rotational servo motor, etc. The servo motors are small in size as well as efficient, and can be used in many applications to provide precise control of position and controlled by the pulse width modulator signal. Lastly, I elected the joystick which is an input device and consists of many supplementary switches for controllingnumerous aspects of an aircraft.

3.8 After selecting the above-mention components, I started the development of the step-up by explaining the verification of every component to provide a clear idea of the proposed required setup. I considered Raspberry pi model B as the most crucial component which plays a vital role in the development of the prototype for the Aircraft Anti Hijacking system with the help of RFIDs, so I commenced the design by installing an Operating system in the Raspberry Pi in the following ways. I downloaded the file operating system (i.e. Raspbian OS) into thePC, and then I copied this downloaded file into the Micro SD card because it would be worked as a hard disk for the mini-computer. Next, I made the files unzipped present in the SD card and insertedthem into a Raspberry Pi, where internal drivers were automatically uploaded and RPiwas ready to use. After performing these steps, I installed a few software to enable the working of the components when connected to the RPi, such as YAML, PYQT, etc. Here, I also connected GPIO pins in theRPi to allowthe connection ofall external components with the RPi to interconnect them.

3.9 In the next step, I performed verification of the RFIDs which have tremendous applications during our daily life activities, i.e. such devices are installed in an anti-hijacking system as a switch devicefor disabling all manual inputs by switching ONan autopilot. To verify the RFID, I had to identify its unique codes because RFID is unique and doesn't work for one another, one RFID reader has a unique RFID tag, so there would be no misuse of RFID in complex mechanisms. Hence, I obeyed the following main steps to perform its verification, i.e. I connected the RFID with the RPiby using jumper wires, and ensured that during this process, the RPiwas switched OFF. Afterward,I run a pre-loaded python code in the RPI terminal to read the RFID. Here, I identified the tag as four numeric digits. The connections for connecting an RFID to the RPi GPIO are

1) SDA = 24
2) SCK = 23

3) MOSI = 19
4) MISO = 21
5) GND = 6
6) RST = 22
7) 3.3v = 1

The SDA, SCK, MOSI, MISO, GND, RST are acronyms of serial data, serial clock, multiple output single input, multiple input single output, ground.

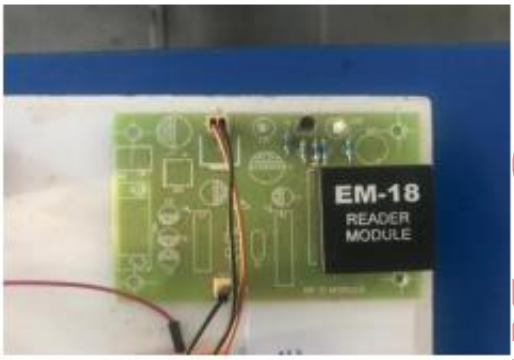


Figure 9Connection of RFID reader module

3.10 Next, I verified the servo motor so that it can efficient. In the servo motors, there were wires which need to be connected to the RPi and an external power supply was to be given. Therefore, I used a DC which applied a voltage of 5v to the connection for each servo motor. Then, the GUI was developed in the RPi to control the motion of the servos. In this project, I used 3 GPIO pins in this connection i.e., GND, GPIO20, GPIO21 (6,28,21 respectively). During the deflect of the developed GUI, I observed a familiar deflection in the servo motor which defined that the servo motors wereverified.

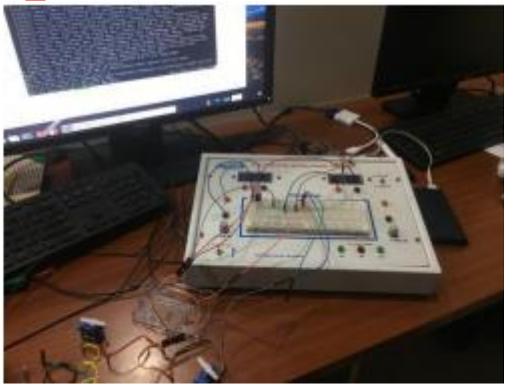


Figure 10 Servo Motor's verifications

3.11 Lastly, for the verification of the joystick, I used an analog joystick to control the servo motors in the system. This joystick has a two-axis motion i.e., x and y-axis respectively, and there are 5 pins present on a joystick which are defined as GND (ground), voltage (5v), Xoutput, Youtput, and optional blink operator. Since I used the joystick in analog configuration, so I also used an ADC (analog to digital convertor). The ADC that was used in the verification is MCP3008, it reads simple analog signals precisely. The following GPIO pins were used to connect to the RPi; 17,29, 31, 33, 35, and 39.

