Study Programme in Telecommunication Engineering – Student Laboratory Work

Zlatica Marinković

Abstract – **Practical work plays a very important role in the education of electrical engineers. For that reason, within the scope of the new curriculum in Telecommunication Engineering developed at the Faculty of Electronic Engineering in Niš, special attention has been paid to organization of the laboratory work. The developed curriculum has been supported by the European Commission curricula development project TEMPUS JEP 41112-2006. This paper focuses on the laboratory and practical work organized within two courses: Mobile Communication Systems and Optoelectronic Communication Systems, with emphasis on the exercises based on the equipment purchased from the project funds.**

Keywords – **Master Curriculum, Laboratory work, Mobile Communication Systems, Optoelectronic Communication Systems**

I. INTRODUCTION

People working in the field of electrical engineering education recognize practical work done by students that as a very important part of the studies. Eventhough the students get strong theoretical background during studies, their engineering skills are not complete without practical exercises. Well skilled graduated engineers are preferred as the labour worldwide. Students themselves recognize the importance of the practical training. In the official polls organized by the Faculty at the end of semesters and in the unofficial talks of the teaching staff and the students of telecommunications at the Faculty of Electronic Engineering (FEE) in Niš, the students have expressed their opinion that they needed „more practice“. Moreover, their comment „we need more practice“ is rather a request that just a comment. These are the reasons why special attention has been paid to organization of student laboratory and practical work during the development of the new master curriculum in Telecommunication Engineering at the FEE within the European Commission curricula development TEMPUS project „Development of Master Study Programmes in Telecommunications and Control“, [1].

The goals of organizing the student practical work have been to provide the students with the possibility of the following:

- working in laboratory conditions,
- becoming familiar with the equipment and
- using standard engineering software packages

According to the plan of the master program, almost all of the courses assume 1 class hour of the laboratory work per week, i.e. 14 class hours per semester. In practice, during the first year of the pilot program, laboratory exercises have been mostly organized in duration of 2 or 3 class hours - in total 10-14 class hours per semester.

The laboratory work has been organized in a different manner depending on a particular course. But the following four main categories of the laboratory work can be recognized:

- Updated earlier established laboratory exercises,
- Newly developed exercises based on the equipment existing in FEE laboratories,
- Newly developed exercises based on the equipment purchased from the TEMPUS funds,
- Software based exercises.

For the courses that are same or similar to the courses from the current study programme in telecommunications at the FEE, laboratory exercises established within the existing courses have been updated when possible and appropriate manuals have been written or updated.

Then, within certain courses new laboratory exercises have been developed exploiting equipment existing in the FEE laboratories.

Most of the work has been done in establishing of laboratory exercises based on the equipment purchased from the project funds and will be done in the future. The complete list of the purchased equipment can be found on the project web site, [1].

Laboratory work of most of the courses includes software based exercises. They are mostly related to standard engineering software packages but also to some specialized software packages depending on a field of a course. Practical work within some courses includes different interactive animated examples describing particular topics covered by the course. This helps students to understand the course contents better.

In this paper, laboratory and practical work organized within the courses *Mobile Communication Systems* and *Optoelectronic Communication Systems*, both from the second semester of the new master curriculum in Telecommunication Engineering, are presented in more details, with emphasis on the exercises based on the equipment purchased from the TEMPUS project funds.

II. MOBILE COMMUNICATION SYSTEMS

Mobile Communication Systems is a mandatory course developed within the pilot master programme in Telecommunicaton Engineering. A specialized education kit, Mobile Telecom Trainer by Man&Tel, [2]-[3], has been purchased from the TEMPUS funds and has been exploited for the experimental work within this course.

The education kit is aimed to provide students with theory and practical experience in radio and mobile full duplex

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communications. In the automatic mode, the equipment provides the same quality of voice transmission as commercial products available in the market.

The kit consists of two main parts: the basic station and the mobile station, Fig. 1. The basic station works in the frequency range from 46.51 to 46.97 MHz, and the mobile station in the frequency range from 49.67 to 49.99 MHz. Communications can be established through 15 full duplex channels. A channel width is 25kHz. Maximum output power of a unit is +4.5dBm. FM modulation scheme is applied.

