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**EDUCATION OF METROLOGY IN ELECTRONIC
AND TELECOMMUNICATION STUDIES AT TECHNICAL
UNIVERSITY OF BIAŁYSTOK**

In this paper the general description of the schedule of studies on Electronic and Telecommunication at Technical University of Białystok from the point of view of delivering metrology knowledge is presented. Also three typical subjects of metrology like the base of metrology, surveying of electronic and technique of experiment are underlined. The attempt of qualification the profile of graduate is one of the final conclusion of this work.

Key words: metrology, education

*Never the time, and the place, and the loved one all together .
Robert Browning (1812-1889)*

1. INTRODUCTION

This evident truth of our life (written by english poet) may be introduced to illustrate academic metrolog's expectations of a place, dimension and importance of their loved discipline – metrology on successive semestres of studies.

In the years 2000-2001 author of this paper participated in elaboration of a new studies schedule for Electronics and Telecommunication line in the Faculty of Electricity in Technical University of Białystok. The main reason which caused changes of existing plan was a resolution of a new law by the Main Council of Higher Education in April 1998. Minimum-requirements in programme of studies for this kind of line as an obligatory part were contained in this law. Also according to recommendations which are specified in general description, the total number 3800 hours of occupations during

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all process of studies was fixed (including about 400 hours for master's thesis preparation). Requirements mentioned above refer only of 1455 hours, the remaining time is to be fulfilled by common subjects from basic and technical groups (see Fig. 1).

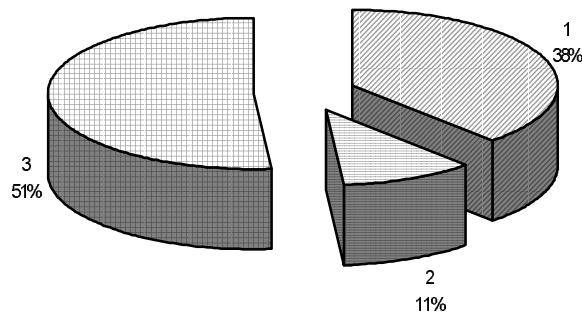


Fig. 1. The partition of total hours (3800) fixed through resolution of Main Council of Higher Education: 1- minimum requirements (1445), 2- time for master's thesis (400), 3- subjects established by Faculty Council (1945)

It is important to ascertain that in spite of forced settlements more than 50% of time could be established in local conditions.

2. METROLOGY SUBJECTS

In total number of hours in the minimum programme there are 60 hours for subject called *Metrology and Experiment Technique* and 90 hours for *Fundamentals and Algorithms of Signal Processing*. During composition over the new schedule, after long discussions, some other subjects which belong to metrology groups have been proposed and placed for all specializations into frames of programme in effect:

- *Metrology* (30 hours of lectures in 2nd semester of studies and 30 hours of laboratory work in 3rd semester),
- *Electronic Measurement* (30 hours of lecture in 5th semester and 30 hours of laboratory work in 6 semester),
- *Architecture and Programming of Digital Signal Processors* – 30 hours of lecture, 60 hours of laboratory in 8th semester).

It is a problem strongly discussed what subject could be included as metrology one. In this work all subjects with elements of measurement and signal processing are to be accepted that belong to this group. There is no enough place to quote the frame programme of each subject so only their names are given. Except already specified the following subjects have been taken in to consideration:

Electronic Measurement Devices, Electronic Medical Apparatus, Advanced Digital Signal Processing, Methods Of Coding And Signal Transmission, Signal Processing And Modelling Of Biological Systems, Processing And Recognition Of Images In Medicine, Imaging Engineering In Medicine, Analytical And Laboratory Devices, Measurements In Medicine, Sensor Devices, Photometry, Sources And Detectors Of Radiation, Fibre Optic Sensors, Industrial Metrology, Computer Measurement Systems, Theory Of Measuring Transducers, Dynamic Metrology, Measuring Systems, Digital Measuring Systems.

3. THE “AMOUNT” OF METROLOGY AT SPECIALIZATIONS

3.1. UNDERGRADUATED STUDIES

To begin from 4th semester every student chooses a specialization and he terminates his education either after seven semesters as undergraduated engineer or after additional three semesters as qualified master of sciences. There are five specializations on this line at Faculty of Electricity: Electronic Apparatus (EA), Electronic Medical Apparatus (EMA), Electronics of Industry (EI), Optoelectronics (OPT), Teleinformatics (TIN). On the first (undergraduated) step of studies 510 hours fullfil needs and applications of individual specialization (in total number of 2295 hours). In the Table 1 the hourly dimension of all and metrology subjects is presented. The question mark placed in seventh semester is because the metrology engagement of every student during the work for engineer’s diploma thesis depends on the theme of composition.

