

## NEW TREND IN LABORATORY SESSIONS

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**Abstract** – Due to growing classes, reduced availability of tutors and shortage of time to be devoted to experimental activities, there is a need of finding a mandatory way of performing laboratory sessions. The advanced technologies allowing for a massive use of remote driven instruments could improve the quality of the experiments especially for what concerns the very specific high-level classes. In order to give flexibility and high performances to the educational tool a user friendly virtual instrument has been realised: it allows the choice of boot the experiment to be performed by the user and the procedure to be followed without loosing the contact with real instrumentation.

Keywords: Laboratory session, virtual instrument, remote driven devices.

### 1. INTRODUCTION

Undergraduate students can carry out some practical training by using driven measurement systems as well as by running simulation software. This approach can be very useful for beginners: indeed, they can test their theoretical knowledge, can perform a useful self-training and can acquire a limited hands-on experience with some problems correlated with the real-world experiment.

Nevertheless, real experiments with real electronic components and circuits, carried out by using advanced instrumentation, “are relevant to more accurate training and to providing a better feeling to students about measurement procedures and measurement system design” [1, 2].

In previous papers the authors proposed the results obtained by adopting some educational tools realised with the aim of enhancing the effectiveness of the experimental activity in the laboratory.

A first step was accomplished in order to reduce the boring waste of time for writing technical reports. At the end of the experimental work, the students must write an accurate technical report, in this way they are required to review the work just carried out and to analyse the involved theoretical aspects. This additional time can be reduced by using the tool that has been realised on purpose [3]. It has also been adopted in order to evaluate the interactive quality of the laboratory sessions.

The following step has been represented by a deep study on the possibility of controlling remotely connected real instruments [4]. In spite of the reduced flexibility of the implemented system, the increase of the availability of the laboratory has been emphasized.

On account of the already obtained results, in this work a new hardware/software tool has been implemented: it supports some tutorial assistance, reduces the loss of time due to rough inconveniences and represents a key point in the topic of realising remote laboratory sessions, which will be developed in a next future step.

In particular, in the paper a totally PC controlled board is presented; some suitable test circuits for carrying out experimental training of the undergraduates are at present implemented.

### 2. AN OUTLINE OF THE DEVELOPED SYSTEM

Standard experimental sessions include measurement on first-order and second-order systems, as well as frequency measurement and amplifier characterisation. For this purpose a suitable system has been developed; it consists of a motherboard that is connected to two function generators and a digital oscilloscope; the system is controlled by a dedicated software running on a personal computer.

The whole implemented system is sketched in Fig. 1.

The motherboard that includes the measuring circuits is aimed to perform suitable connections between these implemented circuits and the measurement devices (function generators and scope).

An user-friendly interface has been realised; it enables the user choosing the experiment to be carried out, among the programmed ones; moreover, the user can choose the mode that will characterise the laboratory session, the circuit parameters, the waveform generator that will be used to force the investigated circuit and the signals that should be sent to the channels of the oscilloscope.

As an example, the RC and RLC circuits have been implemented on the board. Some values of the resistor and of the capacitor are available in such a way that the user can suitably select the values of the parameters; it is well known that the correct choice of the values of the parameters will enable the user analysing the loading effects of the probe of the oscilloscope, as well as the effect of the internal resistance of the function generator.

As far as the second order system is concerned, the analysis of the effects of the values of R is very effective in the training activity.

In order to perform a test of the realised system, and moreover to verify the possibility of increasing the power of the motherboard, characterization of a simple amplifier and also frequency measurement on a circuit with fixed parameters are available.

