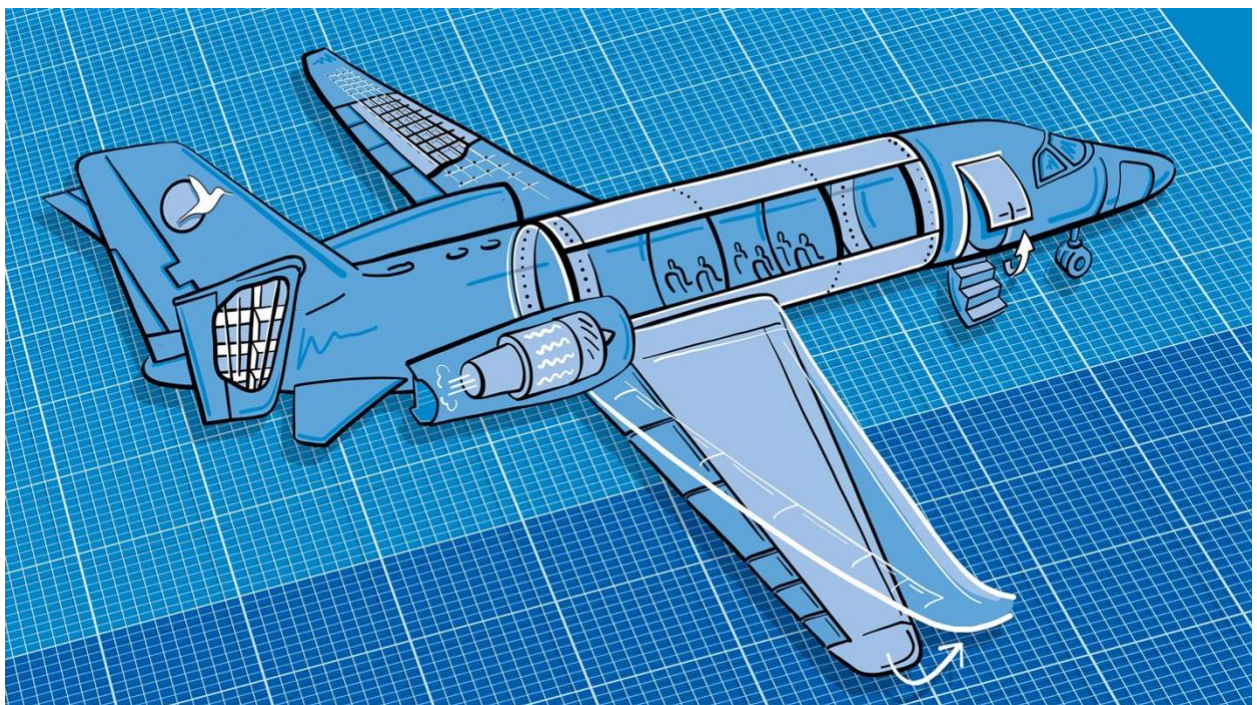


# Introduction to Aerospace Structures and Materials

MOOC Run 2: 9 April 2019 – 8 February 2020



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# AEASM1X in a Nutshell

## Badge 1. Materials and the Environment



LO: Stress and Strain, Material Properties, Effect of Temperature and Environment

Activities: Your Favorite Aircraft/Spacecraft, Video, Lectures, Experiments, Quizzes, Readings

Deliverables: Exam 1, Assignment 1

Module 1

## Badge 3. Aerospace Structures



LO: Definition and Function of Aircraft and Spacecraft Structures

Activities: Naming Aircraft Parts, Video, Lectures, Experiments, Quizzes, Readings

Deliverables: Exam 3, Assignment 3

Module 3

## Badge 5. Selection of Materials and Structures



LO: Structural Performance, Design Criteria for Aircraft and Spacecraft

Activities: Video, Lectures, Experiments, Quizzes, Readings

Deliverables: Exam 5, Assignment 5

Module 5

## Badge 7. Joining & Assembly



LO: Types of Joining Methods and Assembly Selection.

