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CENTRALE NANTES

ENGINEERING PROGRAMME

SPECIALISATION

ENERGY PRODUCTION AND MANAGEMENT

AUTUMN SEMESTER

Établissement public sous tutelle du
ministère de l'Enseignement supérieur, de la Recherche et de l'Innovation

GROUPE **CENTRALE**

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COMBUSTION AND POLLUTANT EMISSIONS

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Alain MAIBOOM

Objectives

This course has two main goals:

- Provide fundamental knowledge on combustion and pollutant emissions
- Present some technical aspects of the combustion process in machines (internal combustion engine, gas turbines) and strategies to reduce pollutant emissions.

Course contents

This course covers the main understanding of the processes linked to combustion, the formation of pollutant emissions and abatement techniques.

The fundamental aspects of combustion are presented in the first part of the course: chemistry, thermodynamics, initial and final states, enthalpy of formation, chemical kinetics, inflammation, laminar and turbulent combustion, physical and chemical mechanisms of pollutant formation during combustion.

The second part of the course deals with a study of combustion and the formation of pollutant emissions in the combustion chamber of some machines (piston engines and gas turbine). Strategies to reduce pollutant emissions are also covered. Practical class exercises are conducted and corrected as a part of the course. Post-processing methods to reduce pollutant emissions are covered in a separate course.

Course material

Keywords

Chemical kinetics, pollutant emissions, combustion chamber, pollutant emission abatement

Links with other programmes

Applied Thermodynamics, Thermodynamic of engines, Gas dynamics

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	12 hrs	18 hrs	0 hrs	0 hrs

TURBOMACHINERY

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Pascal CHESSE

Objectives

To understand how incompressible fluid (pump) and compressible fluid (turbine, compressor) turbomachines work.

Course contents

The course begins with a presentation of the general working principles of a turbomachine and a classification of turbomachines. The Euler theorem is then introduced followed by the layout and functioning of a centrifugal pump: wheel, pressure, diffuser. The course then deals with machine yield and cavitation.

An application for compressible fluid machines is then covered.

Following an explanation of how turbocompressors work, the focus turns to entropy charts, yield determination, other losses and shaft work. Then, typical turbomachine curves (compressor and turbine curves) are analysed.

Finally, the course examines turbomachine similarity and then concludes with a study of several practical exercises: powering up gas turbines, pressure-charging turbocompressors, jet turbopumps.

Course material

M. SEDILLE, Turbomachines hydrauliques et thermiques, Tomes 1,2,3, Masson Paris
M. PLUVIOSE, Turbomachines, Vuibert Ed.

Keywords

Pumps, turbines, typical curves, wheel, blades, diffuser, cavitation, compressor turbocharger

Links with other programmes

Gas dynamics

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	8 hrs	14 hrs	0 hrs	8 hrs

APPLIED THERMODYNAMICS

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Jean-Francois HETET

Objectives

This course aims provide knowledge of the principal notions of fluid mechanics and energetics. These skills are necessary tools for any engineer who intends to pursue a career in the field of energetics and propulsion systems.

Course contents

The first part of the course presents simple compressible flow and how to model a flow, be it adiabatic or compressible etc.

Heat transfer basics are presented in the second part with application to real systems. Conduction and convection are introduced in this context. Then, a thermal analysis of a heat exchanger is undertaken to introduce the notion of logarithmic average value of temperature and the NUT number. This part of the course concludes with a case study on an exchanger and a full presentation of radiative heat transfer.

In the last part of the course the notion of exergy is introduced. Exergy leads to a better representation of the energy transfer in any system taking into account irreversibility (second law of thermodynamics). How to make an energy and exergy balance is the objective of this part with an application to some real systems (compressor, turbine, heat exchanger).