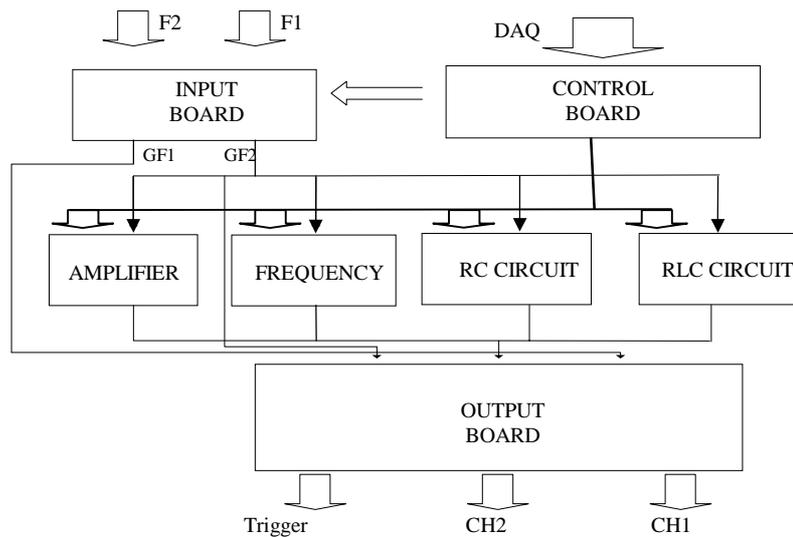


Fig. 1. A general view of the whole developed system for smart laboratory sessions.

Basic experiments can be performed by the users, therefore they can carry out the analysis of the chosen circuit on the domain of both the frequency and the time.

The software realised for this work consists of a virtual instrument, implemented in the LabVIEW™ environment that enables the student performing the management of the used instruments and the realised hardware.

It should be emphasised that the control of the instruments is performed via the IEE488.2 standard interface while the board is controlled by the digital port of a DAQ board installed in the PC and software managed.

The configuration panel of the software tool is reported in Fig. 2.

As it can be observed, the user can act on the dialog box in order to choose the experiment to be carried out (upper part of the left-hand site), the execution mode for the measurement session (upper part of the central site), the circuit configuration, the characteristics of the supplying signal and the configuration of the oscilloscope.

According to the previous considerations, for some circuits the values of the passive components can be chosen by the user, among few ones.

