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Classroom, laboratory and WWW integration in teaching Telecommunication Fundamentals - initial experiences, plans and vision

The collaborative efforts to construct vessels and shelters are now replaced by collaborative efforts to solve the unique problems faced in a rapidly changing world where a person is measured not by what she knows, but by how well she can solve problems. Thus we need new ways of communicating, new ways of collaborating, and new ways of teaching and learning.

http://oii.org/html/communication_collaboration.html

1. Introduction

It is possible to treat a higher education curriculum as a project, three months long, with a goal - student passes the final exam of a study subject. Persons involved may be grouped in faculty staff including a teacher (or a few of them) and students (few of them up to hundred or more). Educational process is not possible without intra and inter **communication** between two parts involved, **co-ordination** performed by administration and teacher, and a certain degree of horizontal and vertical **collaboration** among all of them. This is a classic drama, a few centuries old, repeating each year since the first university was founded.

Distance learning is not a new phenomenon, either. With the development of the postal service in the 19th century, commercial correspondence colleges provided distance education to students across the country. This trend continued well into the 20-th century with the advent of radio, television, and other media that allowed learning at a distance. In the last decade, distance education has changed significantly with the use of computer-mediated learning, two-way interactive video, and a variety of other combined technologies.

What has changed in the meantime?

Internet!

New faculties, studies, curriculum...

But, what's new in teaching technology and organization?

WWW, is it the new momentum that will start the revolution?

Are we involved without being notified? Are we standing high enough to see what is happening, where we are going, what obstacles are in front of us, beyond a bend?

Internet is relatively a new communication media. Some people are euphoric with its widespread power, other are skeptic.

So, don't talk too much, let's try and see!

That was an idea a few years ago, and here are some initial results. Why initial? A lot of reasons exist. The most important one was a lack of critical mass of PC-s available to students and teachers. Asymptotic, ideal standard is when each student has a PC (laptop!) with Internet access at home or campus, and an individual workstation (PC) in the laboratory.

Curriculum of Telecommunication Fundamentals as most of curriculum on technical engineering studies consists of three components: theory, numerical examples and laboratory exercises.

As usual, theory is realized ex-cathedra, in front of a blackboard, under the overhead projected graphs, tables, diagrams, or PowerPoint version of the same documents. The teacher is face-to-face with a few tens, up to more than a hundred of students, with broad spectrum of motivations, so communication is single-way and broadcast like. Only feedback available is visual, and occasional questions, usually rhetoric and not serious.

Similar situation is during "auditory exercises"

With laboratory exercises situation is quite different. Lack of laboratories, sophisticated electronic instruments, time and teachers on one side, and enormous interest of students on the other. Nobody is missing, even without any evidence, everybody is trying to be active and in the "first line" in direct contact with experiment in progress. In certain laboratory exercises such a situation is real, but then a new problem arose: different pace of individual student. But, because of previous lacks, most of students were slightly disappointed. So, the intention to implement some distance learning elements was not motivated with **distance** by itself, but with possibility of asynchronous, self paced approach to certain parts of laboratory exercises, especially those devoted to computer simulations and calculations, sometimes in the form of introduction to real measurements.

2. Project - Seamless integration of analytical and numerical models, simulation and experiment in digital signal transmission analysis

2.1. Analytical model

Circuit diagram (graphical model) for analytical model of the simple RC low-pass filter is presented in fig.1. Intention is to find a response of the circuit on different stimulus.

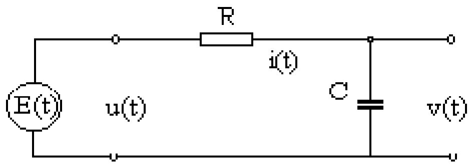

Fig. 1 RC low-pass filter

From I. Kirchoff's law, we have

$$v(t) + R \cdot i(t) - E(t) = 0 \qquad (1)$$

where the current is $i(t) = C\dfrac{dv(t)}{dt}$ (2)

By substituting (2) in (1), we get the well known RC circuit differential equation:

$$v(t) + RC\frac{dv(t)}{dt} - E(t) = 0 \qquad (3)$$

Solving the equation (3) for step function stimulus E(t) = E, we get:

$$v(t) = v(t_0)\exp(-\frac{t-t_0}{RC}) + E\left[1 - \exp(-\frac{t-t_0}{RC})\right] \qquad (4)$$

For a periodic bipolar pulse train stimulus (Fig. 2), equation (4) is implemented with input signal $E_1(t)$= 1 V and $E_2(t)$= -1 V.

