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INSTITUTE OF SCIENCE AND TECHNOLOGY

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SCHOOL OF MECHANICAL OF ENGINEERING

Department of Aeronautical Engineering

Value-Added Courses Conducted During the Academic Year 2017-2018

Electric Propulsion trends and future

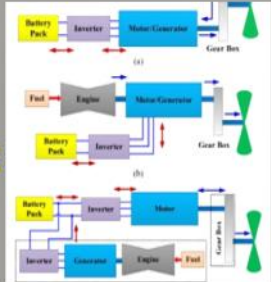


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"ENTRY IS NOT IMPORTANT, EXIT IS IMPORTANT"
LEARN TODAY - LEAD TOMORROW

ELECTRIC PROPULSION TRENDS AND FUTURE

ORGANIZED BY

**SATHYABAMA
INSTITUTE OF SCIENCE
AND TECHNOLOGY**



ORGANIZER

**Dr.A.Anderson
Mr.P.Gunasekar**

DATE: 10.07.2017 - 18-08-2017

VENUE: DEPARTMENT OF AERONAUTICAL ENGINEERING

Electric power and propulsion systems enable new ways of air transport. All-electric and hybrid electric drive systems allow aircraft to fly with power from renewable resources or e.g. fuel cell instead of only fossil fuels, and make new aircraft designs possible. Electrical technology will allow us to increase aircraft efficiency, reduce aircraft emissions and fuel consumption, and build aircraft with very low noise levels and new, short and vertical take-off-and landing capabilities. It's a future that's closer than you think. Light sport and training aircraft already fly electrically today. Electric commuter class aircraft and air taxis are on the way, and we aim to see the first all-electric aircraft transport people and goods in the middle of the decade. It's a bold vision. But it is one worth doing for a connected future protecting our planet's environment for generations to propulsion systems from the basic principles, showing how each uses sources of propulsive mass. These subject treats aerospace propulsion



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systems of all kinds, from civil turbofans to spacecraft thrusters. Its intent is to foster an understanding of the characteristics of these diverse and energy to produce thrust. The subject is divided into two roughly equal parts, the first covering rocket propulsion and the second aircraft propulsion. In the portion devoted to rocket propulsion, two classes of propulsion systems are considered: chemical, in which the propulsive mass and energy are combined in chemical propellants, and electrical, in which the propulsive mass is separate from the energy source, which may be either nuclear or solar. Emphasis is on chemical propulsion. In the portion of the subject devoted to aircraft propulsion, aircraft turbine engines are discussed, both those primarily suitable for military aircraft and commercial transport. For lack of time, very high velocity (hypersonic) air breathing propulsion is not discussed. As reflected in the learning objectives, a goal is to introduce you to the methods of mathematical modelling of propulsion systems and then to use these modelling techniques to develop an understanding of the characteristics of the several types of propulsion systems treated.

The modelling uses thermodynamic arguments based on the First and Second Laws, and fluid mechanical principles that enable the linking of the thermodynamic behavior to the geometry of the propulsion devices. In this respect the subject goes considerably beyond most introductory treatments of propulsion, which usually limit the logic to thermodynamic arguments. Such developments can be somewhat abstract and lacking in physical substance in that they do not connect the behavior of the devices to their geometry. Because of the time limits of a single semester subject the mechanical or structural aspects of propulsion devices are touched upon with less emphasis, as are such issues as cost and environmental effects.

Outcomes

- Explain the different features and capabilities of chemical and non-chemical rocket propulsion systems.
- Calculate the specific impulse and mass flow for a rocket engine with the fluid considered as an ideal gas with constant specific heats.
- Estimate the specific impulse and mass flow for a rocket engine accounting for chemical reaction and non-constant specific heats.
- Explain the causes of, and estimate, the stress on rocket casings, turbomachine blades,



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and blade disks in turbomachines.

- Estimate the heat transfer rates in rocket nozzles and in aeroengine turbine components. Explain the different performance metrics, and the corresponding performance limits, for gas turbine aeroengines and link these to the design features.
- Explain the physical constraints which couple the different components in a gas turbine.