3.12 After doing the verification step, I connected the three components which are shown in the following figure:

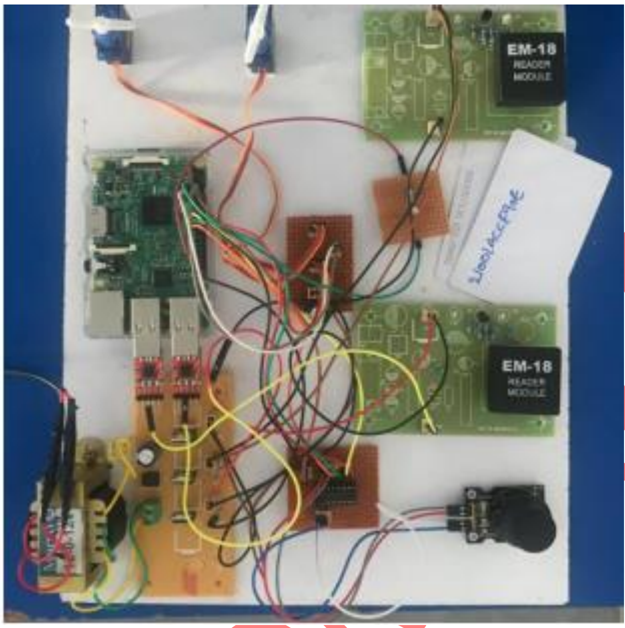


Figure 11Assembled circuit of Anti Hijacking System

I defined the work of the system using python codes, once the python codes were run then there will be no need of running the code frequently to demonstrate the working of the system. Here, I also used an external transformer to power the components individually which helps each of the components to take the required load.

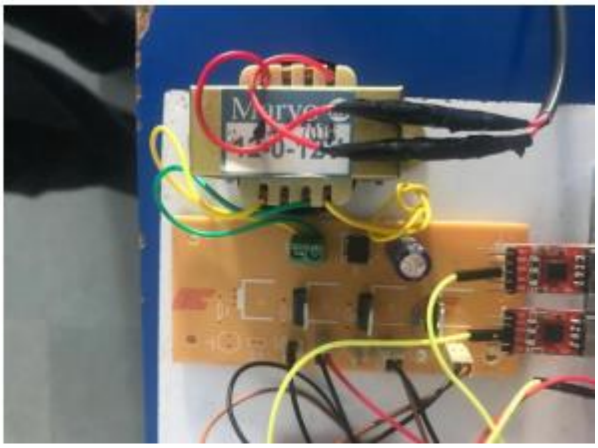


Figure 12Transformer for the individual supply of power

Next, I produced a python code such that, when the RFIDs were active an LED lights up which showed that the autopilot is turned on.