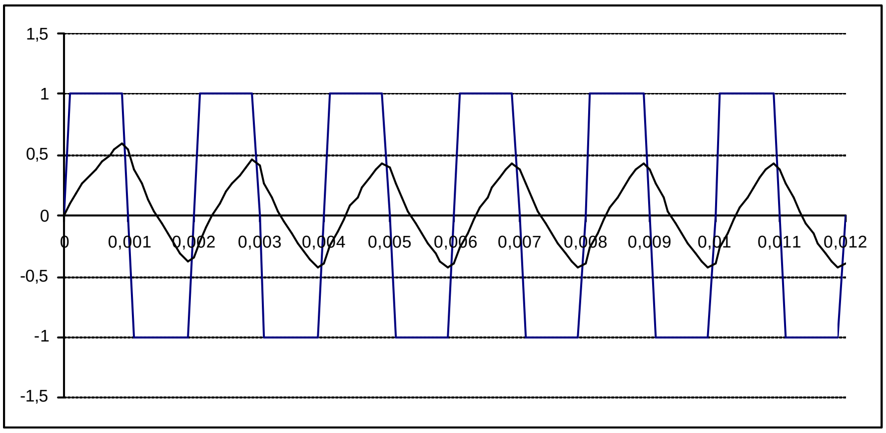

Fig. 2 Periodic bipolar pulse train input, and saw-tooth output signal

2.2. Numerical model

For a harmonic signal stimulus (Fig. 3), we have steady-state harmonic output signal with amplitude determined by R-C voltage divider (Fig. 1):

$$\frac{V}{U} = \left| \frac{1}{1 + jwRC} \right| \tag{5}$$

Let R = 10 kΩ, C =0,1 μF.

$$\frac{V}{U} = \left| \frac{1000}{1000 + jw} \right|$$

For sinus signal with amplitude U=1 V and frequency f=1 kHz, from (5), we have:

V = 0,1572 V

From fig.3, one could find that in steady state, output signal amplitude is about 0,15 V. In calculation tables, we find amplitude of V=0,1577 V.

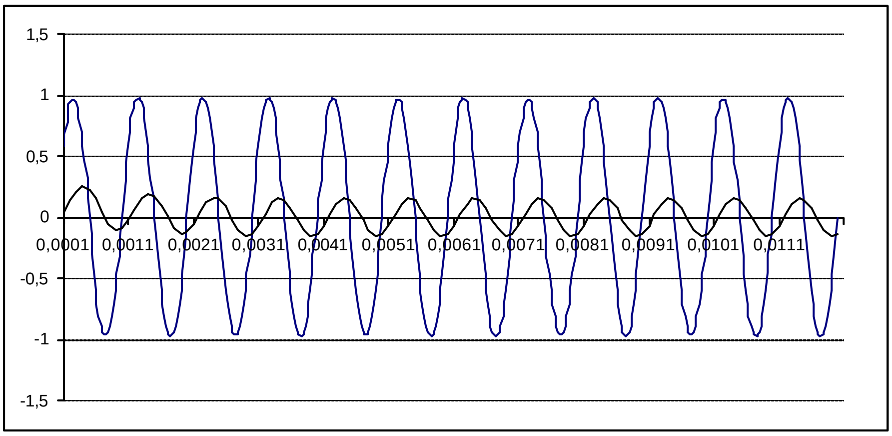

Fig. 3 Harmonic input and output signals calculated by MS Excell

2.3. Simulation

As a suitable simulation tool CircSolv was chosen. Based on P-Spice and with graphic user interface, it seemed that optimal solution was chosen. The following results are obtained:

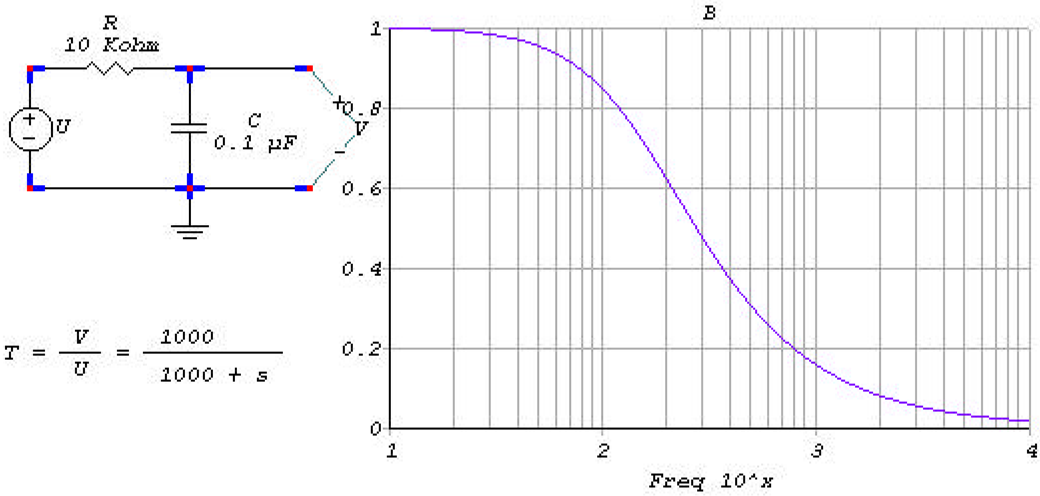

Fig. 4 RC circuit, transfer function equation and amplitude characteristic graph

At frequency 1 kHz (3. decade) transfer function modulus is about T=0,17.