List of Participants

S.No	Roll.No	Name
1	14SAE301	Adlinnija M
2	14SAE101	Amar S K
3	14SAE603	Murali Krishna Appari
4	14SAE121	Satya Narasimha Gopal Bandaru
5	14SAE102	Benjamin S K
6	14SAE311	Binisha K A
7	14SAE103	Bharath Sai Kumar Dasari
8	14SAE551	Dhinesh T
9	14SAE104	Naveen Kumar Gandikota
10	14SAE604	Gautham T M
11	14SAE105	Gokul Kishan G
12	14SAE106	Gokulraj P
13	14SAE552	Gopi R
14	14SAE605	Gundlapallijyothirnaga Manjari
15	14SAE302	Jahnavi Vaka

16	14SAE107	Venkata Sujay Kumar Reddy J
17	14SAE303	Kajol Kulkarni
18	14SAE304	K Srisindhu
19	14SAE108	Karthick V
20	14SAE129	Keroji Akshay Arun
21	14SAE501	Kishorekumar M
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23	14SAE130	Konitham Sri Krishna
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25	14SAE602	Madam Aditya Chandra
26	14SAE305	Magdalene Christilla A
27	14SAE110	Mahammed Khaif Sha Ali Baig
28	14SAE111	Aditya Malla
29	14SAE610	Marella Raviteja
30	14SAE112	Mohan Raj R



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Concepts of UAV design

SATHYABAMA UNIVERSITY
CONCEPTS OF UAV DESIGN
ORGANIZED BY SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY DEPARTMENT OF AERONAUTICAL ENGINEERING

21.08.2017 – 30.09.2017

CHIEF PATRONS
Dr. Mariazeena Johnson
President
Dr. Marie Johnson
President

WEEK 1: REVIEW OF THE CONCEPTS
WEEK 2: UNDERSTANDING THE STATIC STABILITY OF VARIOUS UAV.
WEEK 3: APPROACH FOR WING DESIGN
WEEK 4: TAIL SIZING
WEEK 5: SUBROUTINE FOR DESIGN PROCESS
WEEK 6: DESIGN EXAMPLE FOR CONVENTIONAL TAKEOFF
WEEK 7: DESIGN EXAMPLE FOR HAND LAUNCH FIXED WING UAV
WEEK 8: DESIGN EXAMPLE FOR VTOL FIXED WING UAV

COORDINATORS
Mr.P. Gunasekar,
Mr.S. Manigandan

CONVENORS
Mr. Alexander
HOD, Aero
Dr. A. Anderson
Prof, Aero

Course Outline

This course introduces the designing and sizing process (Simulation/Experimental) for fixed? wing UAV technology, integrated with its performance and stability analysis (Static & Dynamic) and prototype testing

Course Layout

Week	Time	Topic
Week 1	3 hrs	Review of the concepts covered in first part of the course.
Week 2	5 hrs	Understanding the static stability of various UAVs. Significance of location of Neutral point and centre of gravity for a stable flight.
Week 3	4 hrs	Approach for wing design and airfoil selection with examples
Week 4	4 hrs	Tail sizing, control surface sizing and significance of tail volume ratio with examples.
Week 5	3 hrs	Developing subroutine for design process.
Week 6	4 hrs	Design example for conventional takeoff fixed wing UAV for various mission requirements.
Week 7	4 hrs	Design example for hand launch fixed wing UAV for various mission requirement.
Week 8	3 hrs	Design example for VTOL fixed wing UAV for various mission requirement.



