Universidad de Alcalá

TEACHING GUIDE

Strength of materials

Degree in
Industrial Electronics and Automatics Engineering

Universidad de Alcalá

Academic Year 2025/2026

3rd Year - 2nd Semester

Approved by the EPS School Board on June 16th, 2025

TEACHING GUIDE

Course Name:	**Strength of materials**
Code:	**600019**
Degree in:	**Industrial Electronics and Automatics Engineering**
Department and area:	**Teoría de la Señal y Comunicaciones** **Mechanical Engineering**
Type:	**Compulsory**
ECTS Credits:	**6.0**
Year and semester:	**3rd Year, 2nd Semester**
Teachers:	Por definir
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	English

1. COURSE SUMMARY

Strength of Materials is located in the second semester, third course of the graduate in Electronics and Industrial Automation Engineering Degree (GIEAI). Strength of Materials together with Materials Science (600007) and Mechanical Systems (600006) cover the disciplines of mechanical/materials imparted in the GIEAI. In addition, Strength of Materials can be studied by some students enrolled in the Master of Industrial Engineering of the Universidad de Alcalá as a complementary course.

Strength of Materials deals with the fundamental concepts of Theory of Elasticity. The objective is to analyze and design beam (type) structures by the study of their stresses and strains caused by external loads. The main structural elements studied are beam, shafts and columns.

Since Strength of Materials is in an Electronic and Automation Industrial degree, the main objective is to introduce basic concepts and examples such as the design of transmission shafts and reduction gears. In addition, due to the fact that engineers usually work in multidisciplinary teams, the subject also incorporates exercises with technical documentation used by Industrial Engineering and Architects.

Note: The students should have good knowledge of Physics (statics and dynamics) and Mathematics (linear differential equations).

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/351/2009:

en_TR2 - Knowledge in basic and technological subjects, which enables them to learn new methods and theories, and gives them versatility to adapt to new situations.

en_TR3 - Ability to solve problems with initiative, decision making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.

en_TR4 - Knowledge to carry out measurements, calculations, assessments, appraisals, appraisals, studies, reports, work plans and other similar works.

en_TR5 - Ability to handle specifications, regulations and mandatory standards.

en_TR9 - Ability to work in a multilingual and multidisciplinary environment.

en_TRU1 - Capacity of analysis and synthesis.

en_TRU2 - Oral and written competencies.

en_TRU3 - Ability to manage information.

en_TRU4 - Autonomous learning skills.

en_TRU5 - Team work.

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/351/2009:

en_CI8 - Knowledge and use of the principles of resistance of materials

Learning Outcomes

After succeeding in this subject the students will be able to:

RAMSM19: Description and application of strength of materials general principles.

RAMSM 20: Calculation of structural elements by applying bending theory.

RAMSM 21: Analysis and dimension of transmission shafts and columns

RAMSM 22: Analysis evaluation and interpretation of structural results.

3. CONTENTS

Contents Blocks	Total number of hours
Strength of Materials introduction. Basic concepts. Static Equilibrium. Constituent equations. Basic elasticity theory	3 hours
General behaviour of elastic elements. Stress-Strain. Linear elasticity. Inelastic behaviour: Failure criteria. Hooke general theory.	6 hours
Bending theory. Pure Bending. Symmetric and Asymmetric Bending. Bending of members made of several materials. Analysis and design of beams for bending. Shear and bending-moment diagrams. Shearing stresses in beams and thin-walled members. Deflections of beams. Using of singularity functions. Statically indeterminate beams.	23 hours
Tangential stresses in beams under bending. Shear flow concept. Thin-walled elements.	5 hours
Torsion. Analysis and design of transmission shafts	7 hours
Analysis and design of columns. Buckling.	7 hours
General analysis of elements subjected to combined loads (axial, bending and torsion). Principal stresses under a given loading.	7 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	58 hours (56 hours on-site +2 exams hours)
Number of hours of student work:	92
Total hours	150

4.2. Methodological strategies, teaching materials and resources

The teaching strategy of the course is divided into 3 sections: classroom learning, learning in small groups and finally individual study.

Sessions of large group in the classroom:

Working sessions in the classroom, in large groups, will consist of lectures where the main concepts of the theory will be introduced. The understanding of these concepts will culminate with the use of them in both the laboratory and the problem solving sessions in small groups.

Learning in small groups

It will consist of the study and resolution of practical cases proposed in the face-to-face small group sessions. Sharing and exposition of the solutions.

