



Code: ING-IND/14

Credits: 9

Course: Machine Design Elements

Main language of instruction: Italian

Other language of instruction: English

Teaching Staff

Head instructor

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Introduction

The course provides the main theoretical and methodological tools related to the design of simple machine elements.

Objectives

The students will:

1. Review concepts of statics and strength of materials used to determine the stress, strain, and deflection of one-dimensional structures.
2. Learn fundamental approaches to failure prevention for static and repeated loading.
3. Consider the design of common machine elements such as shafts, fasteners, bearings, and gears.
4. Solve open-end design problems involving reliability, drawings, structural and fatigue analyses.

Competencies:

A. Knowledge and understanding:

The student will be able to remember and state the solutions and simplified models adopted in the static and fatigue calculation of mechanical structures.

B. Applying knowledge and understanding:

At the end of the course, the student will be able to carry out the design and verification of medium-complexity machines, with reference to functional and structural problems. He will also be able to develop the structural design of simple machine parts based on the analysis of the state of stress induced by the prescribed

loads and constraints and the properties of the materials used in the expected conditions of use.

In particular, you will have to: be able to identify the most appropriate approach to address a mechanical structural problem; and be able to carry out a resistance and deformation calculation of a mechanical component.

C. **Autonomy:**

The student will be able to simplify a machine (or portion of a machine) from a complex structure into a simple element, to be able to apply the calculation tools provided in the course. The student will also be able to select and use the most suitable calculation tool for this purpose.

D. **Making judgements:**

The student will be able to identify the most appropriate models to resolve the stress state of a component and to apply the appropriate tools for the evaluation of its stress state. The student will also be able to choose the most common bearings and transmission parts from the manufacturer's catalogues.

E. **Learning skills:**

At the end of the course, the student will be able to apply the knowledge acquired to solve unfamiliar problems which have the analysis of machine parts as their object. At the end of the course, the student will have learned how to approach the study of machine parts that are unfamiliar to him, based on the analysis of the basic components that compose it. All this will allow him to continue his engineering studies with greater maturity and will provide him with the basis for learning what will be proposed in the specialized mechanics courses, with reference to the topics of "cold mechanics".

Syllabus

1. *2-D stress*
2. *1-D deflection and stiffness*
3. *Failure criteria*
4. *Fatigue*
5. *Shafts and shaft components*
6. *Gears*
7. *Springs*
8. *Fasteners*
9. *Bearings*
10. *Other machine elements*

Detailed content (may be modified during the semester)



Topic 1	<i>Introduction to Mechanical Design – Course Overview, Design Process; Materials – Material Properties, Materials Selection, Combined Loading</i>
Topic 2	<i>Load and Stress Analysis – Equilibrium and Free Body Diagrams, Shear Force and Bending Moments, Stress, Strain, Torsion, Mohr’s Circle</i>
Topic 3	<i>Deflection and Stiffness – Deflection Due to Bending, Deflection Analysis, Compression, Elastic Stability, Buckling</i>
Topic 4	<i>Failures Resulting from Static Loading – Static Strength, Stress Concentration, Failure Theories for Ductile and Brittle Materials, Cyclic Stress, Fatigue Regimes</i>
Topic 5	<i>Fatigue Failure Resulting from Variable Loading, Fatigue Strength and Endurance Limits, Fluctuating Stresses and Influence of Non- Zero Mean Stress, Combination of Loading Modes</i>
Topic 6	<i>Shafts and Shaft Components – Shaft Materials, Shaft Layout, Shaft design for Stress, Deflection Considerations</i>
Topic 7	<i>Gears – Types of Gears, Gear Trains</i>
Topic 8	<i>Gears - Force Analysis, Spur and Helical Gears, Bevel and Worm Gears, Selection of Gears</i>
Topic 9	<i>Rolling Contact Bearings and Lubrication – Bearing Types, Bearing Life, Bearing Life, Rating Life, Selection of Bearings</i>
Topic 10	<i>Design Case Studies</i>

Evaluation system and criteria

The examination consists of a written test. This includes:

- 1 open-ended design problem
- 20 multiple-choice questions

In addition, five e-tivities, consisting of numerical problems, are compulsory. These need to be sent to the instructor in advance of the examination. Each e-tivity counts 1 mark for a total of 5 out of 30 marks.

Bibliography and resources

1. Materials to consult

Notes written by the instructor are available both in Italian and in English.

2. Recommended bibliography

Suggested readings are:

- R.C. Juvinall. Fundamentals of Machine Component Design. Wiley.