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Training and Development of Mechatronics and Micro- and Nanosystems Technology in Technical University of Gabrovo Bulgaria

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Abstract: *The aim of the study is training and research work in mechatronics and micro- and nanotechnology. A resolution to this question was presented at the present at the TU of Gabrovo, BG. The paper discusses the curriculum and educational program in Bachelor's degree and Master's degree in Mechatronics. Special attention is given to the educational and methodological materials on micro- and nanotechnology and the training opportunities for graduates. There are also major R & D- topics in this area and works for the habilitation of teachers. The training and development period covers the last 10-12 years (2009-2020).*

Keywords: *Mechatronic, Micro- and Nanosystems*

1. INTRODUCTION

The aim of the study is training and research work in mechatronics and micro-and nanotechnology. The subject of attention is the historical development of mechatronics and nanotechnology and the state of the problem worldwide in Bulgaria. The term „Nanomehatronika" introduced by the chief engineer and founder T. Mori S. Yashkava Company Yashkawa Electric, Japan in 1969 and is registered as a trademark in 1972 to receive priority in the competition in the market [1]. Widespread and popular it is accepted that the term „Mechatronics" combines concepts Mechanics (mechanism) and electronics (microelectronics and informatics). Synthesis, however, lies in the concept of katakana (one of the letters of the alphabet or Japanese Alfavit) word composed of elements of English words and manner of entry into language is the same as for a number of Anglo-Americanism - Modernism in the expression of people in the modern world. Later it introduced the concept „Mechatronic approach", an integrated or inter-disciplinary approach for mechatronic systems. It can be discerned in the following features in development: optimizing the design through CAD / CAE - systems, upgrading drives and controls, development of advanced technology related to micro-and nanotechnique and integration in CIM; deployment of intelligent systems meet people's needs. In Bulgaria priority were automation systems engineering developed in the works "Mechatronics - Gabrovo, peripheral and computer engineering at "Orgtehnika" - Silistra, robotic systems and automation of production in the IMM and ITCR - Sofia GAPS in Stara Zagora, but more recently have systems to protect the environment, controllers controls CLM-Procesors BG Academy of Sciences, nanotechnology became strategic and others.

Mechatronics is a set of tools and principles in mechanics, electronics and informatics, synthesis of existing technologies used effectively to achieve a specific goal [2]. Surely, in the other literature to find additional definitions, views and analysis of their contents [3, 4]. However, they do not consider themselves Micro- and nanomehatronics as part of mechatronics. According to the German-Russian electronic dictionary [5] mikromehatronic a subfield of mechatronics, which relates to devices and systems with dimensions of several mm and smaller. Similarly, nanomehatronics is a subfield of mechatronics, which relates to devices and systems commensurate with the molecules of substances. That is to say, a special section on mechatronics, due to its merger with nanotechnology and the vocation to deal with the theory and practice of nanomehatrons systems. Unknown up until about the year 2000, the "Nanotechnology" has become the most common and important word in science, it came into operation in politics and its adoption become a strategic direction in programs (NNI), plans and projects. The author of this paper has already published a study on the state of nano-technology to the 2003-5 year [6, 7].

Mechatronics is a new science that began to teach in universities around 15-25 years as a discipline, an area of specialization, and now has established itself as an interdisciplinary specialty including mechanical, electronic and information systems.