Individual study

Review of video tutorials and support material provided by the teachers before/after classes. Development of practical cases in the laboratory. Individual work for the resolution and delivery of proposed exercices.

Teaching materials will be essential to create reflective learning environments, where students and teachers can undertake a critical analysis that allows the student to autonomously relate concepts.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call (Continous Assessment):

Consisting of:

- the completion of laboratory sessions (PL)
- active participation in face-to-face classes (including completion and submission of tests and problem-solving exercises during in-person sessions, TC and EP)
- completion of a midterm exam (PEI)
- completion of a final exam (PEF)

Given the experimental nature of the subject, attendance and completion of the laboratory sessions are

mandatory in order to successfully pass the module."

The extraordinary exam will consist of a theoretical-practical written test, which will allow the evaluation and grading of all the learning outcomes. The content of this test will depend on the results obtained in the ordinary call.

Assessment by Final Exam:

This will consist of the completion and passing of a Final Assessment Test (PEF), designed to evaluate and grade all the learning outcomes, including those related to laboratory work.

Extraordinary Assessment:

Students who do not pass the standard (ordinary) assessment—whether through continuous assessment or final examination—will be entitled to an Extraordinary Assessment, consisting of a written theoretical-practical exam that will assess and grade all learning outcomes. The content of this exam will depend on the results got in the ordinary assessment.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined::

CE1. Student understands the basic concepts and ideas of each content block.

CE2.Student applies the knowledge to the resolution of practical cases in exercises solved in face-to-face classes (group/individual).

CE3.They actively participate in groups and show initiative in the solving and approach of problems that integrate the knowledge acquired.

CE4. Student solves in a comprehensive way, reasoning the procedures applied and that he/she is able to critically interpret the results.

CE5.There is a continuous evolution in the learning process and the integration of all the contents is go

GRADING TOOLS

The work of the student is graded in terms of the assessment criteria above, through the following tools:

1. Attendance and active participation in theoretical and practical classes (TC).
2. Completion of exercises proposed in problem-solving sessions (EP), both in groups and individually.
3. Completion of laboratory work (laboratory report, EL).
4. Integration of knowledge in the individual midterm exam (PEI).
5. Final assessment (PEF).

GRADING CRITERIA

In the ***ordinary call-continuous assessment*** the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CI8, TR2, TR3, TR4, TR5 y TR9	RAMSM19,RAMSM20, RAMSM21,RAMSM22	CE1, CE2, CE3, CE4, CE5	TC+EP	15%
			PEI	35%
			PL	10%
			PEF	40%

A student will be considered to have participated in the teaching-learning process, and, therefore, she/he is presented in the the Ordinary Call -Continuous Assessment, if he/she has completed the PEI and all deliverables up to the PEI date (EP).

In order to pass it is necessary that he/she obtains a total grade of 5 out of 10 (weighted average) and it is essential to have passed the laboratory.

If the student takes part in continuous assessment and passes both the Final Assessment Test (PEF) and the Laboratory Sessions (PL) with a mark of 5 or higher in each, they will pass the module regardless of the marks obtained in PEI, TC, and EP, provided there is evidence of their academic progress.

In the ordinary call-final assessment, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CI8, TR2, TR3, TR4, TR5 y TR9	RAMSM19,RAMSM20, RAMSM21,RAMSM22	CE1, CE2, CE3, CE4, CE5	PEF	100%

In this PEF, student must demonstrate having acquired the competences developed at lab sessions. The date of this test will be the same as for the students who choose the ordinary call-continuous assessment, but the contents will differ.

Extraordinary call

In the case of the extraordinary call, the same percentages that have been established in the case of the evaluation by means of a final exam will be maintained. The contents of this final test may depend on the results obtained in the ordinary call.

The teaching-learning methodology and the assessment process will be adapted as needed, in accordance with the guidelines of the Diversity Support Unit, to implement curricular adaptations for students with specific needs.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Ferdinand P, Beer. Russell, JR. Mecánica de Materiales. Editorial Mc-Graw-Hill, 6ª Edición. 2013.
- Ortiz Berrocal, L. Resistencia de Materiales.Mc-Graw-Hill, 3ª Edición. 2007.
- Cervera,M. Blanco, E. Mecánica de Estructuras – Libro 1. Resistencia de Materiales. Ediciones UPC. 2002.

6.2. Additional Bibliography

- Online material (Blackboard)
- Mechanics of Materials (YouTube free chanel): https://www.youtube.com/channel/UCE6EiDEJehyE5t-6ff7ThtQ

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.