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Christian EUGENE*

WHAT AND HOW TO TEACH AT THE UNIVERSITY LEVEL IN A BASIC ELECTRICAL MEASUREMENTS COURSE THROUGH A PROBLEM-BASED LEARNING APPROACH ?

Abstract

INTRODUCTION

A completely new engineering curriculum has been introduced in 2000-2001 at our University with a modern pedagogical approach, the keywords of which are problem-based learning, project-based learning, active learning. The lecture will, as an introductory part, present the why's, what's and how's of this revolution.

This new context of teaching, which privileges the knowledge acquisition through practice better than theory, certainly favours creativity and especially motivation. But consequently, the place for formal, traditional courses is reduced to a small portion of the curriculum.

It is in particular the case for the courses in electrical measurements and instrumentation, of concern in this lecture, in the new curriculum of students in electrical engineering. Furthermore, the necessary rigour inherent to any training programme in this discipline becomes difficult to achieve in a pedagogical method enhancing the selftraining.

It is in this context of limited time budget that a recentering is needed on what is essential to keep in a basic training in electrical measurements and instrumentation for every student in electrical engineering. A rapprochement with the course of electrical circuits is also a new accent to be emphasised.

The lecture will draw up a list of uncircumventing topics which will be commented often through very simple examples. Only low frequency measurements (below 1 MHz) are here considered.

* Laboratory for Electrical Measurements and Instrumentation, Catholic University of Louvain, Louvain-la-Neuve, Belgium, Correspondence address: C. Eugène, UCL, Departement ELEC, Maxwell Building, B-1348 Louvain-la-Neuve, Belgium, fax 00-31-10478667, e-mail: eugene@lei.ucl.ac.be

The second part of the lecture will emphasise a new programme of laboratory exercises recently developed in connection with the basic course in electrical measurements reorganized around the new pedagogy. Choice has been made to put the accent on the first laboratory session of this course, for its originality and its richness from an educational point of view (a lot of the basic topics mentioned in the list given in the first part is covered), though using modest equipments and instruments. It is furthermore problem-based learning oriented.

AN EXAMPLE OF LABORATORY EXERCISE THROUGH A PROBLEM-BASED LEARNING APPROACH

Context

This laboratory exercise is the outcome of the first module of the course, devoted to basic industrial measurements. The capabilities the students must master at the end of this module are at the core of a basic training in electrical measurements and instrumentation. Here are a few keywords of these particular skills: loading effect of volt-, amp-, wattmeters and their correction, influence of harmonic distortion on the measurement accuracy depending on the functional principle of the meters, current and voltage transformers, experimental errors (propagation and treatment).

The thematic: correct use of usual measuring instruments in a non-linear context; application to the study of fluorescent tube

The classical fluorescent tube (TL tube) lighting our offices, with its iron ballast, is a remarkable non-linear device allowing both interesting mathematical developments and measuring observations at industrial frequency.

The pedagogical approach

The laboratory exercise is proposed according to a *problem-based learning approach.* The students have to plan an experimental session on a TL tube in order to evaluate if it is appropriate to dim the lamp (i.e. to reduce the applied voltage) from an economical point of view and simultaneously to evaluate the consequences of this dimming on the visual comfort and the pollution of the mains.

The programme

The following quantities are especially to be measured in function of the dimming: RMS current, RMS voltages at the input, at the tube and at the ballast, active power and power factor (at the input and at the lamp), current harmonic distortion, luminous flux...The students have not only to choose the most adequate instrument among a range of devices at their disposal but also to compare their results with those obtained with less adequate devices and justify the difference. The point is that the tube voltage is strongly non-linear (nearly of rectangular shape) with the consequence to also distort the current.

An important part of the student work is to corroborate these experimental investigations by some results obtained by a theoretical modelization of the installation. The analytical solution of this non-linear circuit is to be found (the help of a tutor is here necessary even with simplifications on the model) and interpreted.

The lecture will detail the different phases of this laboratory session. The most difficulties students encounter during this experiment and with the mathematical validation will also be outlined.