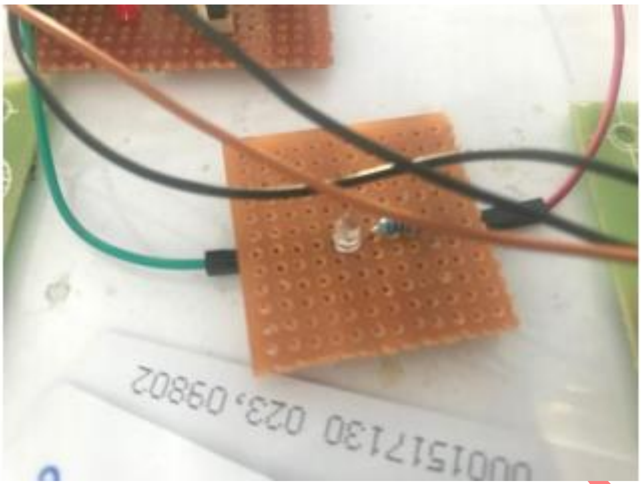


Figure 13LED which shows ON/OFF of autopilot

3.13 I obtained the following results

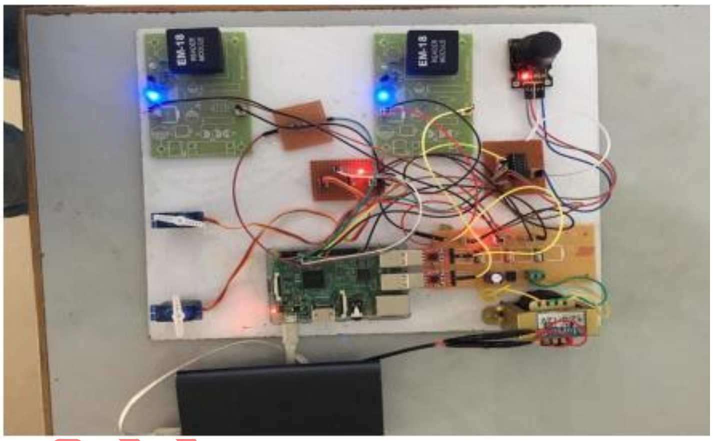


Figure 14RFIDs inactive

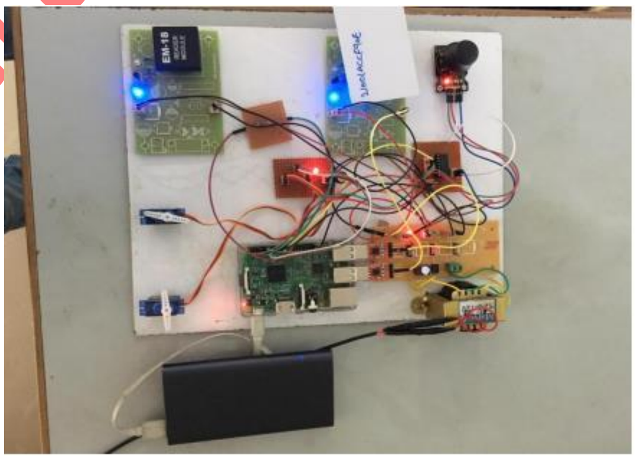


Figure 15Only RFID 1 active

From the figures, I observed that when the random lights that show up in the system were ON, then it turned ON the activation lights for different components i.e., red for joystick and blue for RFIDs. Also, I noticed that when a tag will be on the reader module, then, it makes the blue light blink once and it defined that the RFID tag was read. However, I observed that reading a single RFID didn't activate the system, which means maintaining consistency on activating the device, else switching OFF wouldn't be possible unless the aircraft has landed.