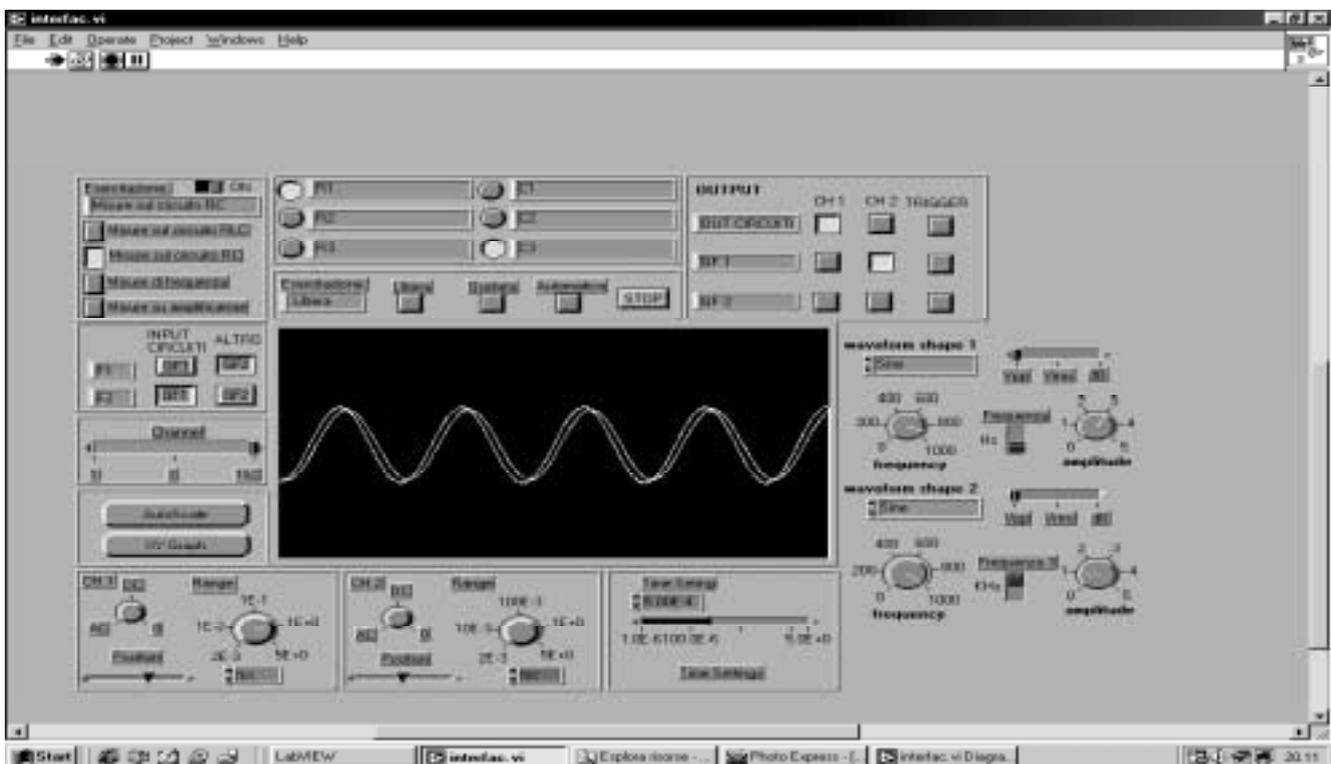


Fig. 2. The configuration panel of the software for the control of the developed board.

Indeed, the user can chose the execution mode among the driven one by himself, the one guided by the expert signal and that automatically performed by the software, the circuit to be analysed, the domain of the study (frequency or time) and the shape of the waveform of the signals supplied by the generator, and also the frequency and the values of the amplitude. Therefore the user can totally control the parameters of the function generators.

Moreover the user can choose the configuration of the scope channels (on the right site and the bottom part of the panel). The signals sent to the scope can be easily accessed by means of the waveform graph in the centre of the panel allowing for monitoring the rightness of the performed choices.

As an example, Fig. 2 shows the configuration panel in the case of a measurement session on the RC circuit.

As far as the user has made the preliminary choices (for instance in this particular case the experiment will be driven by the user), he can proceed to the choice of the resistor and the capacitor values, among the installed ones. The values have been chosen in order to emphasize the consequence of different time constants, as well as the known load effects.

Moreover, the user can choose the configuration of the signal paths from the waveform generator to the scope trough the RC circuits. At last, he can configure the forcing signal on the basis of the measurement target.

After the user had finished taking the complete set of the decisions, he can start carrying out the experiment by using the measurement panel. It enables the user to directly perform several kinds of measurement, both in the time and in the frequency domains, aimed to a deep characterisation of the device which should be investigated and to provide adequate training sessions.

In the frequency domain the Bode diagrams can be obtained. In the implemented system automatic variation of the frequency has been avoided, in order to improve the effectiveness of the training.

The time domain analysis of the RC circuit can be carried out by applying a square-wave at the input terminals: the values of both the time constant of the circuit and the rise time can be measured. Moreover, the effects of increasing the value of the frequency of the square-wave can be highlighted.

The tool is flexible and available for effective training sessions; indeed, the other implemented circuits can be analysed in an analogous way. The realised interface is user-friendly and can be easily improved.

The used hardware has been modified and improved step by step. At beginning simple circuits with fixed components have been implemented; on account of the promising results already obtained, a more flexible motherboard has been designed and a new model will be soon realised. In Fig. 3 a recent hardware structure is shown.

