

**Title of the course: Introduction to Aerospace Structures (AE331A)**

**3L-0T-0P-0A (9 credits) Prereq: Exposure to ESO202;**

**LEC: T 17:00-18:00 L14;WF 14:00-15:00 L14**

**Objectives of the course:** The course deals with study of thin slender members subjected to various resultant loads developed on an aircraft structure. The course develops the theory for obtaining the state of stress in thin structures, in order to predict onset of failure (both material and form). The course prepares the students for design and analysis of aircraft structures.

**Course content:** As given below

**Lecture-wise break-up:**

Topic	No. of lectures
Loads on an aircraft	2
Elements of Linear Theory of Elasticity	3-4
Idealization of Aerospace Structure	1
Stress Resultant	1
Extension-bending of non-homogenous Euler-Bernoulli	4
Bending shear stress (open-closed-solid)	2
St. Venant torsion of arbitrary cross-section	3
Shear flow	2
Thin Walled beams: Single celled and multi celled box beams.	5
Shear center for open and closed section	4
Tapered beams	2
Beam-Column Euler Buckling	4
Principle of virtual work	4
<b>Total:</b>	<b>38</b>

**Suggested text and reference material:**

1. Theory and analysis of flight structures: R.M. Rivello.
2. **Aircraft Structures for Engineering Students (Fourth edition): T.H.G. Megson, Elsevier Aerospace Engineering Series. [ Text Book]**
3. Analysis of Aircraft Structures (second edition): B.K. Donaldson, Cambridge Aerospace Series.

**Instructor: Prof. CS Upadhyay (shekhar[AT]iitk.ac.in)**

Address: Room No 210/H– NWTF Building; Phone: 05126797936

### **Course Expectations:**

- An aircraft is a light-weight structure, and being so inherits a lot of the design philosophy of birds. Thus an aircraft structure is primarily a thin, hollow structure that is capable of carrying 4-15 times the aircraft weight (which also includes other systems, payload and fuel). The lifting load is primarily borne by the wing, while the fuselage and other stabilizing and control surfaces are also subjected to loads due to drag and control forces. **The major emphasis of this course will be on understanding the wing structure, as a critical part of the airframe, with a natural extension to the other structures.**
- What are typical wing configurations? Use your internet skills to create a technical collage of what exists and what is possible.
- As a student, you have to start thinking like a designer. As such it is expected that you develop a global picture of what is required to be done to design a structure that will not fail. How do we define failure? Yielding could be one. But we need to go further – buckling and fatigue. Failure for what material? Material selection will also be an issue that the designer has to bother about. We will focus on Aluminum alloys, steel, composites ( cursory look). You will be expected to read literature, see online reports, etc.
- Thin structure being our focus, we will have to start from what we know – i.e. **beams**. We will expand on what you know, to create a model of the stress state in a loaded hollow, thin-walled beam – using suitable extensions of what you learnt in Mechanics of Solids. So brush up on Crandall and Dahl... Bending, torsion will be crucial. We will take several detours into the unknown – stiffened structures, thermal stresses, bending-torsion coupling, plates, shells, structures of the future, etc.
- Obviously, we need to go beyond, but 40 lectures is a finite time span, so we will restrict the story to this prescribed syllabus.

### **Course Evaluation:**

- NUMERICAL/THEORETICAL ASSIGNMENTS – 5-6 ASSIGNMENT SETS
- READING ASSIGNMENTS – REPORTS ON THE STATE-OF-ART; REVIEW  
[5% MARKS]
- MATLAB PROGRAMMING CHALLENGES – 10% <1-2>
- SMALL EXPERIMENTAL SET-UPS – [BONUS MARKS]
- **EXAMINATIONS** –  
3-4 QUIZZES [15% MARKS]; MID-SEM. [30% MARKS], END-SEM.[40% MARKS].
- ATTENDANCE – MAX. OF 2 DAYS GRACE <FOR MEDICAL, FAMILY AND OTHER EXIGENCIES> - FOLLOWED BY LOSS OF 1 MARK FOR EVERY LECTURE MISSED. MORE THAN 10 UNEXPLAINED ABSENCE – DEREGISTRATION.
- **PERSONAL IDIOSYNCRASIES** – WOULD LIKE TO SEE STUDENTS IN PROPER CLOTHING (NO RUNNING SHORTS, PYJAMAS, RAGS AS T-SHIRTS, DIFFERENTLY-ABLED HAWAII CHAPPALS, ETC); *COPYING, IF DETECTED, WILL LEAD TO DEREGISTRATION FROM COURSE.*