

Overview of the first year of the L3-EOLES training

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Abstract—This paper summarizes the key facts of an innovative e-learning training launched in september 2014 called L3-EOLES ("Electronics & Optics e-Learning for Embedded Systems") including a dedicated remote laboratory. It is important to emphasize that, to the author knowledge, this training is the first nationally-accredited training (and in 3 different countries) fully online in the field of Physics in the world. This is due to the development of a remote laboratory dedicated to the training and allowing students to perform practical works from any Internet connection.

Index terms—e-learning, remote laboratory, national accreditation, double degrees, electronics, optics, embedded systems.

I. INTRODUCTION

This paper aims to do an overview of the first year of an innovative fully online training : the L3-EOLES ([1]-[5]). This training corresponds to a third year of a Bachelor degree delivering 60 ECTS credits for the graduated students in electronics and optics focused on the topic of embedded systems. This training, build in the framework of a TEMPUS project is fully taught in English.

II. GENERAL INFORMATION ABOUT THE TRAINING

A. Training program

The training program, described in figure 1, contains 14 teaching units (TU) with 2 TUs in parallel all the year. The duration of each TU (in weeks) equals the number of ECTS credits given by the TU.

B. Degrees

Table I contains the list of the universities belonging to the EOLES project consortium and giving a Bachelor degree corresponding to the EOLES training, all these degrees being accredited by the national educational authorities of Morocco, Tunisia and France.

C. Number of students

Table II presents the number of students involved in the first edition of the training. All students living in Morocco and Tunisia are also enrolled at Limoges in a double degree process.

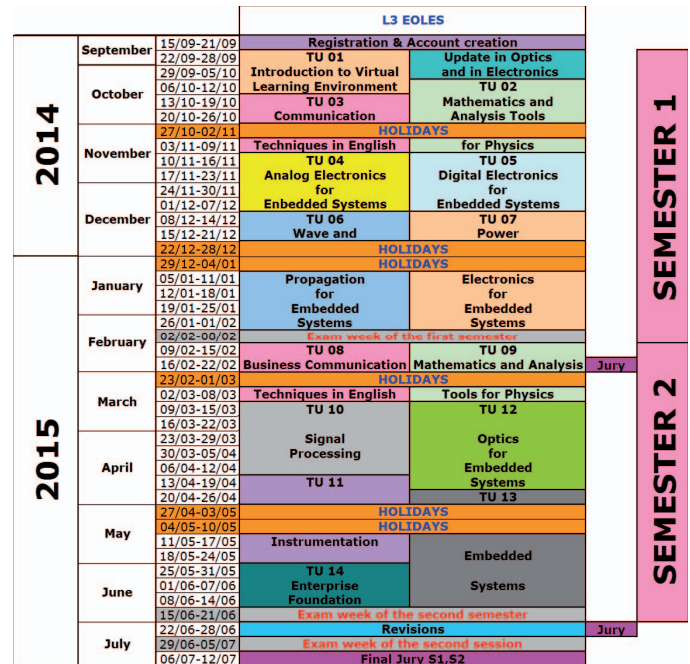


Fig. 1. Calendar of the training for the 2014-2015 edition.

TABLE I
LIST OF THE NATIONALLY ACCREDITED DEGREES CORRESPONDING TO THE L3-EOLES TRAINING

University	Degree
Kairouan (Tunisia)	Bachelor's degree entitled " <i>Diplôme de Licence Appliquée d'Electronique et Optique pour les Systèmes Embarqués</i> ".
Cadi Ayyad of Marrakech (Morocco)	Professional Bachelor's degree entitled " <i>Licence Professionnelle d'Electronique et Optique pour les Systèmes Embarqués (EOSE)</i> ".
Abdelmalek Essaadi of Tetouan (Morocco)	Professional Bachelor degree entitled " <i>Licence Professionnelle Electronic and Optic for Embedded Systems (EOES)</i> ".
Limoges (France)	Bachelor's degree entitled " <i>Diplôme de Licence Sciences Pour l'Ingénieur (SPI)</i> ".

TABLE II
NUMBER OF STUDENTS REGISTERED AND GRADUATED IN EACH UNIVERSITY

University	Registered students	Graduated students
Kairouan	1	0
Cadi Ayyad of Marrakech	10	5
Abdelmalek Essaadi of Tetouan	13	6
Limoges	25	11

D. Number of teachers

42 teachers corresponding to 13 universities among the 15 of the EOLES consortium which demonstrates a high interest and motivation of the teachers belonging to the EOLES consortium. It corresponds of a mean of 3 teachers by TU, which is reasonable and allow interactivity between teachers of different origins and culture.

III. REMOTE PRACTICAL WORKS

A. List of practical works

In the first year of the training, 6 practical works requiring hardware devices (low-frequency generator, oscilloscope, ...) have been developed and used in the training.