Fig.1. Education kit – Mobile Telecom Trainer MT-2000

Each of the units, the base station and the mobile station consists of four boards: Power Board, Audio Board, RF Board and Control Board. In order to provide a signal flow, the boards are connected by connector cables. Both of the units are equipped with speaker and microphone as well as by an external input.

The following experiments that can be realized using this trainer kit:

- Board Unit Module Experiments: Power, Audio, Control Unit, Radio Unit,
- Half Duplex Audio and Data Transmitting and Receiving Experiment,
- Full Duplex Audio and Data Communication Experiment.

Performing these experiments students are able to a better understanding of the role of a particular part of the mobile system as well as of principles of call set up and channel allocation.

Further, in order to illustrate principles of mobile communications better, several interactive software exercises were used; some of them are available through the Internet [4]. These exercises provide better understanding of clearer cellular architecture, call setup in mobile communications, communication between two mobile stations, communication between a mobile station and a fixed phone, roaming issues, etc. The exercises were performed in a computer room equipped with the computers bought from the TEMPUS funds.

Students of the final year of the current study programme in telecommunications have shown interest in helping in the development of this new course. They have participated in preparing of software exercises. Currently, illustrations of mobile-originated and mobile-terminated call- setup have been developed. They can be found at the course web page, [1].

III. Optoelectronic Communication Systems

Optoelectronic Communication Systems is a course aimed at introducing principles of optical communication systems and basic parts of these systems. Within this course much attention has been paid to building practical experience of the students. During the classes students were acquainted with real optical fibers, cables and components and with datasheet reading. Then, exercises using the earlier purchased optical time domain reflectometer (OTDR) HPE6000a, Fig. 2, were performed. These are:

- optical fiber attenuation measurements,
- fiber break locating and
- optical power measurements.

Fig.2. Optical time domain reflectometer (OTDR) HPE6000a

For this course the educational kit, Optical Fibers Communication Trainer - ETEK OFC-9000, [5]-[6], has been purchased from the TEMPUS project funds.

The kit consists of several optoelectronic modules:

- Optical Transmitter Module (660 nm and 820 nm),
- Optical Receiver Module (660 nm and 820 nm),
- Computer Control Module (Transmission interface: RS-232),
- Analog and Digital Signal Modulations Modules, (Modulation Schemes: AM, FM, ASK, PSK),
- Digital Signal Processing Module,
- Signal Source Encoder and Decoder (CVSD),
- Channel Encoder and Decoder (Manchester),
- TV Signal Modulator and Demodulator (including TV Signal Generator).

The transmitter and receiver module, Fig. 3, can work both in analog and digital mode at wavelengths 660 and 820nm. The transmitter module has: a built-in microphone input terminal and audio amplifier, a built-in sine wave output signal, and it also includes a tunable amplitude and frequency output as well as a built-in digital data generator. The receiver is provided with a tunable amplifier, which can drive an 8 W loud speaker.