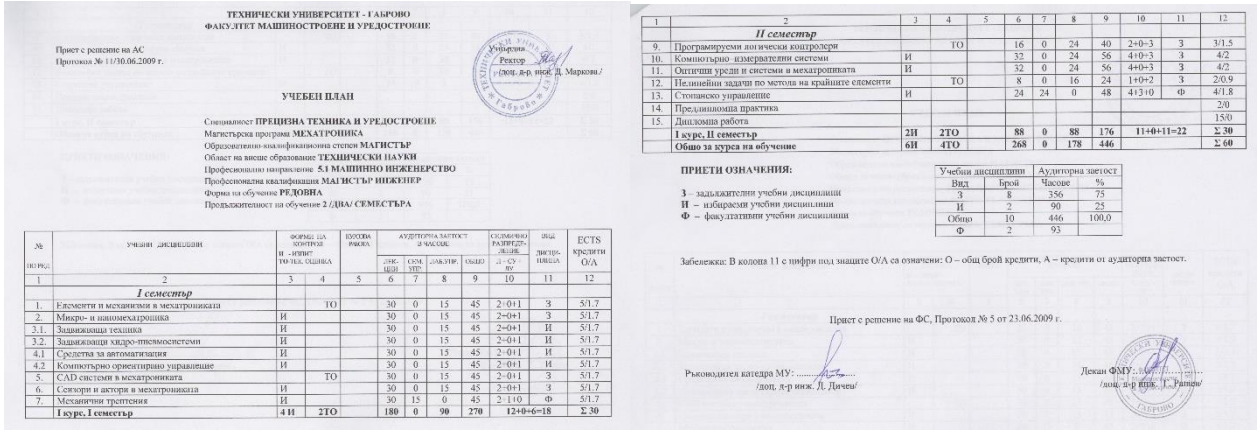
The symbiosis between many studies in mechatronics consists of many levels, from data collection to generate ideas in the design process to implement and introduce products in action [8]. There are several similar versions of the synthesized representation of mechatronics, as here in Fig. 1 which provides a principled and two of them advanced version. Mechatronic systems (MS) is characterized by its integration of components and functions implemented in varying degrees as micro / nanosystem engineering and mechatronics are part of the Precision Engineering. The essence of a mechatronic approach is to merge into a single module / s of the constituent elements in varying degrees of integration. Usually mechatronics is presented as a unity of three parts: 1 - drive 2 - actuators, 3 - management. Area 4 is traditionally called the Electromechanical, Automation - 5, control - 6 and 7 - Core.

Figure 1. *Principle and performance of advanced mechatronics and applied in areas subject (in Russian)*

The area of specialization in Mechatronics is being studied worldwide in manufacturing departments of prestigious universities (Russia - 13 U.S. - 10, Germany - 8 Canada - 5 Holland - 4, Japan, Australia, Belgium -3, Finland and Hungary - 2, New Zealand and Bulgaria - 2, Serbia and Macedonia – 1 and in other countries). According to UNESCO, specialty is one of ten most desired, new and promising in the world.

2. RESULTS

In the year 2009, at the TU-Gabrovo both a regular and part-time training courses in Mechatronics, were established as a Master's degree program after completing a Bachelor of Science degree Precision Engineering, already Mechatronics. The degree allows graduates to gain a thorough theoretical and practical training to the creation, implementation and operation of MS. The Leading Department is "MU", but the teachers from the participating departments such as ET, PC-system and technologies, EE and others. The curriculum is coordinated and consistent with the Technical University of Gabrovo and allows students and teachers from Europe to participate. Is shown in Fig. 2. Curriculum and programs have already been presented in detail in [12, 13, 15].


ТЕХНИЧЕСКИ УНИВЕРСИТЕТ - ГАБРОВО
ФАКУЛТЕТ МАШИНОСТРОЕНИЕ И УРЕДОСТРОЕНИЕ

Приет с решение на АС
Протокол № 11/30.06.2009 г.

УЧЕБЕН ПЛАН

Специалност **ПРЕЦИЗНА ТЕХНИКА И УРЕДОСТРОЕНИЕ**
Магистърска програма **МЕХАТРОНИКА**
Образователно-квалификационна степен **МАГИСТЪР**
Област на висше образование **ТЕХНИЧЕСКИ НАУКИ**
Професионално направление **5.1 МАШИННО ИНЖЕНЕРСТВО**
Професионална квалификация **МАГИСТЪР ИНЖЕНЕР**
Форма на обучение **РЕДОВНА**
Продължителност на обучение **2 /ДВА/ СЕМЕСТЪРА**