Activities: Video, Lectures, Experiments, Quizzes, Readings

Deliverables: Exam 7, Assignment 7

Module 7

Module 2



## Badge 2: Materials and Manufacturing Methods

LO: Describe the Materials and Manufacturing Methods Used in Aerospace Engineering

Activities: Video, Lectures, Experiments, Quizzes, Readings

Deliverables: Exam 2, Assignment 2

Module 4



## Badge 4: Loads and Stresses

LO: Aircraft Loading and Load Paths

Activities: Video, Lectures, Experiments, Quizzes, Readings

Deliverables: Exam 4, Assignment 4

Module 6



## Badge 6: Design Certification, Fatigue and Durability

LO: Safety & Design Philosophies, Fatigue & Damage Tolerance

Activities: Video, Lectures, Experiments, Quizzes, Readings

Deliverables: Exam 6, Assignment 6

To pass you must earn 6 out of 7 badges. Badges are only available if you have upgraded to the Verified Certificate track. Each badge can be earned by scoring more than 60% on each module exam and each module assignment. Deadline for all assignments, exams, and badges is **8 February 2020**

# 1. Introduction

## 1.1. Course overview

How do you design an aircraft or spacecraft? And in doing so, how do you keep the risk of failure minimal while bearing in mind that they will eventually fail?

In this course, you will be taken on a journey through the structural and material design of aircraft. You will see how aircraft and spacecraft are manufactured and learn how safety is enshrined at every stage.

As lecturers from the Aerospace Structures and Materials Department of Delft University of Technology, we will help you analyze the mechanical properties of materials, learn about manufacturing techniques, understand the concepts of fatigue, loads, and stresses, look at design considerations, and much more –as well as the scientific and engineering principles that structural and materials engineers face every day. By the end of the course, you will have learned to think like we do! We would like to stress here that the course is an introductory course and will not go into in-depth calculations and analyses.

To do well in this course, you do not need to be an aerospace aficionado, but it certainly helps. You also do not need an extensive background in math or physics, but if you can remember some of your high school math and physics, it will most certainly come in handy.

The course consists of seven modules, each scheduled to last about 4-6 hours and a final wrap up module, bringing the course to 8 modules in total. The course is designed for you to complete a module per week but do not let that stop you from binging on this course. In each module, you are offered a mix of online lectures, readings from our own e-book, some experiments which you can do at home, small quizzes, and discussion forum activities.

In order to continue providing freely accessible course content to the world while remaining sustainable, the graded elements in this edX course, will only be available to verified learners. If you sign up for a Verified Certificate the course will be available to you until it closes, meaning you have until the official course closing date to finish the course and will have access to the archived course after the course has closed.

Of course, we will follow your progress and where possible engage with you on the discussion forums.

## 1.2. Learning objectives

So, what will you actually learn in this course? At the end of this course, you will be able to:

- Explain how aerospace structures are designed, and why particular choices are made
- Which materials are used, and why?
- Explain the loads and stresses aerospace structures must withstand
- Explain how aircraft and spacecraft are manufactured
- Understand the safety philosophies used in aerospace structural design, and how they affect design choices

- Create preliminary design solutions for structural design problems and material choices

### 1.3. What we expect from you

As an online student, we expect you to be an active participant in this course by contributing to a positive atmosphere. We want you to question, share, and help others by engaging in meaningful discussions.

This course is meant to be a place where you learn with and from others. In this sense, we would like you to experience collaboration and peer feedback, so please make sure you follow along with other participants to enrich the overall learning experience.

You are expected to follow forum and collaboration guidelines. Respect the course policies, academic integrity, and most importantly your fellow students.

### 1.4. What you can expect from the course team

The e-Moderators will guide you throughout the course, we will check your progress and regularly visit the forum to help you and identify any changes or fixes. Guidance and support will be given on a regular basis, mainly once per week.

**Response Time:** This is a self-paced course meaning that the forums are not monitored continuously. We will try to respond to all your questions and posts within 2 working days. If this is not possible for any reason, we will let you know.

## 2. Course Structure

The course is organized in seven topics, each module is designed to be spread over one week and a wrap up module. A brief summary of each topic is presented below. Detailed instructions and resources will be provided during the course.

### Module 1. Course Introduction and Materials and the Environment

In the Getting Started section, you'll get to know the course structure, become familiar with the virtual learning environment, complete your profile, meet your fellow students and the e-moderator. These introductory tasks should be completed in the beginning of the course, after your first login.