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This Aircraft Design option aims to provide a comprehensive overview of whole aircraft configuration design as well as structures and systems. A holistic teaching approach is taken to explore how the individual elements of an aircraft can be designed and integrated using up-to-date methods and techniques. You will learn to understand how to select and integrate specific systems such as fuel systems, and their effect on the aircraft as a whole. You will have the opportunity to fly during a Student Experience Flight in our National Flying Laboratory Centre's (NFLC) light aircraft. This flight experience will complement your MSc studies, focussing on the effects of controls, aircraft stability and angle of attack. During the flight you will have the opportunity to take control of the aircraft. Each experience is 2 to 3 hours in duration and includes a pre-flight safety briefing outlining the details of the manoeuvres to be flown, a flight of approximately 1 hour, and a post-flight debrief. Read Hari's blog on his flight experience. We have been at the forefront of postgraduate education in aerospace engineering since 1946. Aerospace Vehicle Design at Cranfield University was one of the original foundation courses of the College of Aeronautics. Graduates of this course are eligible to join the Cranfield College of Aeronautics Alumni Association (CCAAA), an active community which holds a number of networking and social events throughout the year.





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41	14SAE118	Rakesh Purella
42	14SAE117	Prabakaran S



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ADVANCES IN AEROSPACE MATERIALS

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ADVANCES IN AEROSPACE MATERIALS

ORGANIZED BY SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY DEPARTMENT OF AERONAUTICAL ENGINEERING
22.01.2018 – 23.02.2018

CHIEF PATRONS
Dr. Mariazeena Johnson
President
Dr. Marie Johnson
President

COORDINATORS
Mr. P. Gunasekar
Prof, Aero
Mr.R. Gokulnath
Prof, Aero

CONVENORS
Mr. Alexander
HOD, Aero
Dr. A. Anderson
Prof, Aero

Week	Time	Topic
Week 1	6hrs	Classification of aerospace materials.
Week 2	6 hrs	Aluminum and aluminum alloys
Week 3	6 hrs	Titanium and titanium alloys.
Week 4	6 hrs	High strength steels.
Week 5	6 hrs	Powder materials

Week 1 Module 1. Classification of aerospace materials

This module will introduce you to the classification of aerospace materials. You will learn about the requirements for these materials. Technologies always affect the structure and properties of materials. You will learn about the main forming technologies (metal forming, hot and cold working, and machining) and their effects on the structure of aerospace materials. Phenomena that accompany the machining operations will be examined as well.

Week 2 Module 2. Aluminum and aluminum alloys

This module will introduce you to aluminum alloys, which are crucial aerospace materials. Aluminum alloys were the first to be used in the manufacture of aircraft. The use of aluminum in revolutionized the aircraft industry. Its advantages are high manufacturability and specific strength (the ratio of maximum stresses to weight). We will study various classifications and



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designations of aluminum alloys as well as the basics of heat treatment. We will learn how alloying elements affect the structure and properties of aluminum alloys.

Week 3 Module 3. Titanium And Titanium Alloys

We will learn about the role of titanium in the aircraft industry, its advantages and disadvantages for aerospace applications, the structure and properties of titanium alloys. We will examine promising titanium aluminides and shape-memory titanium alloys. Titanium alloys have unique properties and are very promising as aerospace materials. Titanium alloys are used in heavily loaded airframe sections, undercarriage parts, skins to high Mach speed aircraft, jet engines, and many other aircraft components requiring high strength, fracture toughness and resistance to fatigue, creep and corrosion. These mechanical properties are superior to lightweight structural materials, including aluminum alloys and magnesium alloys.

Week 4 Module 4. High strength steels

This module will introduce you to high strength steels. Steel is used as an aerospace material, but to a lesser extent than titanium, aluminum, and composites. High strength steel cannot be replaced with other materials. Advantages of using steel in highly-loaded aircraft structures include high stiffness, strength, fatigue resistance and fracture toughness. In this part of the video course, we will deal with steels used in landing gear and other high-strength components, namely: maraging steels, medium-carbon low-alloy steels, and stainless steels.

Week 5 Module 5. Powder materials

This module will introduce you to powder metal materials and modern technologies used to manufacture them. Powders are used in the manufacture of complex parts or when increased heat resistance is required. "Sweating" highly porous materials are used to prevent icing on aircraft. Metal powder compositions are of particular interest due to the rapid development of additive technologies. You will learn about the requirements for powders used in additive manufacturing.