3.14 After this, I also observed the next two figures:

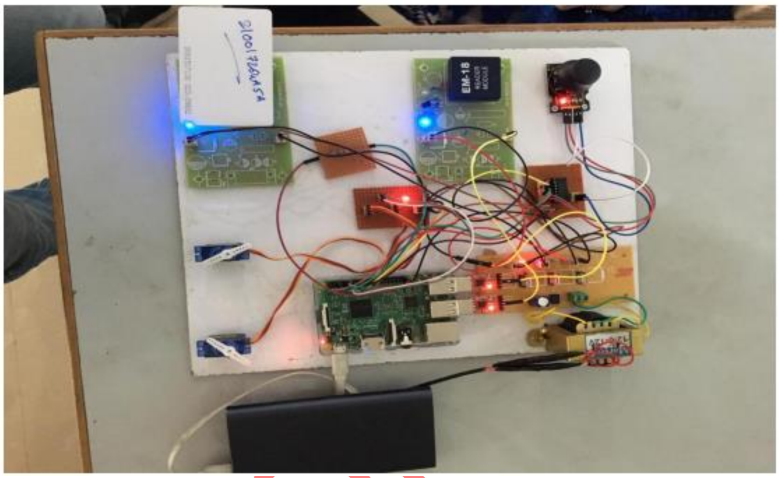


Figure 16Only RFID 2 active

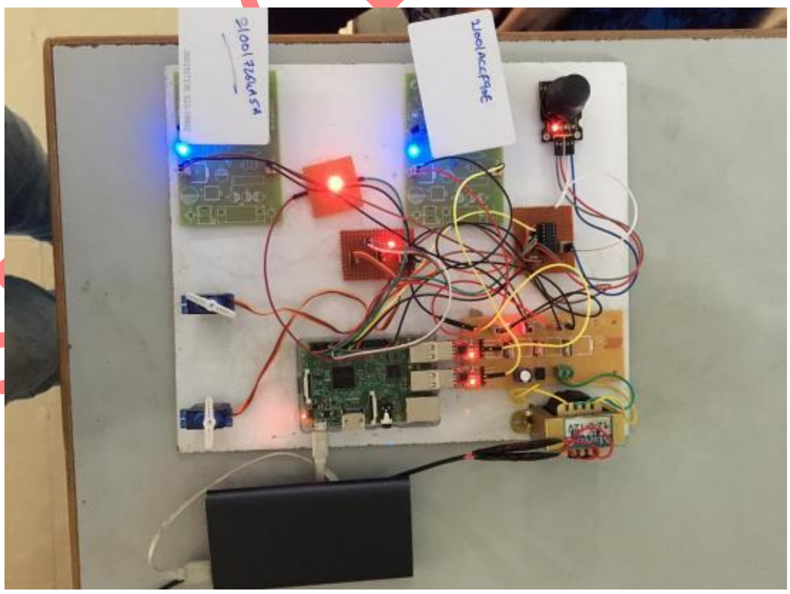


Figure 17RFID 1 and RFID 2 active

I noticed that neither one of the RFID can activate the system, and I concluded that it is necessary both the RFIDs' contributions must be present to activate the system. After the tags were kept on the reader modules, a span of 10 seconds was given to activate the system. Here, I also suggested that if anyone changes mind about deactivating the system, either of the tags can be removed so that it does not get activated. From figure 9, I noticed that the extra red LED shows the ON of the autopilot. Once the system was turned ON it can be brought back into manual control, only restart of the entire system cause the manual controls to come online.

3.15 In each phase of the project, I worked along with my team and attended team & personal discussion meetings to discuss the work status, problems, procedures for verifications, component selections, etc., and also discussed the experimental results which were explained to the supervisor in the final meeting, and ensured that anti-hijacking system was made as per IATA standards.

3.16 While performing the testing and making the connections, I worked very carefully and handled the components and wires safely to avoid electric shocks. Before leaving the university lab, I turned OFF the system properly and didn't work with wet hands. I obeyed safety procedures and used precautionary measures to keep myself and my team safe.

3.17 I made the project document to mention the very single detail of the project and submitted it to the supervisor for review and approval. I often made changes as per the instructions of my supervisor and created the report according to the university format.

d) Summary;

3.18I concluded that the above experiment can obtain better results compared to other anti-hijacking systems such as a panic button type of anti-hijacking system, where this sometimes becomes impossible to activate a similar system due to the access of the cockpit by the hijackers.

PROFESSIONAL ENGINEER

Summary Statement

Competency Element	A brief summary of how you have applied the element	Paragraph in the career episode(s) where the element is addressed
PE1 KNOWLEDGE AND SKILL BASE		
PE1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	During studying Aeronautical Engineering, I was involved in different designing and modification projects to demonstrate my understanding of the aircraft system, synthetic jets, anti-hijacking systems, engineering standards, etc.	1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14

PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics and computer, and information sciences which underpin the engineering discipline	During analysis of the aircraft system, I determined the total energy dissipated while applying the brake from the equation: $E = MV^2$ After fabricating the NACA0015wing by using laser-cut airfoils, I determined the system's performance efficiency by using the formula: $Po - P = 1/2\rho V^2$	1.10 2.10, 2.11
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	While designing the prototype for the Aircraft Anti Hijacking system, I installed different programming programs i.e. YAML, PYQT, etc. to allow the proper connection of components with the RPi.	3.8
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	I was involved in the research-based project to provide recommendations to improve the aircraft system and to ensure the safety of the crew and passengers, and for this, I studied many research articles to learn the latest technique which be introduced i.e. ECS to enhance the safety of the aircraft. Similarly, in the other two projects, I also performed a literature review to collect data on my projects.	1.5 2.6, 3.6