№ по ред.	Учебни дисциплини	Форма за контрол и - изпит / тест, оценка		Курсова работа	Аудиторна заетост и самостоятелна работа				Седмично разпределение	Вид листовка	ECTS кредити О/А
					лекции	семинарни упр.	лаб.упр.	общо			
1	2	3	4	5	6	7	8	9	10	11	12
	I семестър										
1.	Елементи и механизми в мехатрониката		ТО		30	0	15	45	2+0+1	З	5/1.7
2.	Микро- и наномехатроника	И			30	0	15	45	2+0+1	З	5/1.7
3.1.	Задвижваща техника	И			30	0	15	45	2+0+1	И	5/1.7
3.2.	Задвижващи хидро-пневмосистеми	И			30	0	15	45	2+0+1	И	5/1.7
4.1	Средства за автоматизация	И			30	0	15	45	2+0+1	И	5/1.7
4.2.	Компютърно ориентирано управление	И			30	0	15	45	2+0+1	И	5/1.7
5.	CAD системи в мехатрониката		ТО		30	0	15	45	2+0+1	З	5/1.7
6.	Сензори и актори в мехатрониката	И			30	0	15	45	2+0+1	З	5/1.7
7.	Механични трептения	И			30	15	0	45	2+1+0	Ф	5/1.7
	I курс, I семестър	**4 И**	**2ТО**		**180**	**0**	**90**	**270**	**12+0+6=18**		**Σ 30**

1	2	3	4	5	6	7	8	9	10	11	12
	II семестър										
9.	Програмируеми логически контролери		ТО		16	0	24	40	2+0+3	З	3/1.5
10.	Компютърно -измервателни системи	И			32	0	24	56	4+0+3	З	4/2
11.	Оптични уреди и системи в мехатрониката	И			32	0	24	56	4+0+3	З	4/2
12.	Нелинейни задачи по метода на крайните елементи		ТО		8	0	16	24	1+0+2	З	2/0.9
13.	Стохастично управление	И			24	24	0	48	4+3+0	Ф	4/1.8
14.	Преддипломна практика										2/0
15.	Дипломна работа										15/0
	I курс, II семестър	**2И**	**2ТО**		**88**	**0**	**88**	**176**	**11+0+11=22**		**Σ 30**
	Общо за курса на обучение	**6И**	**4ТО**		**268**	**0**	**178**	**446**			**Σ 60**

ПРИЕТИ ОЗНАЧЕНИЯ:

З – задължителни учебни дисциплини
И – избираеми учебни дисциплини
Ф – факултативни учебни дисциплини

Учебни дисциплини	Аудиторна заетост	
Вид	Брой	Часове / %
З	8	356 / 75
И	2	90 / 25
Общо	10	446 / 100,0
Ф	2	93 /

Забележки: В колона 11 с цифри под знаците О/А са означени: О – общ брой кредити, А – кредити от аудиторна заетост.

Приет с решение на ФС, Протокол № 5 от 23.06.2009 г.

Ръководител катедра МУ: ..... /доц. д-р инж. Л. Дичев/

Декан ФМУ: ..... /доц. д-р инж. Г. Рапев/

Figure 2. *Curriculum of a Master's degree program in Mechatronics*

The courses encompass a set of modular training of ADC Company National Instrument (USA) and LAB View a demonstration of virtual instruments and sensors and actuators of the Mitsubishi (Japan) company. An academic laboratory was established using CAD / CAM-systems of PTC Proingeneer Wild Fire 3.0, and the module was equipped with a program for designing printed circuit boards and integrated circuits. Using the system AutoCad students developed a design of pneumatic tools, three dimensional models of a device for checking gears and precision quartz clock as their theses by students (fig. 3). Examples of the designs are presented in the learning process in this course "CAD-systems in mechatronics".