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6	15SAE504	Arunachalam .T
7	15SAE802	Ashwina. J
8	15SAE103	Ballepalli Krishna Chaitanya
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10	15SAE104	Dipshee Dutta
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12	15SAE117	Imadambathuni Venkata Satyanarayana
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ROLE OF CFD IN AVIATION INDUSTRY

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STAR-CCM+

ROLE OF CFD IN AVIATION INDUSTRY

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ORGANIZED BY SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY DEPARTMENT OF AERONAUTICAL ENGINEERING

05.03.2018 - 06.04.2018

Course description:

The emergence of Computational Fluid Dynamics in the last 60 years is fantastic, especially in providing a complete low-cost technical solution to the Aerospace and Defense sectors, compared to the previous experimental and numerical techniques. Starting from the formulation of the governing equations (potential flow, Euler, RANS), the combination of advances in computer power and algorithms, Riemann-based schemes for gas dynamics (Godunov), 2nd-order dissipative schemes for hyperbolic equations (Lax-Wendroff), efficient explicit methods for Navier-Stokes (MacCormack), panel method (Hess-Smith), type-dependent differencing (Murman-Cole), complex characteristics (Garabedian), rotated difference (Jameson), multigrids (Brandt), flux splitting (Steger-Warming), shock capturing via controlled diffusion (Jameson-Schmit-Turkel), approximate Riemann solver (Roe), total variation diminishing (Harten), multigrids (Jameson, Ni), and up to the solution of a complete airplane (Jameson-Baker Weatherill) are the milestones of CFD. Since CFD is a



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numerical technique, especially for dealing the applications in Aerospace and Defence, there is a challenge in computing technique. Let us have a quick look into the development of computers in 30 years, 1970-CDC6600 (birth of supercomputer)-1 Megaflops, 1980-Cray 1 Vector Computer-100 Megaflops, 1994-IBM SP2 Parallel Computer-10 Gigaflops, 2007-Linux Clusters-100 Teraflops, 2007-Box Cluster Four 3 GHz dual-core CPUs (24 Gigaflops peak)- 2.5 Gigaflops, 2009-HP Pavilion Quad-core Notebook 1 Gigaflops, 2011-MacBook Pro Quad-core Laptop-2.5 Gigaflops, etc., where Flops – Floating point operations per second. A typical CFD analysis begins at problem identification with defining goals and identifying the domain, pre-processing with geometry, mesh, physics, solver settings, solving the problem with computing solution, and finally ending with simulation to examine and interpret the results. The CFD for Aerospace and Defence will provide solutions in the areas such as aerodynamics (Fluid Analysis), structure-fluid interface analysis, heat transfer analysis, etc., Here the heat transfer analysis is done not only in engines (propulsion) but also in the components such as de-icing unit, heat in avionics system, heat in electrical and electronics systems, heat in landing gear wheels, air-conditioning unit, fuselage and cockpit pressurization units, etc.

Since the association of CFD with fluid analysis, a discussion about Aerodynamics, Aerodynamic analysis in Aircraft comprises pressure, velocity, lift, drag, etc., at the significant points. Before CFD, analysis was done by some other numerical techniques and was especially carried out with the help of wind tunnels. The Wind Tunnel is a device where the prototype of the object will be tested or the original object will be mounted (static) in the test section and the flying environment will be created inside the tunnel. With the help of sensors, the above said required parameters could be experimentally measured.



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Why this course ?

The prime advantage is the fact that the CFD is a whole-field technique (comprehensive information). That is, all the above-said properties can be found in each point of the tested object. Moreover, it is cost-wise cheap; time taken is less (speed); suitable for any scale; repeatable; from the security point of view safe; and has ability to simulate actual conditions.

