

# Development Tendency of Mathematical Education of TPU Engineer in Accordance with Requirement of SEFI

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## Abstract

There are two experimental educational programs in Tomsk Polytechnic University (TPU): Electrical Engineering, elaborated in accordance with Accreditation Board for Engineering and Technology (ABET) requirement and Computer Engineering, elaborated for approbation of ECTS. Mathematical part of engineering education of TPU is discussed. The requirement for level of mathematical education of engineering first-year students and second-year one, declared by TPU, and real knowledge of them after finish of basic courses are considered. Mathematical part of Electrical Engineering and Computer Engineering curriculum are compared to SEFI-MWG requirements.

New experimental elite technical educational program which started in 2004 is considered. It is made a comparison of the mathematical part of a new experimental elite technical educational program and Electrical Engineering and Computer Engineering programs. Merits and demerits of mathematical engineering education are analyzed.

A role and a place of basic of mathematical disciplines for master's degree programs elaboration is discussed. Experiment in development of a parallel deep basic courses in particular mathematics of TPU is represented.

*Keywords: curriculum, education, SEFI requirement in mathematics*

## 1. INTRODUCTION

Forming and expansion of an educational area inevitably brings to increasing of student mobility. It makes high demands of educational programs at every step of its achievement by university. It requires developing into detail the units of educational services quality and quantity. Credit is universally recognized unit as a tool of academical mobility. European universities approbated credit system and they widely use it several decade. But in Russia application of the credit system to education was begun just 5 years ago. But the expansion the credit system is fast enough through Russia. In 2004 two universities apply like experiment the credit system. In 2006 there are 43 universities which use ECTS by part or completely.

The other reform point of Russian higher education is introduction to double-step bachelor-master degrees system. There is not any common point in this matter of education. As a rule, universities make a decision itself about either two-step or three-step system (bachelor', specialist' or master's degree) and develop corresponding educational program. Specialist-degree is traditional five-year educational program, but bachelor and master degrees programs are formed, discussed, analyzed.

Mathematics is the base of any engineering educational program. Therefore every time the reorganization receives the modification its disciplines first of all.

## 2. MATHEMATICS UNDER REORGANISATION

The deep and width of engineering mathematical education is discussing long ago. Improving bachelor-master scheme intensifies as themes problem as deep. Unfortunately there is the idea that the bachelor (4 study years) is underlearned specialist (5 study years). At the same time development of modern manufacturing methods require knowledge and skills more and more from the graduating student. It reduces to rise of new special disciplines,

passing away or reduction of traditional one. The educational program reorganization tendency is directed to the shorting and simplification of the mathematical courses because they do not connected to industry immediately.

When we improve the bachelor-master scheme, this tendency has great risk if the bachelor's program (with the 1<sup>st</sup> level mathematics) is the base of the master's program and master's one is a simple addition it by the master's level courses. In particular it problem was discussed by [1]. In this case a student who successfully studied mathematical disciplines of the bachelor's level is not ready to assimilate modern, founded on science, high level master's disciplines. On the other hand high-level mathematics of mater's program is not needed for bachelor because of different purpose. If the bachelor is good enough skilled technician who can manage by not great closed production cycle, he douse not need ability of deep analyzing, for example.

If the master is a creation person who is able to create and be adapted to developing complicating technologies then the principal different between bachelor and master is in the mode of thought and the method of attack. And mathematics is the best way to form and develop it.

### 3. TPU EXPERIENCE

Last for five years TPU makes efforts to educational programs modernization, developing and approbation of the bachelor's programs in Electrical Engineering and Computer Engineering. The mathematics was the first that was reorganized. In the first case mathematical cycle of disciplines was formed with accordance to ABET criteria. In the second case it is made with accordance to Mathematical Working Group (MWG) SEFI requirements [2]. Mathematical education within the framework of new version of curriculum Electrical Engineering satisfies the European education standard although ABET doesn't work out in detail the content of curriculum. After study of basic mathematics the students of both programs demonstrate equal set of knowledge and skills under the conditions there are great organization difference in disciplines of mathematics.

At the same time the elite educational program was evolved and introduced along with traditional Electrical Engineering and Computer Engineering programs. Its purpose is to develop creative ability and organization

Item	Traditional programs	Elite educational program
Analytical geometry	Find the line going through the point M(2; 1), to its segment between coordinate axes be halved by M.	1. The points $M_1(x_1; y_1)$ and $M_2(x_2; y_2)$ lie in different half plane from the line $ax + by + c = 0$ . Find the ratio in which intersection point of $ax + by + c = 0$ and $M_1M_2$ divides the segment $M_1M_2$ . 2. Proof, if two hyperbolas have common asymptotes and lie in different pares of vertical angles, formed by asymptotes, then product of their eccentricity is greater then or equal to two, where it is equal to two for equilateral hyperbolas.
Indefinite integral	$\int \frac{x^2 + 1}{x^3 + 1} dx, \int \frac{x^{2n-1}}{x^{4n} + 1} dx$	$\int \frac{x^2 - 1}{x^4 + x^3 + x^2 + x + 1} dx, \int \frac{x^{3n-1}}{(x^{2n} + 1)^2} dx$
Definite integral	Find $\lim_{x \rightarrow +\infty} \frac{\left( \int_0^x e^{t^2} dt \right)^2}{\int_0^x e^{2t^2} dt}$	Find the length of arc $x = \int_1^t \frac{\cos z}{z} dz, y = \int_1^t \frac{\sin z}{z} dz$ from the origin to the nearest point of the tangent line.
Series	Find the region of consequences $\sum_{n=1}^{\infty} \frac{2^{n+1}}{n(n+2)} x^n$	The convergence radius of $\sum_{n=0}^{\infty} c_n x^n$ is $r$ , the convergence radius of $\sum_{n=0}^{\infty} c'_n x^n$ is $r'$ . Find the convergence radius of $\sum_{n=0}^{\infty} (c_n + c'_n) x^n$

TABLE 1. Level of problems of traditional and elite educational programs

activity of students. In particular elite program differs by intensive fundamental courses. All of who wishes to get it must make entrance test, which checks up secondary school level in mathematics and physics and ability of logic thinking. Any student of engineering specialty successfully made the entrance test can study fundamental courses in frame of elite program. But his specialty is remained. The curriculum is corrected only.