TABLE III
LIST OF HARDWARE REMOTE PRACTICAL WORKS IMPLEMENTED IN THE FIRST EDITION OF THE TRAINING

Teaching unit	List of the practical works
TU4 - Analog electronics	PW1 : Characterization of a passive linear two-port network PW2 : Static characterization of a bipolar transistor
TU6 - Wave and propagation	PW1 : Time-domain study of a RG58 cable
TU7 - Power electronics	PW1 : Uncontrolled single-phase half-wave rectifier on various loads PW2 : Uncontrolled single-phase full-wave rectifier, the Diode or Graetz bridge
TU12 - Optics	PW1 : Photodiode practical work

It is also important to mention that some "virtual" practical works have been performed during the training concerning the use of professional software (Matlab, Labview) or computer programming (C-language). These virtual practical works are made available for the students thanks to the use of a remotely controllable application server. Moreover, five other practical works are planned to be implemented in the second year of the training.

B. Presentation of a practical work :

The description of the homemade solution involving a PC Duino containing a Node.js server is out of the scope of this paper. However, it is useful to present in figs 2-6 an example of practical work ("Uncontrolled single-phase half-wave rectifier on various loads") developed in the framework of the Power Electronics TU (TU7).

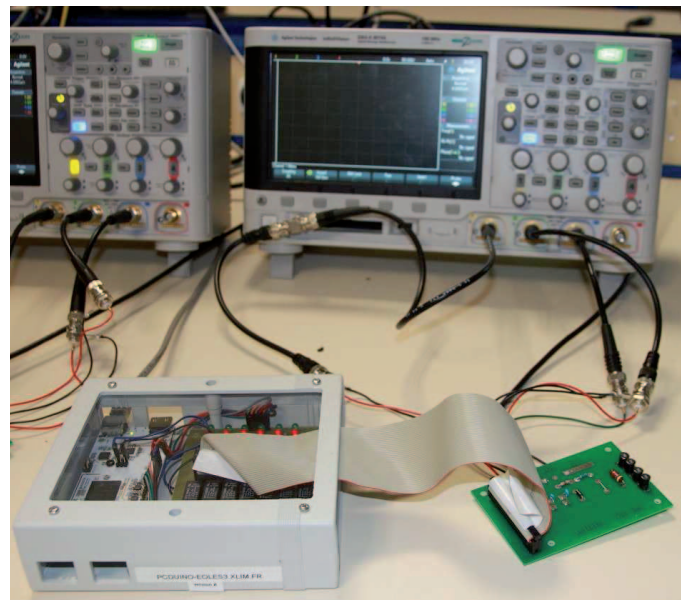


Fig. 2. Experimental hardware setup of the "Uncontrolled single-phase half-wave rectifier on various loads" practical work. This PW requires an remotely controllable oscilloscope including a waveform generator, a PC Duino box containing RF relays giving the possibility for any student to change the circuit configuration, a specific printed circuit board (in green) and some BNC cables and connectors.



Fig. 3. Screenshot of the remote front panel of the oscilloscope. Each authenticated student connected to the application server can then monitor this oscilloscope as a face-to-face student.

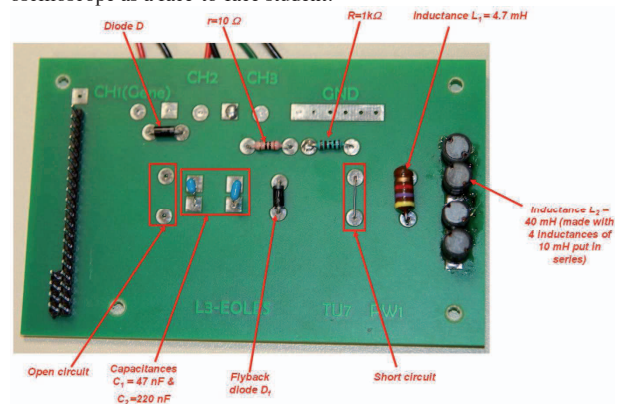


Fig. 4. Printed circuit board specific to this practical work.