The CFD contribution to the periodical technology developments in Airbus and Boeing aircraft is extraordinary. The design of high-speed wing, wingtips, vortex generators, high lifting devices, wing-body fairing, environmental control system inlet, engine-airframe integration, nacelle, control surfaces failure analysis, flutter, vertical tail & aft body, avionics cooling, stability & control, APU inlet & ducting, exhaust system, engine bay thermal analysis, APU & propulsion fire suppression, cabin ventilation, cabin noise, ice prediction, belly fairing, nozzle, fuel system, flow control devices (VG/Strakes), engine core compartment, pack bay thermal analysis, performance prediction, etc., are some of the parameters completely streamlined and improvised both in Airbus and Boeing with the help of CFD. So, after CFD, the utility of a wind tunnel for testing the aircraft is drastically reduced. Especially in the growth and development of Boeing, the contribution of wind tunnel testing was reduced from 77 during the 1980-s to 11 during 2005. Technically and economically, it was a viable option. A502, A488, TRANAIR, TLNS3D, TRANAIR optimization, TLNS3D-MB/ZEUS, CFL3D/ZEUS overflow CFD++, and Unstructured adaptive grid 3-D N-S were some of the Boeing CFD tools utilized. Let us discuss one case study. In 20 years, from 1955 to 1975, wind-tunnel-based development indicated nacelles could not be placed too close to the wing without excessive drag. Then, within the next two



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years, 1975 to 1977, joint CFD/Wind Tunnel studies unlocked the secret of nacelle/wing interference drag. The interference drag is the net effect and impact in drag of any integrated parts design. Around 1980, 707/CFM56 design and flight test validated CFD concepts. Now, it was about the impact of CFD on a Boeing series B737- 300 program. “Without the understanding gained from CFD, there would not have been a 737-300 program!”, was the statement of Walt Gillette, Manager, 737 Aerodynamics – then Vice President, 787 Engineering. Some modifications in the B737-300 program from the previous versions with the help of CFD were the success of that aircraft, as exclaimed by Mr. Walt Gillette. The improvisation of design promoted the sales of B737-300. Now the case study. In the early 1980s, CFM56-3 was selected by Boeing to exclusively power the latest Boeing 737 variant, the 737-300. In Boeing 737, several modifications to the engine were required as the wings were closer to the ground than previous applications of the CFM56. The fan’s diameter was reduced, which resulted in decreased bypass ratio, along with the movement of the engine accessory gearbox from the bottom of the engine to the side of the engine, which gave the engine nacelle its distinctive flat bottomed shape. The reduction of the bypass ratio caused a reduction in overall thrust, from 24,000 to 20,000 lbf (107 to 89 kN). Another significant change was the attachment of the engine with wing, without pylon. Because of all these changes in design, the interference drag was very much minimized to improve forward thrust. This was the success of the Boeing 737-300 with the technology of CFD.

Now a brief about CFD in Aero-Engines. CFD modeling needs to be specifically addressed to Compressor – RANS / URANS / LES; to Combustion Chamber – RANS/LES; to Turbine – RANS / URANS / LES; to Afterburner – RANS/LES, where RANS is Reynolds-averaged Navier–Stokes equations; URANS – Unsteady Reynolds-averaged Navier–Stokes equations;



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and LES – Large Eddy simulation. Each component has distinct flow physics such as Flow separation and Transition, Multi-phase Flows, Chemical Reaction, Mixing, Cooling, Heat Transfer, etc. Turbulence modeling is required since most flows in practice are turbulent, and a very fine grid necessary to describe all length scales. It is a fact that most engineering combustion systems involve turbulent flames. The bottleneck of CFD combustion solvers is the modeling of turbulence – chemistry interaction. Some of the chemical reactions modeling approaches are the Eddy-Break up model, Flamelet model, and detailed chemistry. Modern CFD codes for the formulation of field equations using the Eulerian approach are Fluent, CFD, CFD++, CFD-ACE+, etc.

Course contents

Week	Time	Topic
Week 1	6hrs	Applications Of CFD For Helicopter Design And Development
Week 2	6 hrs	Internal And External Flow Concerns Of The Helicopter And Its Systems
Week 3	6 hrs	Convergence-Related Issues Of Higher-Order Schemes And Turbulence Models
Week 4	6 hrs	Developing And Maintaining An Integrated Simulation And Software Development Infrastructure To Enable Rapid CFD Technology Maturation
Week 5	6 hrs	The Future Of CFD In Aerospace And Defence





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INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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