After that we will really get started. First, we will take you through the basic concepts of material properties and the phenomena of stress and strain. We will also throw in a few experiments, which you can also do at home, so you can get a real hands-on feel for the concepts. After that, we will take you through what happens to an aircraft or spacecraft at different temperatures and environments. In your first assignment, we will ask you to take a closer look at your favorite aircraft or spacecraft and research it from a structures and materials point-of-view.

## Module 2. Materials and Manufacturing Methods

Here, we will introduce the typical aerospace materials such as metals, ceramics, and composites. Every material has its own unique properties, critical to the design of aerospace structures, which we will introduce to you. You will also learn all about various manufacturing methods for these materials. We will also let you play around and create your own composite materials! In your second assignment, you will be challenged to start thinking like a true aerospace structures and materials engineer and come up with your first design proposal.

## Module 3. Aerospace Structures

In this module, we will really dive into the lingo of aircraft and spacecraft. Terms such as stiffeners, frames, and bulkheads, will no longer hold any secrets for you. We will also do some more experiments to demonstrate why certain structural elements are essential to keep your aircraft or spacecraft flying. This module's assignment involves studying the skeleton of your favorite aircraft or spacecraft and identify why certain structural elements were used by their designers.

## Module 4. Loads and Stresses

We continue our focus on structures by studying loads that act on the different aircraft parts, the paths these loads travel through a structure on, and how this affects design choices when designing wings and fuselages. We will explain the consequences of having a pressurized fuselage for aircraft design as well as look in detail of the bending of wing spars and what that means for wing design. At the end of this module, you will face your first dilemma as a designer: how to satisfy all design requirements even if they appear contradictory?

## Module 5. Selection of Materials and Structures

During this module, we will take a closer look at the structural performance of aircraft. Building on your knowledge bank thus far, you will learn how to select the appropriate structural and materials solution for a design problem based on stiffness and strength. The concepts of specific strength and specific modulus will be introduced to aid you in selecting the right material. We will also take you through the basic steps on how to dimension a spacecraft. Your assignment for this module will definitely involve some number cracking!

## Module 6. Design Certification, Fatigue, and Durability

If you are a fan of those aircraft investigation shows on the television, you will most likely enjoy this module. However, we will also show you that life isn't quite like television, should you still be in any doubt. You will learn how, during the design process, many possibilities for failure are already eliminated, and the underlying philosophies for why. We will also discuss fatigue and damage tolerance, as they are critical if we want to monitor and improve the durability of aircraft and spacecraft.

## Module 7. Joining and Assembly

We hope you feel the time has flown by! Though this will be our last module, we still have one more exciting topic to explore. You've learned about different structures in aerospace engineering and how to select the right material for the job, but aircraft and spacecraft aren't held together by magic! In this module, we will look at how aircraft and spacecraft are assembled, and what joining methods are used and why. As your final assignment, you will choose a joining method for your aircraft based on a dilemma we will pose to you!

## Module 8. Wrap up

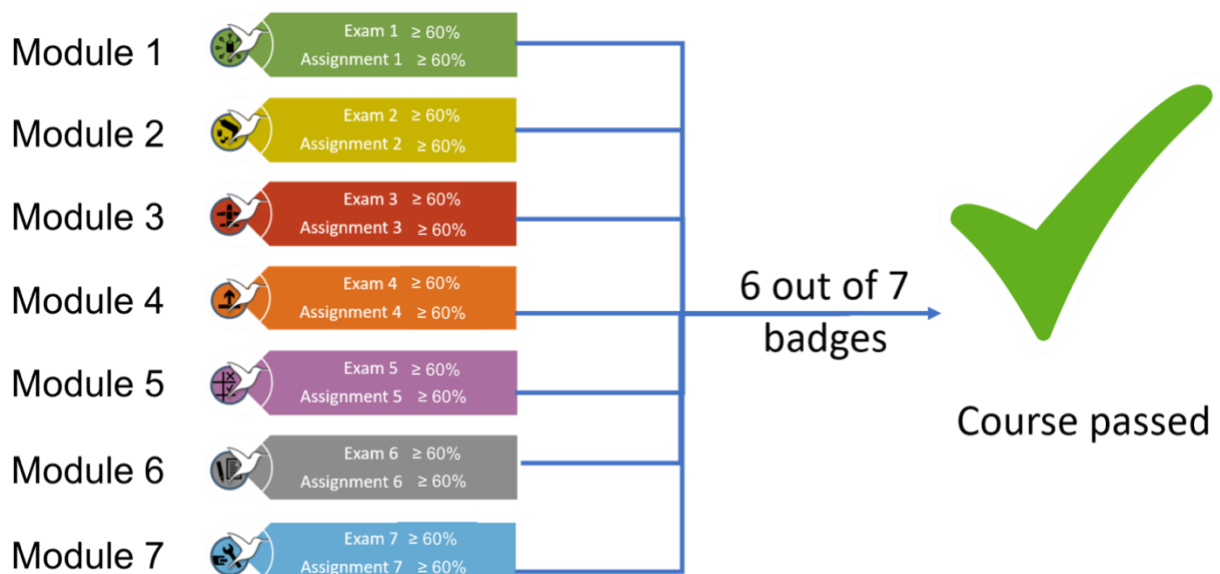
As always, no job is done until the paperwork is done. During the last module, we ask you to look back at your initial expectations and see how far you have come. If you decided to go for the Verified Certificate Option, those will be handed out and we kindly ask you to give us some feedback on what you liked in the course and which bits could be improved.