Course material

Michel FEIDT - Energétique: Concepts et Applications, Dunod Ed. (2006)
Lucien BOREL and Daniel FAVRAT - Thermodynamique et Energétique: de l'Ènergie à l'exergie, Presses polytechniques et universitaires romandes (2005)
Richard E. SONNTAG, Claus BORGNAKKE and Gordon J. VAN WYLEN - Fundamentals of thermodynamics, Ed. Wyley &Sons (1998)
Renaud GICQUEL - Systèmes Energétiques (3 volumes), Presses des Mines Paris Tech (2009)

Keywords

applied thermodynamics, heat exchanger, exergy balance

Links with other programmes

Gas dynamics, Turbomachinery, Energy management in automotive applications

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	8 hrs	22 hrs	0 hrs	0 hrs

THERMODYNAMIC OF ENGINES

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Alain MAIBOOM

Objectives

This course has two main goals:

- Provide core knowledge on internal combustion engines, with a focus on thermodynamic aspects
- Characterize the cycles and behavior of gas turbines and steam cycles used in electric power plants.

Course contents

The syllabus with regard to piston engines is as follows: historical perspective, thermodynamic and mechanical principles, technological aspects; types of engine; engine geometry performance and efficiency; applications, hybridation, energy recovery; intake and exhaust system; supercharging and turbocharging; emission reduction; cooling, lubrication and friction.

With regard to gas turbines (GT) and steam turbines (ST) the course focuses mainly on thermodynamic cycle description and exploitation (Carnot, Joule for GT, Rankine, Hirn with/without overheating, steam extraction, supercritical cycles). Real cycles are also described (irreversibilities, pressure losses) as well as means to increase performance (combined cycles, cogeneration).

The course includes practical exercises on performance and efficiency evaluation.

Please note that fuel systems and combustion processes of these thermal machines are covered in the Combustion and pollutant emissions course. The fundamental aspects of gas dynamics and turbomachinery are addressed in the Gas Dynamics and Turbomachinery courses.

Course material

J.B Heywood, Internal Combustion Engines - Fundamentals, Mac Graw Hill, 2011
W.W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 2003

Keywords

Performance and energy conversion efficiency, system interaction

Links with other programmes

Applied Thermodynamics, Combustion and pollutant emissions, Gas Dynamics, Turbomachinery.

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	25 hrs	5 hrs	0 hrs	0 hrs

PRACTICAL WORK

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: François ROIGNANT

Objectives

Understanding from a practical point of view the fundamental and technical aspects presented in the other courses of the autumn semester by undertaking practical work on machines.

Course contents

Practical exercises are conducted using the following machines:

- Airconditioning
- Heat pump
- Thermal solar pannel
- Turbine
- Energy conversion (fuel cell)
- Parameter identification on a heat exchanger
- Tuyere
- Combustion in a boiler
- Fan
- Internal combustion engine

Course material

Keywords

Measurement, practical work

Links with other programmes

Applied thermodynamics, Combustion and pollutant emissions, Turbomachinery, Thermodynamic of engines, Conventional energies, Low-carbon energies, Transport - storage - conversion - energy management, Heating and air conditioning systems.

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	0 hrs	0 hrs	32 hrs	0 hrs

CONVENTIONAL ENERGIES

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Thierry JASZAY

Objectives

This course provides a broad overview of the different types of conventional energy.

Course contents

Part 1 (16 hrs) intervention by M. Postaire (engineer at the EDF nuclear power plant of Chinon): fundamental aspects on nuclear energy, technical aspects for the control of a nuclear reactor for electric production.