During the first term the mathematical disciplines of elite program is equal to traditional one. But elite students consider harder problems: the problems with proof, with general solution, connected with other parts of mathematics. Their aim is to develop creative thinking, skills of optimal solutions finding. At the beginning of the second term the subjects of elite and traditional mathematics are the same. But elite math is deeper and more intensive. The problems about interconnection of sciences are obligatory, as a rule it is considered physical and chemical problems. In order to demonstrate the difference between elite and traditional programs there are some of them in the table 1.

The problems within the framework of elite program are directed not only on repetition and using of studied algorithm, but on the evolution of ability to find optimal algorithm and to construct novel one, if known standard algorithm douse not run or uncomfortable.

Nevertheless mathematical part of 3 above-mentioned programs satisfies MWG requirements. All of zero level subjects are studied at a secondary school except 'complex number' (it is studied as the item of 'complex functions') and 'set' (it is studied as the item of 'calculus'). Table 2 contents some of common items and general subjects level by level, which have been picked by MWG and terms when they are studied in TPU.

The third-level subjects included in to programs selectively in context of specialty disciplines.

<i>MWG requirements</i>			<i>'EE'</i>	<i>'CE'</i>	<i>Elite Education</i>
1-st level	A	matrix, determinant, homogeneous and inhomogeneous system of linear equations, linear space, vector algebra, .	I	I	I
	C	elementary functions, continuous and limit of functions, differentiation of one variable function and its applications, integration numerical and functional series	I	I	I
			II	I	II
	D	sets mathematical logic, induction and recursion, graphs	III	II	III
			I	I	I
G	canonical equation of quadric curve, line and plane, quadric surface	-	V	-	
P&S	combinatory, basic laws of probability, distribution, sampling, statistical inference	I	I	I	
2-nd level	A	matrix algebra, eigenvalue and eigenvector	IV	IV	IV
	C	differentiation of multivariable function, multiple integral, Fourier series, ordinary differential equations vector calculus complex functions and series, Laplace transformation partial differential equations simplex method, non-linear optimisation	-	I	I
			I	II	II
			II	II	II
			II	-	II
			III	II	IV
	-	III	III		
-	V	-			
D	number systems, algebraic operations, relations, graphs, algorithms	-	V	-	
G	helix, geometric spaces and transformations	II	II	II	
P&S	one-dimensional random variables, two-dimensional random variables, hypothesis tests, linear regression, Multiple linear regression	IV	IV	IV	

TABLE 2. Distribution of the general items by terms in EE, CE and elite programs of TPU in comparing with SEFI MWG requirement (Algebra – A, Calculus – C, Discrete mathematics – D, Geometry – G, Probability and Statistics – P&S). The first, the second and so on terms is denoted by I, II, III, IV correspondently.

During the first term student can change elite math discipline to traditional one (if he does not feel his abilities are good enough or need) and vice versa (if he is a good or an excellent student). But beginning at the third term even a good student is at a loss for catching up the style of thinking and lesson's temp. It is not connected with the level of complexity problems. It is the first distinctive property of elite program's students. After the first

year elite mathematics studying they are already differed by skills to find the best and the shortest solution, easy using mathematical tool, proof knowledge, courage to consider and solve any problem.

Thus, inside one university it is observed considerable differentiation of student educational level under equal programs. In fact, EE student who studied elite fundamental courses is ready to creation and scientific activity. However it is not mark into diploma. Credit of discipline and specialty of elite program student keeps equivalent to traditional programs from which he came. The table 2 shows the clear coincidence of studying items, but the deep and quality of education must be marked by credit at least. And for sure any traditional bachelor's program and elite educational program can not be accepted by equivalent.

Even if there is great difference of student levels inside one educational program in one university then union of an educational area complicate the issue several orders greater.

#### **4. CONCLUSIONS**

Undoubtedly, after the total application of credit system in TPU elite disciplines will get greater credit them traditional one. But exchanging by students universities of the global education market must be sure, that credit of discipline corresponds to quality of acquired knowledge and skills of student. May be it would be easier to regulate mutually recognition of mathematics disciplines if outcomes of the first and the second levels are accompanied by standard problems as it have been done for the zero level.

On the other hand mathematicians can not declare the requirement to bachelor's or master's mathematics. And as soon as universities or engineering associations do not find common point about fundamental minimum of bachelor's or master's programs, every university has the right to establish any fundamental level of education and others have to examine students in order to accept them.

Finally there are different aims for bachelor and master. It brings to different frame of bachelor's and master's educational programs and diverse way of their learning. Moreover, it seems to us, it is impossible to learn master from bachelor by additional study of several disciplines. Separation of the programs must begin with fundamental disciplines at least at the third term and the student has to choose his future at the early stage of learning. It is fundamental courses that can form thinking and knowledge which diverse master from bachelor.

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#### **Curricula**

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