

# UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

## **SYLLABUS DEL CORSO**

## **Energy Physics**

2526-1-F1703Q007

## **Aims**

Knowledge of the physical principles at the basis of primary energy resources, of their availability and possibility of use. Energy transformations. Combination of energy sources for sustainability

#### **Contents**

Definition of energy systems and related problems. Global energy landscape: resources, uses and trends

Elements of thermodynamics

Fluid dynamics for energy conversion.

Introduction to nuclear energy.

Nuclear fission.

Nuclear Fusion.

Renewable energy sources: principles, sources and technologies

Fossil fuels: formation, reserves, combustion elements and calorific value.

Introduction to electricity distribution networks and storage systems.

Sustainable low carbon energy mix

## **Detailed program**

DdD 1: knowledge and understanding

Definition of the energy systems and related problems. Evolution of the energy request. Sustainability of energy systems. Capacity Factor, Energy Return On Investments.

Dynamics of fluids for energy conversion. Conservation of energy in an ideal fluid, Bernoulli equation, dynamics of

a viscous fluid, lift and drag forces, circulation, flow on a wing profile, Euler equation for a turbine.

Elements of thermodynamics. Thermodynamic cycles for energy production and their efficiency, examples of application in power plants.

Introduction to nuclear energy. Binding energy, stability curve, radioactive decay, drop model of the nucleus, hints of the interaction of ionizing radiation with matter.

Nuclear Fission. Chain reaction, activation energy, neutronics, reactor kinetics and moderator. Operating diagrams of thermal neutron and fast neutron reactors. Fuel cycle

Nuclear fusion. Fusion reactions, hints of thermonuclear plasma physics, inertial confinement of plasma, plasma magnetic confinement, tokamak devices, thermonuclear reactor operation scheme.

Renewable sources of low-enthalpy thermal energy: solar thermal, geothermal, hydrothermal. Examples, potential availability, lines of technological development

Renewable sources of energy of mechanical origin: wind, tides, sea waves. Examples and potential availability, lines of technological development.

Hydroelectric energy. Power output from a hydroelectric basin. Impulse turbins and reaction turbines and respective operating ranges

Biomass energy. Energy conversion processes of plant biomass. Selection of biomass coltures for energy production.

## **Prerequisites**

Knowledge of thermodynamics, electromagnetism and structure of matter from the first level degree

## **Teaching form**

Taught class 21 lectures of 2 hours

Some seminars on specific topics will be organized as parts of the course program, plus some seminar on complementary topics

An integral part of the course is the preparation of an individual study according to one of the following typologies, agreed with the teacher and conducted under his supervision (DdD 2: applying knowledge and understanding; DdD 3: making judgements; DdD 5: learning skills)

IN-DEPTH ANALYSIS OF A SCIENTIFIC ARTICLE (presentation of topics not covered in class); CASE ANALYSIS (Description of a situation or real example whose interconnections are analysed between the different elements/variables in the light of one or more theoretical paradigms); PROJECT WORK (Development of an original project starting from a simple idea or from the analysis of an existing case).

#### Textbook and teaching resource

John Andrews, Nick Jelley. Energy Science: Principles, Technologies, and Impacts. Oxford University Press, 2017 (third edition or newer, fourth edition 2021)

Bob Everett, Energy Systems and Sustainability: Power for a Sustainable Future. OUP Oxford, 2012 Ibrahim Dincer, Calin Zamfirescu. Sustainable Energy Systems and Applications. Springer Science 2011 Tushar K. Ghosh, Mark A. Prelas. Energy Resources and Systems: Volume 2: Renewable Resources. Springer Business & Economics 2011 Lecture notes.

#### Semester

Second semester

#### Assessment method

Evaluation based on the following three elements

- -Written report, on topics and insights inherent to the course. (DdD 2: Applying knowledge and understanding, DdD 3: Making judgements).
- -Presentations held by students. (DdD 4: Communication skills)

Such seminars can be related to

IN-DEPTH ANALYSIS OF A SCIENTIFIC ARTICLE (presentation of topics not covered in class); CASE ANALYSIS (Description of a situation or real example whose interconnections are analysed between the different elements/variables in the light of one or more theoretical paradigms); PROJECT WORK (Development of an original project starting from a simple idea or from the analysis of an existing case).

-Interview.

Oral examination - (DdD 5: Learning skills, DdD 1: Knowledge and understanding of the course topics).

No intermediate evaluation will be organized

## Office hours

Monday - Friday by appointment

## **Sustainable Development Goals**

AFFORDABLE AND CLEAN ENERGY