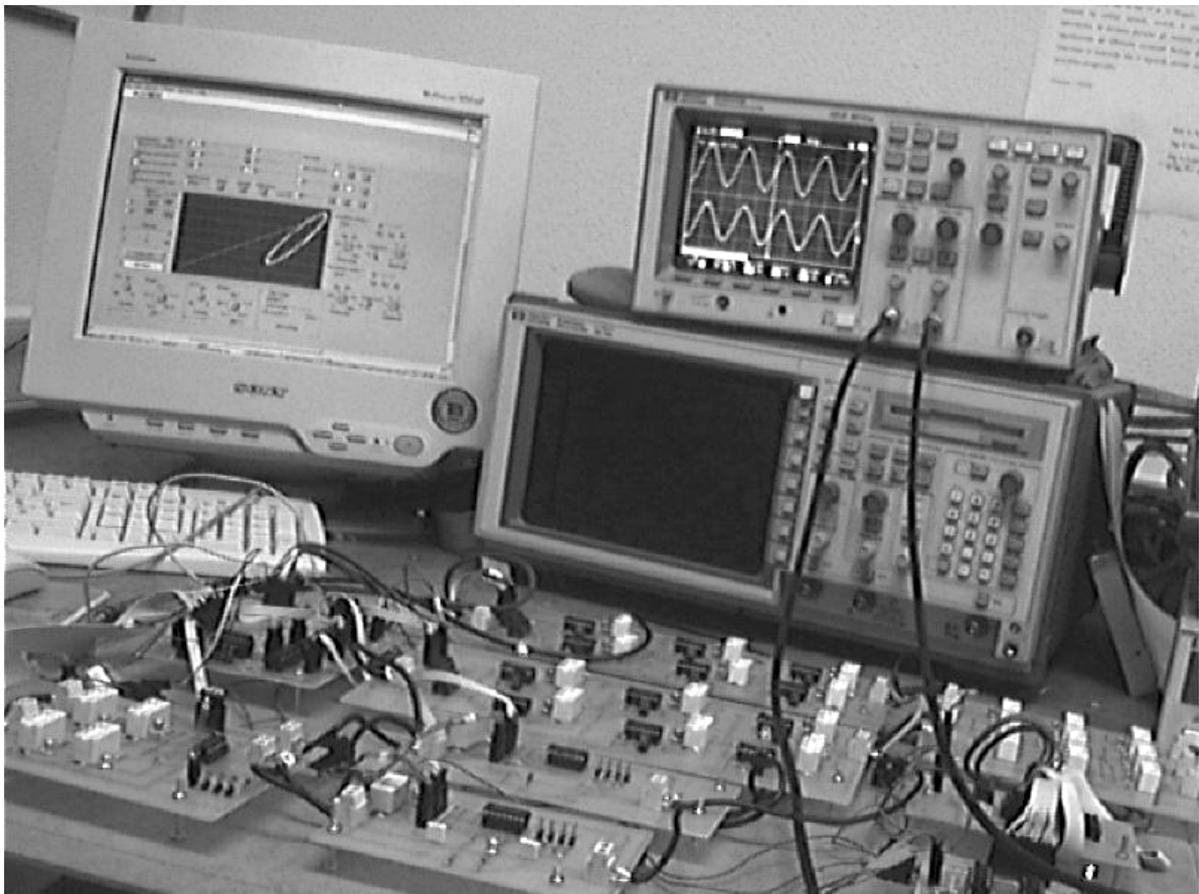


Fig. 3. An overview on the used hardware.

An experimental laboratory session is going on, the RC circuit is analysed, as it can be noticed by the reported plots on the figure. It is shown that also the phase analysis can be carried out.

### 3. CONCLUSIONS

In a step-by-step developing work, a recently realised motherboard has been presented; it includes some circuits that will be used for carrying out classical experiments, for an accurate training of undergraduates. Indeed, some difficulties stress the reduced availability of the lab. In particular, the system can help the user overcoming the lack of tutors.

To drive the various pieces of the used hardware suitable software has been implemented. The main features of the system have been analysed in some details. The hardware as well as the software can be easily modified and upgraded.

The work is in progress: the next development is represented by the implementation of a system for distance

learning; this system will drastically improve the availability of the laboratory. Moreover, other test circuits can increment the set of circuits that can be analysed. Of course, the used instruments can be replaced by new ones.

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