# A VIRTUAL LABORATORY FOR ELECTRICAL ENGINEERING COURSES

**Sofronie Stefanescu**

*University of Pitesti- Romania*

Email:sofstef@rdslink.ro

## ABSTRACT

The Curriculum and the employed methods in Technical Universities Education have to be permanently adapted to correspond to the necessities and to benefit from the existent technological opportunities.

The increasing power and availability of software and hardware on personal computer (PC) has already begun to change significantly the way engineering subjects are taught and learned.

We describe a software-based Laboratory, known as Virtual Laboratory (VL), which we designed to assist and advance Learning efficiency in electrical engineering programs. The paper has the goal to present the undertaken efforts and the obtained results in the modernization of the Signal, Circuits and Signals (SCS) course taught at the University of Pitesti designing the VL, which is we use continuously since 1998

***Index* Terms**- *Virtual Laboratory, Computer based Laboratory, Electrical Signals and Circuits*

## DESCRIPTION

The Computer use in didactical process is not at all a new activity, but the domain is in permanent development.

On recommend that the theoretical information would be as large as possible but one has to taking into account that those applications should be accomplished with minimal difficulties. The selected solution for the SCS course consisted in an integration to the maximal extent of the Laboratory works and Seminary applications with the course lessons. To efficiency increase of this activity we introduced, as much as it was possible, the Computer use. The base idea was that the students should complete in the frame of Laboratory works the SCS study and the characteristic parameters visualization. The first problem consisted in the selection of used Computer Programs . After an analysis we concluded that for the purposed aim are not suitable the very advanced programs, in

which one need just to input the data needed for obtaining the results expected from the program. In this case the students would learn only the Computing Programs use. We decided therefore to use those Computer Programs in which the student participation is maximal possible. Based on the above principle we adopted the use of Mathcad and Spice Programs.

The Mathcad program corresponds to the proposed objective, because it offers the major advantage of employing a writing manner of the mathematical relations, which is very close to the one of current use. We preferred to determine the students to accustom not only with the Computer Programs use, but also with the effective elaboration of such programs. It is obvious that this kind of students' preoccupations should be encouraged, because it contributes to attract the students towards creative activities.

There are two relatively distinct parts: a first one referring to the study of Signals, which has as main objective "Fourier Integral and Fourier Series"[1], and a second one, referring to the study of Electrical Circuits and Systems [2].

For both parts study we considered that the evolution of electronics has lead to the development of measuring devices embedding computers for processing digitally the input signals and displaying the obtained results. We succeeded to simulate input signals of very different forms and in an amount as large as necessary. While processing these signals it is possible to accomplish summing, multiplication and introducing different phases, which would be for real, conventional measuring devices if not impossible, at least very difficult to achieve.

For a study as efficient as possible of the "Electrical Circuits and Systems" relying on laboratory works we have decided not only to design the proposed circuits and systems, but also the emulation of their behavior. We have envisaged permanently to evidence that computing performances of the Mathcad application were constantly similar to the ones obtained from the Spice application.

## LIST OF THE LABORATORY WORKS

First Part :1) Sinusoidal Signal, 2) Discrete spectrum time function 3) Amplitude modulation
4) The phase and its effects ,5) Fourier Integral - Fourier Series,6) Uncertainty principle 7)Spectrum of sampled functions

Second Part : 1) Derivation and integrating circuits 2) Bode Diagrams 3) Project and testing of RC uniport circuits 4) Study of resonant circuits with losses 5) Designing and Testing of Amplitude Equalizer 6) Designing and Testing of LC Tchebishev Low Pass Filter ,7) Designing and Testing of Band pass filter .