Table 1. Number of hours on each semester with specification of metrology subjects

Semester	Common subjects		Subjects at specializations (in parenthesis the number of metrology hours is placed)				
	all	metrology	EA	EMA	EI	OPT	TIN
1	360	-	- (-)	- (-)	- (-)	- (-)	- (-)
2	330	30	- (-)	- (-)	- (-)	- (-)	- (-)
3	360	30	- (-)	- (-)	- (-)	- (-)	- (-)
4	300	45	90 (30)	105 (0)	90 (30)	105 (0)	105 (0)
5	330	60	105 (30)	120 (45)	75 (0)	120 (30)	90 (0)
6	105	60	285 (0)	255 (150)	315 (90)	255 (60)	285 (60)
7	-	-	30 (?)	30 (?)	30 (?)	30 (?)	30 (?)
total	1785	225	510 (60)	510 (195)	510 (120)	510 (90)	510 (60)
Total number of hours at first step of studies					1785 + 510 = 2295		

The comparison of “metrology” hours in relation to total number is shown on Fig. 2 (in percentages).

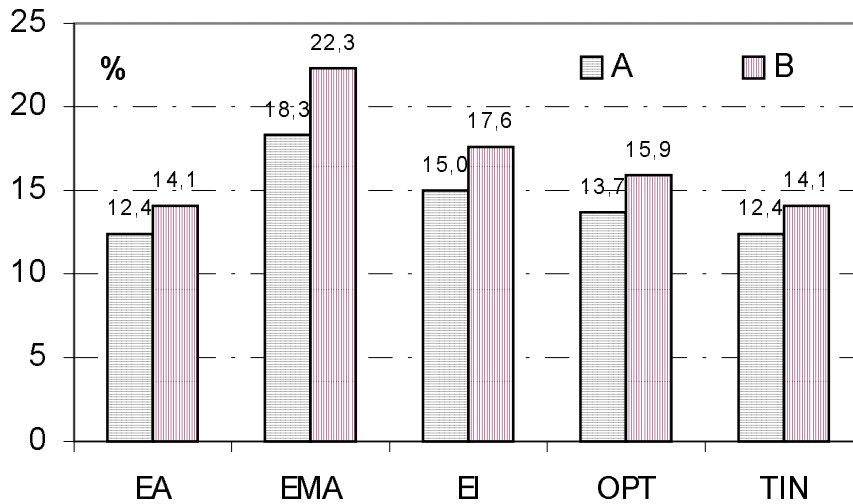


Fig. 2. The number of hours of metrology subjects at specified specializations in relation to total number (A) and to remaining (B)

3.2. GRADUATED STUDIES

On the second (graduated) step of studies 540 hours belong to specified specializations (in total number of 1125 hours). Table 2 similarly as previous one contains the hourly dimension of all and metrology subjects. Also the meaning of question marks is the same only refers to the work for master's thesis. The seventh semester of under-graduated studies differs from that of second step of studies.

Table 2. Number of hours on semesters of graduated studies with specification of metrology subjects

Sem-ester	Common subjects		Subjects at specializations (in parenthesis the number of metrology hours is placed)				
	all	metrology	EA	EMA	EI	OPT	TIN
7	330	-	60 (0)	60 (0)	60 (0)	60 (0)	30 (0)
8	210	150	150 (30)	180 (30)	165 (90)	195 (60)	150 (0)
9	45	-	300 (75)	285 (120)	285 (30)	240 (45)	330 (60)
10	-	-	30 (?)	30 (?)	30 (?)	30 (?)	30 (?)
total	585	150	540 (105)	540 (150)	540 (120)	540 (105)	540 (60)
Total number of hours at graduated studies			585 + 540 = 1125				

On Fig. 3 the comparison of hours of metrology subjects in relation to total number is presented (in percentages).