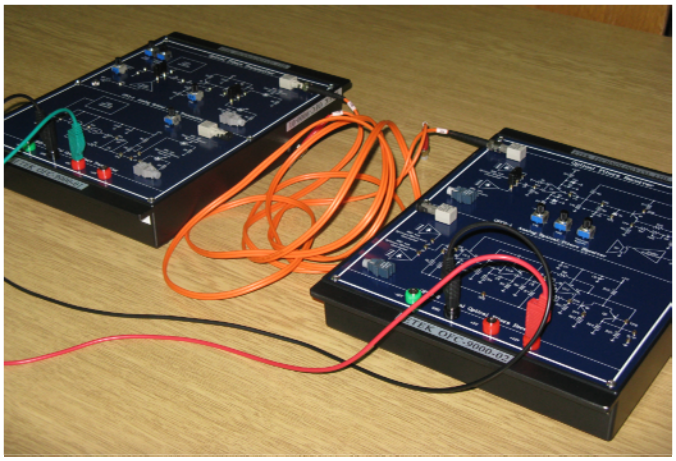

Fig.3. ETEK OFC-9000 - Optical transmitter and optical receiver

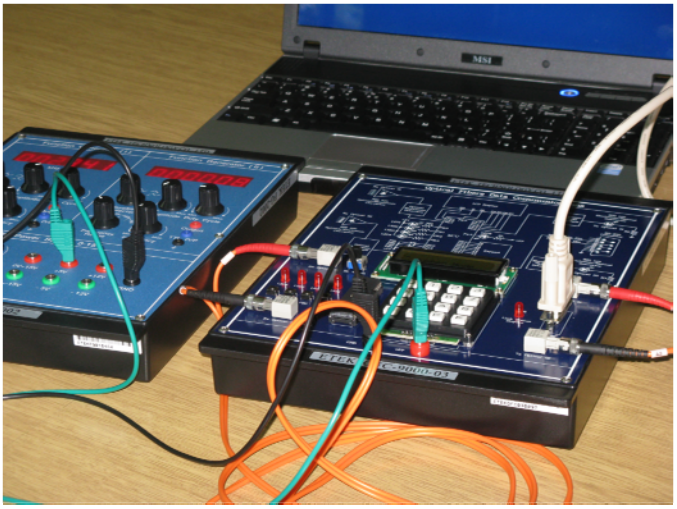

Fig.4. ETEK OFC-9000 - Computer Control Module

Experiments performed using the education kit ETEK OFC-9000 provide students with the following:

- understanding of the function of optical analog/digital transmission,
- understanding of the function of optical analog/digital transmission of particular parts of a communication system,
- measuring and adjusting transmitters, receivers, modulators and demodulators,
- understanding of the application of optical fibers to data transmission for far distance monitoring and controlling.

In order to make optical fibers and cables more familiar to the students an experimental class was organized in collaboration with a local telecommunication company "POGLED telekomunikacije". Engineers from the company visited the course classes and demonstrated splicing, a procedure of making permanent joints (splices) on optical fibers using a specialized piece of equipment, splicer, Fig. 5. They started by explaining the structure of a fiber optical cable, the procedure and accessories for preparing fibers for splicing. The splicer was connected to a projector in order to make contents of the splicer screen visible from all parts of the classroom. This was followed by the demonstration of the procedure and explanation of the influence of different factors on the quality of the procedure and joints themselves. After the demonstration, there was a very fruitful discussion with the students, Fig. 6. They liked the class very much and expressed later their opinion that such kind of classes improve quality of courses.

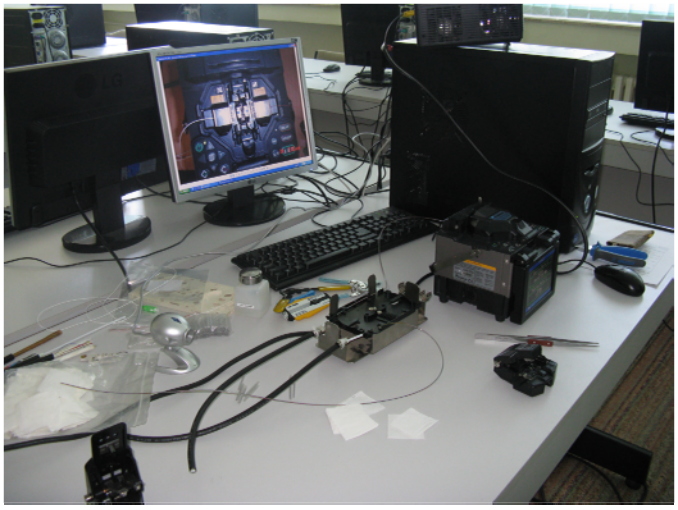

Fig.5. Fusion splicer and accessories

Fig.6. A detail from the demonstration class

IV. Conclusion

At the Faculty of Electronic Engineering in Niš, within the new curriculum in Telecommunication engineering, developed under TEMPUS curricula development project JEP_41112-2006 "New master curricula in telecommunications and control", special attention has been paid to including practical/experimental work in the courses. The type of work depends on a course. It is mostly experimental work based on equipment purchased from the project funds or on the earlier bought equipment. In addition to the experiments, several software based exercises have

been conducted. Further, local companies, as well as students of final years of the current study programmes in telecommunications, have recognized importance of the practical experience got within the studies and have been willing to help in the process of establishing laboratory exercises and providing practical knowledge to the students.

After the first year of the pilot master program, positive feedback was obtained from the students. It has been confirmed that the practical work makes courses more interesting and helps students to understand the course contents better.

Having in mind the above, further continuous activities in enriching and improving student practical/laboratory work within courses from this master program will be done. The main goal in this process is to prepare students to adapt more easily to the work environment after graduation.

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