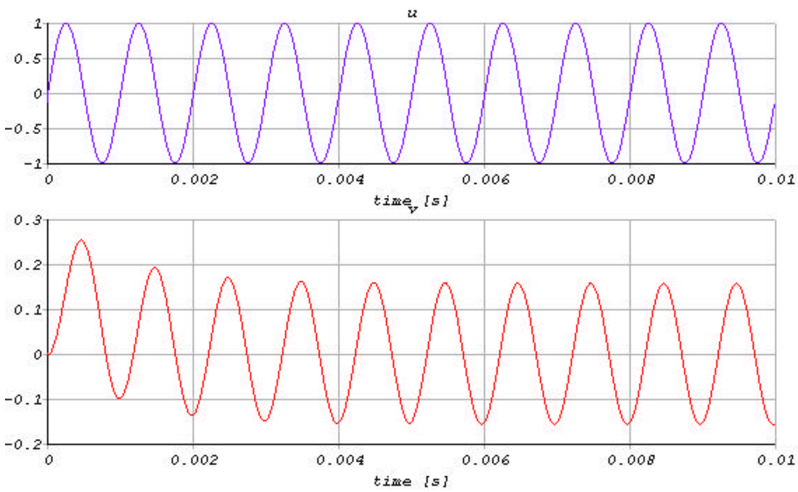

Fig. 5 CircSolv results: harmonic input and output signals, f=1 kHz

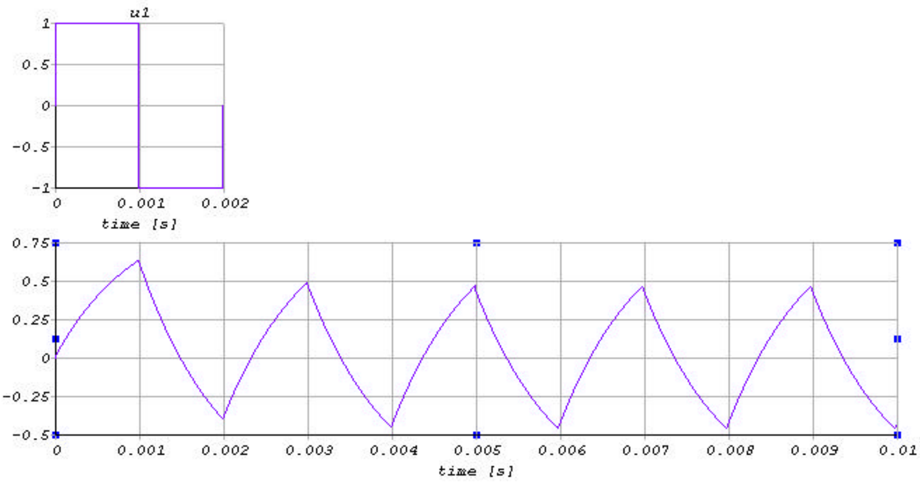

Fig. 6 Periodic bipolar pulse input, and saw-tooth output signal f=500 Hz

2.4. Laboratory experiment

As a third anchor, laboratory experiment is performed. Input signal from function generator was applied to RC circuit.

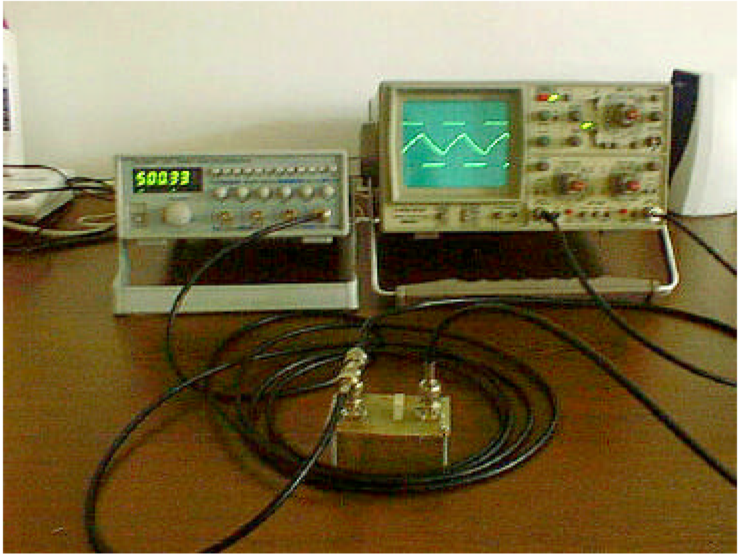

Fig. 7 Experiment setup: Function generator, RC filter and scope

Input and output signals were observed by analog scope (fig. 8).