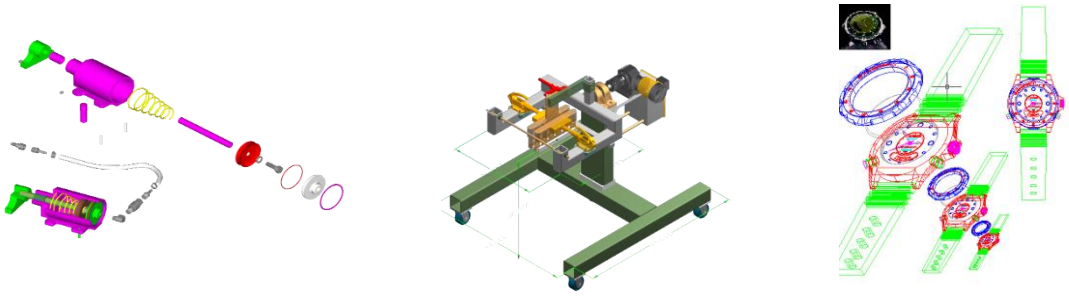
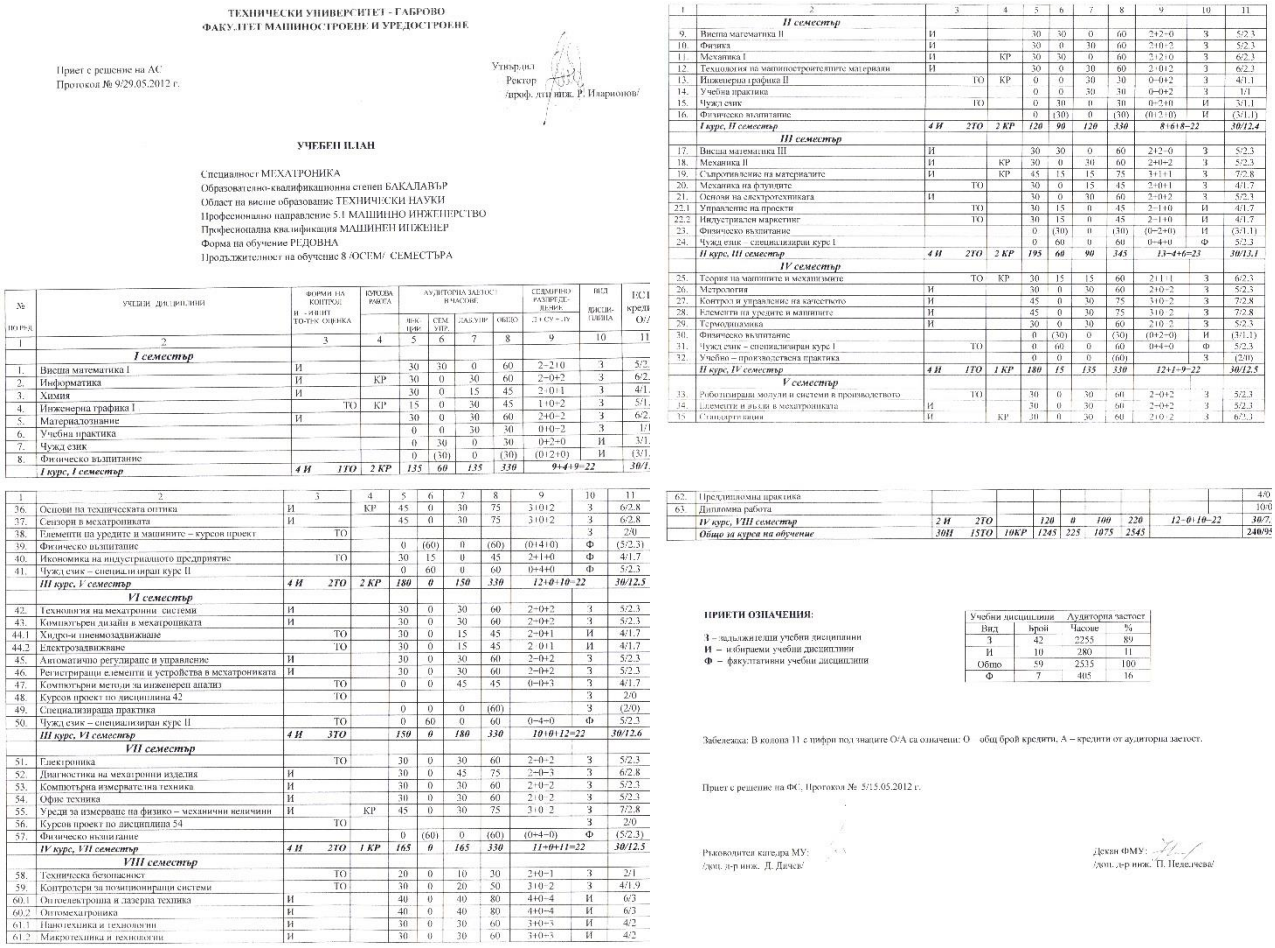