PE1.5 Knowledge of contextual factors impacting the engineering discipline	To suggest the optimal modifications in the aircraft system, I first studied the effects of the outside and internal ambient temperatures, unpressurized volumes, solar heating effects, heat loads, etc. I analyzed the effects of the synthetic jets with and without wings by first fabricating the NACA 0015 wing at the university laboratory. To design the anti-hijacking system, I selected the required components and then verified them to provide a clear idea of the proposed required setup	1.6, 1.7, 1.8, 1.9, 1.10 2.7, 2.8 3.7, 3.8, 3.9, 3.10, 3.11
PE1.6 Understanding of the scope, principles, norms, accountabilities, and bounds of contemporary engineering practice in the specific discipline	Iadhered to the international aeronautical standards and engineering ethics to perform my tasks accurately i.e. IATA and ICAO rules and regulations. I always worked by keeping in mind the safety rules and precautionary measures to show myself a vigilant person.	1.6, 2.18, 3.15 2.15, 3.16
PE2 ENGINEERING APPLICATION ABILITY		

PE2.1 Application of established engineering methods to complex engineering problem solving	I studied the effects of the temperature, heat loads, unpressurized volume, etc. on both military and commercial aircraft, and then provided optimum suggestions and modifications in the systems to overcome these issues. While checking the performance efficiency of the proposed system, I found it very difficult to read the reading at the lowest RPM, but I immediately found out the solution of using vane anemometer wind speed and it helped to reduce this issue.	1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13 2.12
PE2.2 Fluent application of engineering techniques, tools, and resources	I worked on the different engineering tools and applied different techniques to deliver the best results, such as MS-Excel, PowerPoint, MS Word, YAML, PYQT, etc.	1.14, 1.15, 2.18, 3.8
PE2.3 Application of systematic engineering synthesis and design processes	To overcome all the effects on the aircraft system, I recommended installing the ECS system, and air distribution system (A/C) in commercial air flights to overcome the temperature issues. I applied my systematic engineering knowledge and tested the proposed system to check the effects of synthetic jets with and without wings. I developed the prototype by using a servo motor, joysticks, and RFID, and performed testing on it.	1.11, 1.12, 1.13 2.13, 2.14 3.12, 3.13, 3.14

PE2.4 Application of systematic approaches to the conduct and management of engineering projects	I managed the engineering tasks and the team by working in collaborating with them and supervised the progress of the work. I always advised my team to work efficiently by using all the project resources efficiently.	1.16, 2.16, 2.17, 3.15 2.17
PE3 PROFESSIONAL AND PERSONAL ATTRIBUTES		
PE3.1 Ethical conduct and professional accountability	I demonstrated my professional accountability in my projects by working according to safety rules and engineering standards, as well as, ethically deal with my team and showed honesty towards my work.	1.6, 1.16, 2.15, 2.17, 2.18, 3.15, 3.16
PE3.2 Effective oral and written communication in professional and lay domains	In my projects, I did correspondence with my team and the supervisor by meetings, emails, etc. to effectively manage the project. I jotted down the project's weekly progress in the report and submitted them to the supervisor.	1.14, 1.16, 2.6, 2.16, 2.17, 3.15 1.15, 2.6, 2.18, 3.17

PE3.3 Creative innovative and proactive demeanour	I worked under the guidance of my supervisor and often enlightened my knowledge by seeking his advice.	2.17, 3.15
PE3.4 Professional use and management of information	I well-documented the project details to represent my understanding the Microsoft Office and to manage the information, and also gave presentations.	1.14, 1.15, 2.6, 2.18, 3.17
PE3.5 Orderly management of self, and professional conduct	By selecting the systemic approach, I observed the status of the project tasks and reported to the supervisor about the performance of each member. I was also involved in the project data collection process which was done by carrying out a literature survey.	2.16 1.5, 2.6, 3.6
PE3.6 Effective team membership and team leadership	I coordinated and communicated with my team to develop a friendly working environment.	1.16, 2.6, 2.16, 2.17, 3.15