1SC2491 – Study, modelling and experimental validation of a wirless energy transfer system

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Department: DOMINANTE - ENERGIE
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00

Description

This course was created in collaboration with the company Renault and theVedecom institute. The subject matter is the modelling and sizing of an inductive wireless power tranfer charging system. Emphasis is made on the magnetic coupler. In parallel to the functional aspects of the charging system, the problem of user exposure to magnetic fields will also be explored. This public safety issue will be treated by proposing solutions which may reduce the magnetic field emitted by the system in order to conform to the applicable norms. The envisaged modelling approach must take into account the different aspects of the posed problem (system geometry, material properties, sheilding, alignment, environment, ...). The proposed methodology will take advantage of a combination of modelling tools for electromagnetism (COMSOL) and other software for circuit analysis (LTSpice and matlab/Simulink).

Quarter number
ST2

Prerequisites (in terms of CS courses)
The elective course "electric energy" is recommended

Syllabus

- Modelling of a magnetic coupler
  - Use of comsol to model a magnetic coupler taking into account its physical and geometrical properties
  - Establish a modelling method for the determination of the parameters of the equivalent electric circuit
  - Experimental validation
- Construction of a model circuit for wireless power transfer system
  - Determination of the compensation mode and calculation of the values for capacitors

- Analysis of the results obtaiend by simulation - LTSpice or Matlab/Simulink
- Study of the power converter (inverter)
- Analysis and validation of the results
- Determination of the energy efficiency

- Study of electromagnetic radiation
  a. Determination of electromagnetic radiation using Comsol
  b. Study of the impact of the field on health
- Experimental Study
  - Utilisation of a test bench for validation of the results obtained from the modelling
  - Measurement of the magnetic field

Class components (lecture, labs, etc.)

This course will take place in the format of a student project with groups being constituted during the first session. Session 1 and 9 will be take place in the classroom while the other sessions will be held in the nergy department's teaching laboratory.

Session 1 : Presentation of the subject and project specifications
Session2 : Literature search on inductive wireless power transfer systems and the different approaches to modelling those systems
Session 3-4 : Modelling (both analytical/numerical) of the coupler
Session 5-6 : Study the compensation of the reactive power and the type of the converter to be employed.
Session 7 : Study the electromagnetic radiation
Session 8 : Experimental validation
Session 9 : Delivery of final report and student presentations before the teaching team and industrial partners

Grading

The students will be evaluated based on their final reports and their oral made in the final session.

Course support, bibliography

handhout

Resources

Teaching team : Mohamed Bensetti (CentraleSupélec), Amir Arzandé (CentraleSupélec), Mike Kirkpatrick (CentraleSupélec), Bruno Lorcet (CentraleSupélec), Ingénieurs de recherche (Renault et Vedecom).
Software tools: Comsol, matlab and LTSpice
Laboratory equipement: test bench + measuring devices (LCR Meters, Impedance analyzer, scope, ...)

Learning outcomes covered on the course

At the end of this course, students will be able to:

- Modelling of magnetic coupler for the determination of electrical parameters.
- Use and implement appropriate models to solve electromagnetic problems.
- Study of electromagnetic radiation of a magnetic coupler.
- Modelling of wireless power tranfer charging system from the source to the load.
- Validate and analyze the results obtained by modelling with experimental results.

Description of the skills acquired at the end of the course

C1.1: Study a problem as a whole and an overall situation
C1.2 : Identify, formulate and analyze a problem in its scientific, economic and human dimensions
C1.3 : Use and develop appropriate models, choose the right modelling scale and the relevant simplifying hypotheses to deal with a problem
C2.1 : Thoroughly master domain or discipline based on fundamental sciences or engineering sciences.