Figure 3. *Examples: Construction of pneumatic tools, three dimensional models of a device for checking gears and precision quartz clock*

In various training practices modular robots were developed (e.g. a robotic supplis us a with a glass of water on sloping terrain). The module 9841 NXT LEGO Company is a programmable controller program secured with a friendly interface and convenient for this purpose, allowing it to include servomotors and sensitive sensors (fig. 4). Contains 9787 NXT contains structural elements and servomotors, 9648 – has an additional design kit, color sensor, accelerometer, IR-sensor, touch sensor and ultrasonic sensor (fig. 9).

Fig. 4. *The module 9841 NXT*

Beginning in the academic year 2013/14, the TU-Gabrovo established the specialty „Mechatronics" with a Bachelor of Science degree. For this purpose special were prepared teaching aids such as [16]. Training will be in operation with Higher school Shmalkalden, Germany for direction „Total engineering" and University of Thrace - Edirne, Turkey "Automotive engineering" to obtain a double diploma in the EU. Practical training takes place in the companies "Mechatronics" AD-Gabrovo, AMK - Gabrovo, a carmaker with China in Lovech and others. Curriculum have already been presented in fig. 5.



ТЕХНИЧЕСКИ УНИВЕРСИТЕТ - ГАБРОВО
ФАКУЛТЕТ МАШИНОСТРОЕНЕ И УРЕДОСТРОЕНЕ

Приет с решение на АС
Протокол № 9/29.05.2012 г.

Утвърдил:
Ректор
/проф. дтн инж. Р. Изарнонов/

УЧЕБЕН ПЛАН

Специалност МЕХАТРОНИКА
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Форма на обучение РЕДОВНА
Продължителност на обучение 8 /ОСЕМ/ СЕМЕСТЪРА