Part 2 (10 hrs) Presentations on:

- Oil - History of consumption, current global situation in terms of production, consumption and resources, prices, prospects. Shale oil.
- Gas - History of consumption, current global situation in terms of production, consumption and resources, prices, prospects. Shale gas.
- Coal - History of consumption, current global situation in terms of production, consumption and resources, prices, prospects.
- Oil crises - History of crises since 1900. Origins and characteristics of the 1973, 1979, and 1986 crises. Geopolitical considerations. Global economic consequences. Prospects
- Hydraulic power - General working principles. Different dam types. Prospects.
- Geothermal energy - General working principles. Resources and examples. Prospects
- Concentrated solar power - General working principles. Examples. Prospects
- Biomass (except biofuels) - Sources. Different sectors. Mechanisation. Prospects.
- Bio-fuels - Production methods. Environmental impact. Assessment of well-to-wheel.
- Energy consumption in the future (world and France). Overview of current global energy resources. Forecasted consumption to 2020. Long-term problems posed by energy consumption and potential solutions. Prospects for the 2100s.
- Energy saving in the world and in France - Embodied energy. Energy control and energy saving certificates. Energy performance. Recycling and waste recovery (glass, paper, plastic etc). Examples.
- Carbon collection and storage - Different collection methods.

Part 3 (4hrs): post-treatment of pollutant emissions from thermal power plants

Course material

Keywords

Nuclear energy, nuclear fission, conventional energies, post-treatment of pollutant emissions from thermal power plants

Links with other programmes

Applied Thermodynamics, Thermodynamic of engines, Combustion and pollutant emissions, Low carbon energies

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	**3**	**30 hrs**	**0 hrs**	**0 hrs**	**0 hrs**

PROJECT 1

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Alain MAIBOOM

Objectives

To be involved in a collaborative project (2/3 students) on energy engineering.

Course contents

Examples of previous projects:

- Design, manufacturing and experimentation of an air solar collector
- Study of inter-seasonal heat storage
- Study of a concentrated solar collector
- Study of a CHP system with combined cycles

Course material

Keywords

project, experiments, calculation, predimensioning

Links with other programmes

All the courses of the specialisation.

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	1	0 hrs	0 hrs	0 hrs	32 hrs

LOW-CARBON ENERGIES

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Alain MAIBOOM

Objectives

This course presents an overview of low-carbon energies.

Course contents

Part 1 (10hrs): intervention by Mr. Hernigou (Cohérence Energies) on wind power
Part 2 (8hrs): intervention by Mr. Joubert (IMN) on fuel cells
Part 3 (4hrs): intervention by Mr. Babarit (LHEEA) on marine renewable energy - wave power systems
Part 4 (8hrs): intervention by Mr. Saab (Valéo) on energy management and CO2 reduction from vehicules

Course material

Keywords

Low-carbon energies, wind power, fuel cell, marine renewable energy, CO2 reduction from vehicules

Links with other programmes

Applied Thermodynamics, Turbomachinery, Conventional Energies

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	30 hrs	0 hrs	0 hrs	0 hrs

TRANSPORT - STORAGE - CONVERSION & ENERGY MANAGEMENT

ENERGY PRODUCTION AND MANAGEMENT, ENGINEERING PROGRAMME SPECIALISATION
AUTUMN SEMESTER

Professor: Thierry JASZAY

Objectives

This course presents the issues associated with managing, transporting and storing energy.

Course contents

Part 1 (4hrs) - intervention by Ms. Ponsot-Jacquin (IFPEN) on technologies for energy storage
Part 2 (8hrs) - intervention by Mr. Bondon (RTE) on electricity transport
Part 3 (4hrs) - intervention by Mr. Contreau (GDF Suez) on smartgrids
Part 4 (6hrs) - intervention by Mr. Dedieu (GRT Gaz) on gas transport
Part 5 (4hrs) - intervention by Mr. Le-Du et Ms. Lefrère (CEREMA) on heat networks

Visit of the RTE electricity dispatch centre in la Chapelle-sur-Erdre.

Course material

Keywords

Electricity transport, dispatch, gas transport, smart grids, heat networks

Links with other programmes

Applied Thermodynamics, Conventional Energies, Low Carbon Energies

LANGUAGE	ECTS CREDITS	LECTURES	TUTORIALS	LABO	PROJECT
French	3	30 hrs	0 hrs	0 hrs	0 hrs