After that we will say goodbye, although we do hope to see you again in some of our other course offerings in aerospace structures and materials as listed on [www.online-learning.tudelft.nl](http://www.online-learning.tudelft.nl).

## 3. Assessment

As previously mentioned, if you have signed up for a Verified Certificate, which we wholeheartedly recommend, you can earn a badge for each module by scoring at least 60% on the exam and completing the assignment by also scoring at least 60%. To pass the course you must earn 6 of the 7 badges. This is shown in the Progress Tab as if you have to score 85%, meaning you must gain 6 out of the 7 badges. The assignment will automatically become available after you have scored 60% on the exam. The criteria for each assignment are detailed in the course.

The deadline for all exams and assignments is **8 February 2020 at 12:00 UTC**.



## 4. Resources & Tools

All educational resources will be available in the course. They consist of short videos and readings to support you in the completion of the learning activities for each module.

If you want to repeat some of the experiments shown, you may need to acquire some items. We have aimed to create each experiment so that you can easily get the items you need without great expense, if any at all.

Additionally, you will be given access to the newly published Open Textbook Introduction to Aerospace Structures and Materials by René Alderliesten. This book will be made available for free as a PDF.

No special tools will be needed to complete this course.

## 5. Verified Certificate

In order to have access to the exam and assignment of each module you must upgrade to a Verified Certificate. This was done to ensure that we can continue providing freely accessible course content to the world while remaining sustainable. An ID verified Certificate of Achievement is available for \$50. You can Upgrade on your edX Dashboard to Verified during the course. Upgrading to a Verified Certificate gives you:

- a certificate if you successfully completed the course;
- access to graded assignments;
- the ability to take until the course end date to complete the course,
- access to the archived course after the end date

These certificates will indicate you have successfully completed the course, but will not include a specific grade. Certificates will be issued by edX under the name of DelftX, designating the institution from which the course originated.

BTW, did you know that research shows that students who upgrade to verified certificates are 8 - 10 times more likely to finish the course? Give yourself that extra edge, both psychologically and in your professional field by upgrading and completing the course, and you will receive a certificate signed by the lecturers of this course, which you can share with your network on platforms like LinkedIn.

Do you need financial assistance? EdX offers up to a 90% discount on our verified certificates to learners who cannot afford to pay full price. Check the [edX support page for financial assistance](#).



## Generating an ID verified certificate

Verified certificates will be issued automatically after you have completed the course, if you have achieved at least 85% of the total grade. To request your certificate, select "Request Certificate" on the Progress Tab. After that, you can download your certificate directly from the Progress Tab, or from your Student Dashboard (look for the Download button next to the name of our course).

We hope the certificate will assist you in achieving your personal and professional goals in life! Remember that in order to qualify for a certificate, you must achieve a total grade of 85% or higher. You can check your grade at any time under the course's Progress page. Once produced, a certificate cannot be reissued, hence it is very important that you verify the way in which your name appears. Check that, in your edx.org account, your name is correctly spelled, since it will appear on the final certificate.

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Office Hours: every day from 08:00 to 24:00 (Amsterdam time)