***Example.***

Let p(t) be a Dirac pulse train function (sampling or comb function) as is illustrated in fig 1a.[1]

$$p(t) = \sum_{k} \delta(t - k.T) \qquad (-\infty < k < \infty) \qquad (1)$$

*T is the interval between Dirac pulses and k is the pulse number*

The p(t) Fourier transform is the F(ω )spectrum function given by :

$$F(\omega) = 1 + \sum_{k} \left( e^{jkT\omega} + e^{-jkT\omega} \right) = \frac{\sin\left[ (2k+1) \cdot \pi \cdot \left( \frac{\omega}{\omega_0} \right) \right]}{\sin\left( \pi \cdot \frac{\omega}{\omega_0} \right)} \qquad (2)$$

Using the Mathcad program we obtain for k=1, k= 2 and k= 9, the spectrum functions illustrated in fig 1 f),1g) and 1h)

If $k \Rightarrow \infty$ then the impulse train becomes a sampling function in the ω domain,.given by (3) and represented in fig 1b ::

$$F(\omega) = \omega_0 \cdot \sum_{k} \delta(\omega - k\,\omega_0). \qquad \omega_0 = \frac{2.\pi}{T} \qquad (-\infty < k < \infty) \qquad (3)$$

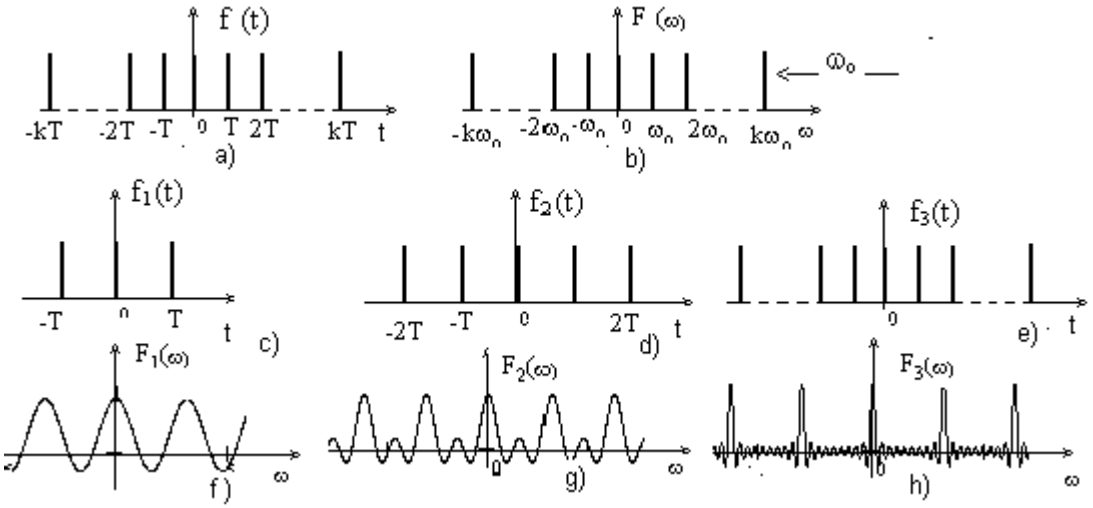


Fig 1

*From the represented spectrum functions we conclude:*

*-the pulse amplitudes in the ω domain is proportional with the pulses number k*

*-the pulse widths is inverse proportional with k*

*-the spectrum function F(ω ) of the sampling function p(t) (1) is also an sampling function (3) represented in ( fig 1b )*

## CONCLUSIONS

The computer use in the educational process is not a task without difficulties. If today the endowment, due to the PC relatively accessible prices is not a big task, but specialized didactic staff who can draw up the didactical courses is a serious problem.

For writing lessons which use computer in educational purposes (as Virtual Laboratory) it is necessary that the author be specialist in domain (SCS in our case) and is well familiarized with IT. The content of a Laboratory work is not possible to be write in a conventional form and entrusted to an IT professional to be adapted for Computer use.

In principle they are the possibility of a collaboration between a domain specialist and the IT specialist., but due to the absence of a common language the obtained results proved to be not very encouraging. The solution is the accumulation of required IT knowledge by the domain specialist.

The technical literature abounds with general information referring to new IT technologies and those advantages but we observe that are little information regarding the adopted practical solutions.

The University has not the financial possibilities to achieve the necessary modern and expensive measuring instruments;

The VL allows us to elaborate very sophisticated and well illustrative solutions. It is hard to imagine real instruments that generate so many signal and signal types for the analysis and synthesis purposes.

The VL is well suited for e-Learning .

## REFERENCES

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