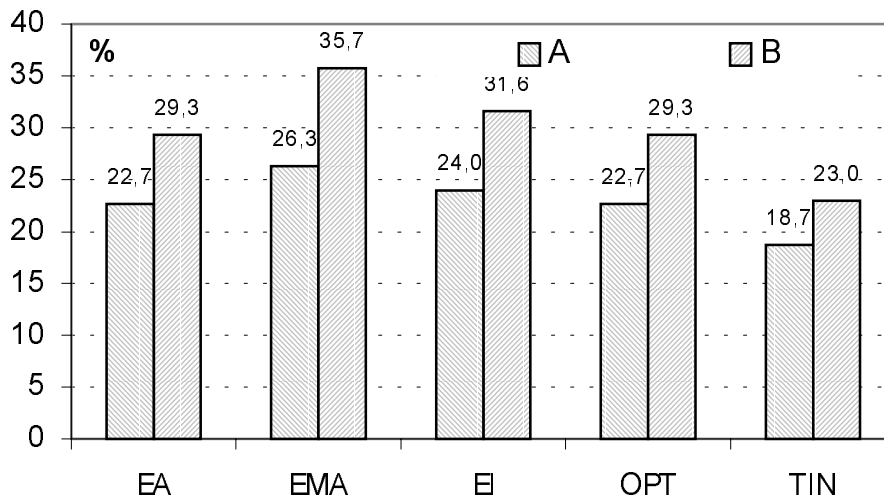


Fig. 3. The number of hours of metrology subjects at specified specializations in relation to total number (A) and to remaining (B).

On the base of analysis of represented graphs following conclusions could be introduced:

- The “saturation” of metrology knowledge on different specializations is diverse according to their specificities. Most of all is on Electronic Medical Apparatus (EMA) and this is intelligible when one will arise under attention, that engineers to services and repair of medical devices are the final product of it. Majority of medical devices are for analytical and diagnostic aims.
- Also the “last” position of Teleinformatics (TIN) is not surprise because this area of modern technique will demand of specialistic methods and tools of measuring.
- One can ascertain that the enlargement of metrology education follows on second stage of studies.

4. PRACTICAL OR THEORETICAL METROLOGY?

Teaching the practical form of engineers is very important part of their education. The growing cost of studies involved in changing the laboratory works to oral presentation (lectures are very cheap). It is a dangerous tendency which could play unprofitable role in engineering courses taught at universities. Polish tradition of teaching metrology accepts the relation of laboratory work to total number of hours as 60 %. In the plan of studies described above this relation is about 50% (see Fig. 4).

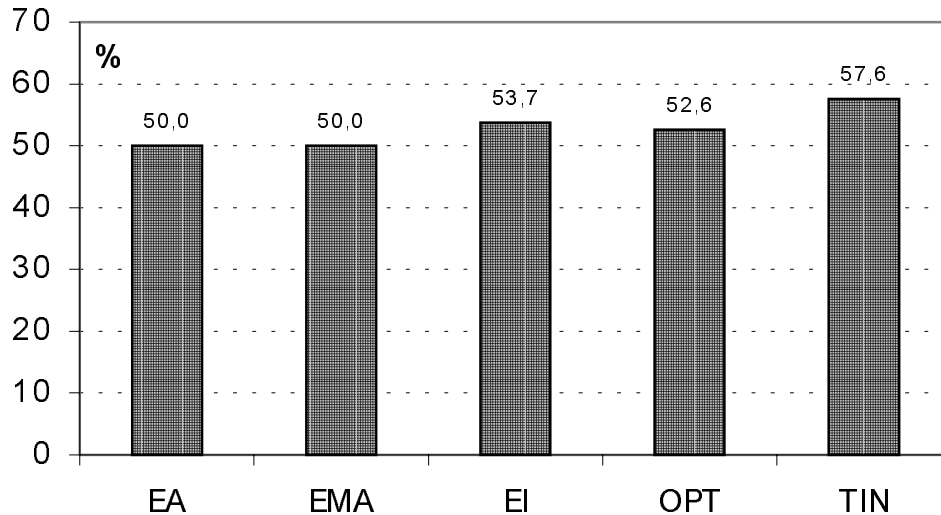


Fig. 4. Relation of time of laboratory works to total number of hours of metrology subjects at specified specializations at Faculty of Electricity

The “amount” of metrology during graduated studies (including first sixth semesters) in relation to assumption contained in minimum requirements is about twice greater. This confirms to great meaning of knowledge of metrology in teaching of engineers in modern technical university. In spite of economic conditions and top recommendations (Main Council of Higher Education indicates 40 % relation of laboratory work to total time of studies) one tried to hold superiority of practical teaching confirming this fact, that metrology can not be taught theoretically.

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