# COURSE DETAILS

# " APPLIED MECHANICS FOR ENERGY EFFICIENCY "

# SSD ING-IND/13

DENOMINAZIONE DEL CORSO DI STUDI: INGEGNERIA MECCANICA PER LA PROGETTAZIONE E LA PRODUZIONE

ANNO ACCADEMICO 2022 - 2023

## GENERAL INFORMATION – TEACHER REFERENCES

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## GENERAL INFORMATION ABOUT THE COURSE

ANNO DI CORSO: I o II
PERIODO DI SVOLGIMENTO, SEMESTRE: II
CFU: 9

## I REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

*"no one"*

## PREREQUISITES (IF APPLICABLE)

*"no one"*

## LEARNING GOALS

*The aim of the course is to provide knowledge about techniques typical of applied mechanics useful to improve the energy efficiency of mechanical systems. Two paths are followed for improving efficiency: the first concerns the reduction of the energy used while the second concerns the recovery of energy that should be dissipated. Therefore, the main causes of dissipation due to dynamic phenomena and the techniques to reduce their effects will be faced. Furthermore, the mechanical phenomena that allow energy recovery and the techniques used in the case of low-power applications will be illustrated, with a focus on modelling and design methodologies.*

## EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

### Knowledge and understanding

*Once the student has deepened the engineering issues related to lubrication, surface wear and recovery of energy dispersed by vibrations, he will be able to develop energy efficiency projects. The student will identify the main components of transmission systems and sources of inefficiency. The student will understand the basic principles of energy storage.*

### Applying knowledge and understanding

*The student must demonstrate that he knows how to choose, among the different possibilities available, employing between various tools and different analysis methodologies those most suitable for solving a specific problem in the mechanical energy efficiency field. The student will learn how to choose suitable combination of mechanical and electric components for energy transformation, transfer and storage.*

## COURSE CONTENT/SYLLABUS

*Mechanical energy efficiency*
*Introduction to functional design, classification of the mechanisms and motion systems. Advanced model-based approaches to study energy efficiency in:*

- *Contact mechanics*
- *Friction phenomena*
- *Mechanical hysteresis and viscoelasticity*
- *Wear mechanisms*
- *Lubricants and lubrication*
- *Mechanical and hybrid power transmissions*

*Mechanical components for transferring and transforming energy. Classification based on function, working principle as well as performance and efficiency. Optimal mechanical design for machine quality of motion and energy efficiency. (4 CFU)*

*Mechanical energy harvesting*
*Mechanical energy sources: analysis and extraction. Cyclic sources, stationary sources, intermittent sources and noise. Energetic aspects of vibration mechanics: systems with n degrees of freedom and modal analysis. Main physical phenomena linking mechanical and electrical quantities (piezoelectric effect, Villari effect, Faraday's law). Electro-mechanical characteristics and dynamic behavior of piezoelectric and magnetorheological materials. Outline of electrical energy storage*

*and management circuits. Multi-physics modelling methodologies and approaches. Energy harvesting applications for low power systems: self-powered, autonomous and smart devices. (5 CFU)*

## READINGS/BIBLIOGRAPHY

*Slides provided to the students after each lecture. There is no single textbook that covers the entire course. A collection of suggested readings from various sources will be announced during the course.*

## TEACHING METHODS

*The teachers will use a) lectures for about 60% of the total hours, b) exercises to practically deepen theoretical aspects for about 20% of the hours, c) laboratory to deepen the applied knowledge for about 20% of the hours*

## EXAMINATION/EVALUATION CRITERIA

**a) Exam type:**

| L'esame si articola in prova | |
|---|---|
| **WRITTEN and oral** | |
| **Only written** | |
| **Only oral** | |
| **Project discussion** | X |
| **other** | |

b) **Evaluation pattern:**

*The Examination Commission assign a grade based on the consistency of the answers provided by the student to the questions that have been formulated.*

*The final grade is also suitably motivated to the student.*