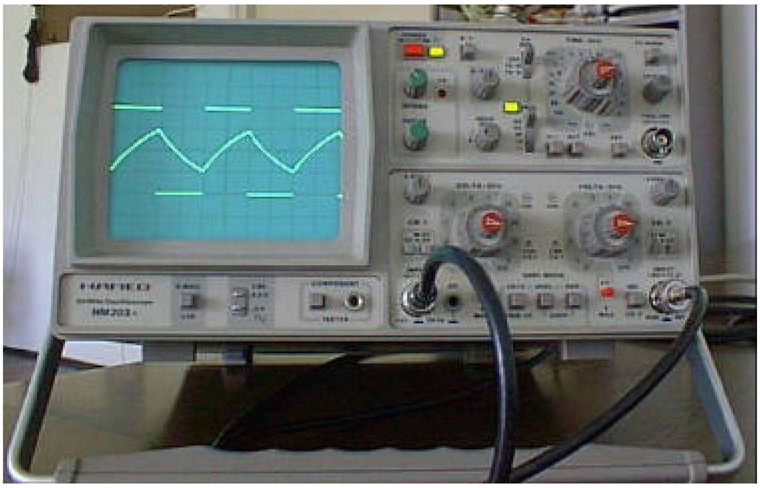

Fig. 8 Experiment: Periodic bipolar pulse train input, and saw-tooth output signal f=500 Hz

It is evident that great degree of agreement between theory, simulation and experiment is achieved. So, in further investigation of digital signal transmission, it is not necessary to perform all four type of models: analytic, numeric, simulation or experimental, it is possible to use only the most suitable one.

That was a shortened project resume, but where can we find WWW, Internet, communication and collaboration?

WWW as **library**:

1. WWW is the main literature source, for laboratory exercises on Telecommunication fundamentals and Telecommunication systems.
2. Simulation program CircSolv was picked up as share-ware on the Internet.
3. WWW was of great help in classical literature (books) searching too.
4. Certain books have "personal" Web pages with help for instructors and students, illustrations suitable for lecture notes or PowerPoint lectures, examples solutions etc.
5. It is possible to find a lot of Java applets suitable for animated presentations.

WWW as **communication** tool:

1. All communication between project participants was performed by electronic means. Internet (e-mail) was the most important media and floppies were used only in few occasions.
2. Laboratory exercises manuals and work sheets were published on the Web page.

And finally, where is the Web supported **collaboration**?

It is well known that in study subject development cooperation with students is of great help. It is not only the question of document technical preparation, but error correction, improvement of certain formulation, time planning etc. Final result: well documented exercise on digital signal transmission over UTP cable, was a result of such collaboration between the teacher and students. As mentioned before, most of communications was by Internet. Laboratory exercises and lecture notes were published on the Web.

3. Conclusion

Collaboration over Internet is possible only if certain project already exists (1st C of C^3)[1]. Project has to be computer supported and communication dependent.

Dynamics of communication and its kind depends on project organization, especially on the degree of participant synchronization. Sometimes communication is independent and asynchronous, or interdependent with mediator activated communication sequences. Other possibilities are synchronous or simultaneous communication (virtual conference, virtual

[1] Content, creativity and collaboration.

classroom or virtual laboratory). Best one, or optimal combination of different types, depends on the project nature.

Certain expectations about IP communication were remarked and proven. Internet is notoriously unreliable and random[2]... Today's Internet attempts to deliver all traffic as soon as possible within the limits of its abilities, but without any guarantees related to throughput, delay, delay variations (jitter) and packet loss ("best effort" paradigm)[3].

Even when the communication was asynchronous and of low intensity, the probability of message transmission depended on CARnet system availability, starting with LAN at Polytechnic of Zagreb, CARNet server at SRCE, HT ISDN System etc. It is evident that in the case of simultaneous (real-time, interactive) collaboration, communication availability and reliability has to be close to PSTN ("Five Nines"[4] - five minutes of downtime per year is fantastic!).

Close future:

A multi-level collaboration project. A project structured as a few sub-projects each of them performed by Web and Internet based communication. Best practical reason and motivation source for Internet communication is "green" one - paperless documentation.

Next future ?

A National collaboration project, organized and supported by CARNet?

Far future ??

A International collaboration project, organized and supported by CARNet?

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[2] Three Paradoxes of High Availability, Directions on Microsoft Update, June 2001.

[3] Towards an integrated solution for multimedia over IP, Alcatel Telecommunications review, 2nd Quarter 2001.

[4] Microsoft advertising campaign