# Stability and integrity of aerospace structures

**Academic Year: ( 2017 / 2018 )** **Review date: 03-02-2018**

**Department assigned to the subject: Bioengineering and Aeroespace Engineering Department**

**Coordinating teacher: CAVALLARO , RAUNO**

**Type: Compulsory ECTS Credits : 6.0**

**Year : 3 Semester : 2**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Advanced Mathematics
Aerospace Materials I and II
Introduction to Structural Analysis
Aerospace Structures

## OBJECTIVES

- Understanding of the concept of instability and the loading conditions in which it appears.
- Ability to calculate the onset of instability in aerospace structures.
- Understanding the effects that cycling loading, stress level and geometric configuration have on the life of structural members.
- Understanding the mechanism by which cracks grow and variables that affect their growth rate.
- Ability to calculate when aerospace structures will fail when subjected to cycling loading.
- Knowledge of design concepts and inspection methods that will safeguard aerospace structures from catastrophic failure.

## DESCRIPTION OF CONTENTS: PROGRAMME

1) Stress Analysis of Aircraft Components
- Structural Idealization
- Wing spar and box beams
- Wings
- Fuselage

2) Structural Stability
- Columns:

Elastic buckling of ideal columns. Euler Curve. Inelastic buckling of columns. Euler-Engesser Curve. Real effects on column stability: Imperfections. Local Buckling and Crippling. The Johnson-Euler curve.
- Plates:

Elastic buckling of plates (compression, bending, shear and combined loading). Plastic effects in plate buckling. Effect of panel curvature. Panel failure: compression and shear panels. Diagonal Tension.

3) Structural Integrity:
- Constant and variable amplitude fatigue:

SN Curves. Stress concentrations. Cycle counting. Cumulative damage rules. Residual stresses. Design Criteria.
- Linear Elastic Fracture Mechanics:

Energy release rate and Stress Intensity Factors. Plastic zone size. Fracture Toughness and failure prediction. Thickness effects on Fracture Toughness. The plane strain Fracture Toughness test.
- Fatigue Crack Growth:

Fatigue crack growth rate curve. Stress ratio effects. Paris Law and other analytical representations.
- Damage Tolerance Analysis:

Life prediction. Closed form integration for constant Beta and Paris Law. Retardation effects. Design Criteria.

## LEARNING ACTIVITIES AND METHODOLOGY

Theory sessions.
Problem sessions working individually and in groups.
Experimental and numerical Lab-sessions.

## ASSESSMENT SYSTEM

End-of-term exam (60%)
Midterm test (10%)
Lab sessions - projects (30%)

In order to pass the subject the following two conditions must be met:

1) A minimum grade of 5.0 (End-of-term + continuous evaluation) must be obtained,
AND
2) A minimum grade of 4.0 in the end-of-term exam must be obtained.

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| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

## BASIC BIBLIOGRAPHY


- Anderson, T. L. Fracture Mechanics: Fundamentals and Applications, CRC Press, 1995
- Megson Aircraft Structures for Engineering Students, Elsevier, 2012
- Ralph I. Stephens, et. al. Metal Fatigue in Engineering, Wiley, 2001
- Timoshenko & Gere Theory of Elastic Stability, McGraw Hill, 1985


## ADDITIONAL BIBLIOGRAPHY


- Broek, David The practical use of fracture mechanics, Springer, 1989
- Bruhn, E.F. Analysis and design of flight vehicle structures, Jacobs, 1973
- James Gere and Stephen Timoshenko Mechanics of Materials, PWS Publishing, 1990 (or newer).
- Jan R. Wrigth Introduction to Aircraft Stability and Loads, John Wiley & Sons, 2007
- John M. Barsom and Stanley T. Rolfe Fracture and Fatigue Control in Structures, ASTM, 1999