UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Energy Physics

2627-1-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.
Elements of thermodynamics. Thermodynamic cycles for energy production and their efficiency, examples of

application in power plants.
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.
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