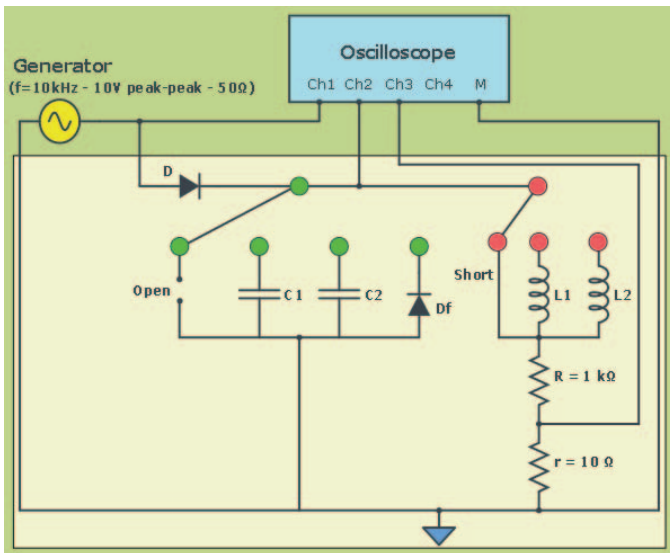


Fig. 5. Screenshot of the student webpage. The colored circle are possible connections potentially modified by the student. For instance, it is possible to put in series with the 1 k Ω resistance a short-circuit or two different inductances L1 and L2.

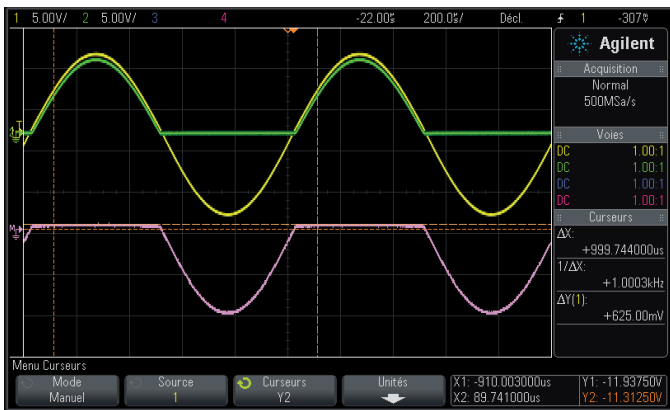


Fig. 6. Screenshot of the oscilloscope when the load is only a 1 k Ω resistance (in yellow : the voltage source, in green : the rectified voltage, in pink : the diode voltage).

C. Typical scenario of a practical work session

In this 100% online training, a practical work session follow this generic calendar :

- Stage 1 : in a synchronous session made online with Adobe Connect or Big Blue Button, the teacher describes the practical work and give to the students all the useful documents (description of the practical work, list of questions). All the links to the different devices and to the pages are given to the student.
- Stage 2 : during generally one or two weeks, each student has to make its own measurements on the different setups available online. It is important to note that each setup is available 24/7 during this period.
- Stage 3 : each student has to upload before the given deadline on the Moodle learning platform its report containing its own measurement results.

- Stage 4 : in a final synchronous session made few days after the deadline, the teacher details the correction of the practical work.
- Stage 5 : after this session, the teacher corrects and annotates the report submitted by each student.

Due to the reasonable number of students involved in the training and the fact that each practical work is available online on multiple setups, it is worth noting that no booking system has been implemented letting the student to book a time slot when he is the only one able to monitor the devices. This is planned in the future if the number of students increases.

D. Student assessment of the practical work quality

In order to assess the quality of the practical works developed for the Bachelor program, anonymous questionnaires (See Table VI) have been offered for students involved in the training some days after the end of each TU. The questions are listed in the following Table.

TABLE IV
LIST OF QUESTIONS OF THE PW QUALITY ASSESMENT QUESTIONNAIRE
(The right column corresponds to the mean grade obtained at each question, 13 students having replied to the questionnaire)

Q1	How difficult is it to have access to all the different elements of this practical work (getting all the links, going to the webpage, connecting to the instruments, connecting to the application server, practical work's availability, etc) ?	4 - No problem 3 - Few minor difficulties 2 - Quite difficult 1 - Very difficult	3.46
Q2	Are the provided documents for this practical work clear enough about what you have to do ?	4 - Very clear 3 - Quite clear 2 - Not very clear 1 - Not clear at all	3.38
Q3	How difficult is it to handle all the practical work's elements (webpage, instruments, etc) ?	4 - No problem 3 - Few minor difficulties 2 - Quite difficult 1 - Very difficult	3.15
Q4	How long did you take for this practical work's online experimentations (handling the webpage, handling the instruments, doing the measurements, etc) ? Be careful, your answer should be in minutes.	N/A	105 (1h45)

Q5	How long did you take to process the results and write this practical work's report ? Be careful, your answer should be in minutes.	N/A	133 minutes (≈2h15)
Q6	According to you, does this practical work match the theoretical concepts developed in this TU ?	4 - Yes, totally 3 - Yes, partially 2 - Not so much 1 - Not at all	3.54

IV. STUDENT ASSESSMENT OF THE TEACHING UNITS

In order to assess the quality of the teaching units of the Bachelor program, anonymous questionnaires (See Table V and VI) have been offered for students involved in the training some weeks after the end of each TU. The questions are listed in the following Table.

TABLE V
LIST OF QUESTIONS OF THE TU QUALITY ASSESSEMENT QUESTIONNAIRE

Q1	In your opinion, is the work plan of this TU clearly presented (1 : very unclear - 5 : very clear).
Q2	In your opinion, are the resources provided by the pedagogical staff sufficient in order to understand the theory to be acquired in this TU ? (1 : not at all - 5 : yes, definitely).
Q3	In your opinion, how are the availability and the reactivity of the pedagogical staff availability in general in this TU ? (1 : very unsatisfying, 5 : very satisfying).
Q4	What do you think about the difficulty of this TU ? (1 : very easy - 5 : very difficult).
Q5	On a global point of view, how do you evaluate this TU ?(1 : very bad - 5 : very good).

The following table contains the number of answers on the questionnaire of each TU and the mean grade given by the students. In addition, students were invited to write in a text area their answer to the following question : "Do you have any comment, remark or suggestion concerning this TU?". Thanks to this questionnaire, three main problems have been identified. First, students emphasize the lack of clarity of some TUs (4 & 12 in particular) and students emphasize the unreasonable required workload of some TUs (10 & 12 in particular). The pedagogical responsables of these TUs have been alerted and will try to remedy this problem during the second edition of the training. Second, some students had not sufficient background in Optics in their previous studies. This has led the concerned students to high difficulties in the TU 12 (see figure 1). In the second edition of the training, we have try to select students with theoretical background in Optics during the recruiting procedure. Third, an important problem concerns the fact that students had to do an internship of 6 weeks in parallel to the TUs of the second semester. This induces a considerable amount of work for the students during the internship leading to low results in TUs of the second semester. The calendar of the training has been modified in order to solve this problem.

TABLE VI
LIST OF QUESTIONS OF THE TU QUALITY ASSESSEMENT QUESTIONNAIRE

	Number of answers	Q1	Q2	Q3	Q4	Q5
TU01	11	3.9	3.7	4.4	2.3	4.5
TU02	14	4.1	3.4	4.1	3.6	3.7
TU03	9	4	3.6	3.4	2.2	3.6
TU04	7	2.9	3.1	2.4	4.3	2.6
TU05	9	3.4	3.3	3.6	3.3	3.4
TU06	8	4	3.4	3.9	3.5	3.8
TU07	6	3.7	3.3	3.8	2.8	3.8
TU09	8	3.3	2.9	3.4	3.5	2.9
TU10	10	2.4	3	2.8	3.6	3
TU11	6	2.8	3	3.2	3.2	3.2
TU12	6	1.7	2	2	4.5	2.2
TU13	7	2.9	2.7	3	3.3	3
Mean	8.4	3.2	3.1	3.3	3.3	3.3

V. CONCLUSIONS

This paper summarizes the main point of interests (number of accredited universities, registered and graduated students, teachers, practical works) of the first edition of an innovative training entitled L3-EOLES build in the framework of a TEMPUS project. As it is already written in the abstract, it is worth noting that, to the author knowledge, this training is the first nationally-accredited training fully online in the field of Physics in the world. This is due to the development of a remote laboratory dedicated to the training and allowing students to perform practical works from any Internet connection.

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REFERENCES

- [1] A. Fidalgo, M. Gericota, D. Barataud, G. Andrieu, R. De Craemer, M. Cristea, A. Benachenhou, M. K. Bouchlaghem, P. Ferreira, "The EOLES project remote labs across the mediterranean", Proceedings of the REV 2014 Conference, Porto, Fév. 2014, pp. 211 - 216.
- [2] A. Fidalgo, M. Gericota, D. Barataud, G. Andrieu, R. De Craemer, M. Cristea, A. Benachenhou, M. Ankrim, K. Bouchlaghem, P. Ferreira, "The EOLES project", Proceedings of the EDUCON 2014 Conference, Istanbul, Avr. 2014, pp. 943 - 946.
- [3] M. Gericota, A. Fidalgo, D. Barataud, G. Andrieu, R. De Craemer, M. Cristea, A. Benachenhou, M. Ankrim, K. Bouchlaghem, P. Ferreira, "EOLES course the first accredited on-line degree course in electronics and optics for embedded systems", Proceedings of the EDUCON 2015 Conference, Tallinn, Mar. 2015, pp. 403 - 410.
- [4] S. Farah, A. Benachenhou, G. Neveux, D. Barataud, G. Andrieu, T. Fredon, "Flexible and Real-Time Remote Laboratory Architecture Based on Node.js Server", Proceedings of the 3rd Experiment@ International Conference, Azores, June 2015.
- [5] S. Farah, A. Benachenhou, G. Neveux, D. Barataud, G. Andrieu, T. Fredon, "Real-Time Microwave Remote Laboratory Architecture", Proceedings of the European Microwave Week, Paris, Sep. 2015.