№ по ред.	УЧЕБНИ ДИСЦИПЛИНИ	ФОРМИ НА КОНТРОЛ И – ИЗПИТ ТО-ТЕК ОЦЕНКА	КУРСОВА РАБОТА	АУДИТОРНА ЗАЕТОСТ В ЧАСОВЕ ЛЕК. УПР.	СЕМ. УПР.	ДАБ.УПР	ОБЩО	СЕДМИЧНО РАЗПРЕДЕЛЕНИЕ ЛЕКЦИИ + СЕМ + ЛУ	ВИД ДИСЦИПЛИНА	БРОЙ КРЕДИТИ О/А
1	2	3	4	5	6	7	8	9	10	11
	I семестър									
1.	Висша математика I	И		30	30	0	60	2+2+0	З	5/2.3
2.	Информатика	И	КР	30	0	30	60	2+0+2	З	6/2.
3.	Химия	И		30	0	15	45	2+0+1	З	4/1.
4.	Инженерна графика I		ТО	КР	15	0	30	45	1+0+2	З	5/1.
5.	Материалознание	И			30	0	30	60	2+0+2	З	6/2.
6.	Учебна практика				0	0	30	30	0+0+2	З	1/1
7.	Чужд език				0	30	0	30	0+2+0	И	3/1.
8.	Физическо възпитание				0	(30)	0	(30)	(0+2+0)	И	(3/1.
	I курс, I семестър	***4 И***	***1ТО***	***2 КР***	***135***	***60***	***135***	***330***	***9+4+9=22***		***30/1.***
	II семестър									
9.	Висша математика II	И			30	30	0	60	2+2+0	З	5/2.3
10.	Физика	И			30	0	30	60	2+0+2	З	5/2.3
11.	Механика I	И		КР	30	30	0	60	2+2+0	З	6/2.3
12.	Технология на машиностроителните материали	И			30	0	30	60	2+0+2	З	6/2.3
13.	Инженерна графика II		ТО	КР	0	0	30	30	0+0+2	З	4/1.1
14.	Учебна практика				0	0	30	30	0+0+2	З	1/1
15.	Чужд език		ТО		0	30	0	30	0+2+0	И	3/1.1
16.	Физическо възпитание				0	(30)	0	(30)	(0+2+0)	И	(3/1.1)
	I курс, II семестър	***4 И***	***2ТО***	***2 КР***	***120***	***90***	***120***	***330***	***8+6+8=22***		***30/12.4***
	III семестър									
17.	Висша математика III	И			30	30	0	60	2+2+0	З	5/2.3
18.	Механика II	И		КР	30	0	30	60	2+0+2	З	5/2.3
19.	Съпротивление на материалите	И		КР	45	15	15	75	3+1+1	З	7/2.8
20.	Механика на флуидите		ТО		30	0	15	45	2+0+1	З	4/1.7
21.	Основи на електротехниката	И			30	0	30	60	2+0+2	З	5/2.3
22.1	Управление на проекти		ТО		30	15	0	45	2+1+0	И	4/1.7
22.2	Индустриален маркетинг		ТО		30	15	0	45	2+1+0	И	4/1.7
23.	Физическо възпитание				0	(30)	0	(30)	(0+2+0)	И	(3/1.1)
24.	Чужд език – специализиран курс I				0	60	0	60	0+4+0	Ф	5/2.3
	II курс, III семестър	***4 И***	***2ТО***	***2 КР***	***195***	***60***	***90***	***345***	***13+4+6=23***		***30/13.1***
	IV семестър									
25.	Теория на машините и механизмите		ТО	КР	30	15	15	60	2+1+1	З	6/2.3
26.	Метрология	И			30	0	30	60	2+0+2	З	5/2.3
27.	Контрол и управление на качеството	И			45	0	30	75	3+0+2	З	7/2.8
28.	Елементи на уредите и машините	И			45	0	30	75	3+0+2	З	7/2.8
29.	Термодинамика	И			30	0	30	60	2+0+2	З	5/2.3
30.	Физическо възпитание				0	(30)	0	(30)	(0+2+0)	И	(3/1.1)
31.	Чужд език – специализиран курс I		ТО		0	60	0	60	0+4+0	Ф	5/2.3
32.	Учебно – производствена практика				0	0	0	(60)		З	(2/0)
	II курс, IV семестър	***4 И***	***1ТО***	***1 КР***	***180***	***15***	***135***	***330***	***12+1+9=22***		***30/12.5***
	V семестър									
33.	Роботизирани модули и системи в производството		ТО		30	0	30	60	2+0+2	З	5/2.3
34.	Елементи и вълни в мехатрониката	И			30	0	30	60	2+0+2	З	5/2.3
35.	Стандартизация	И		КР	30	0	30	60	2+0+2	З	6/2.3
36.	Основи на техническата оптика	И		КР	45	0	30	75	3+0+2	З	6/2.8
37.	Сензори в мехатрониката	И			45	0	30	75	3+0+2	З	6/2.8
38.	Елементи на уредите и машините – курсов проект		ТО							З	2/0
39.	Физическо възпитание				0	(60)	0	(60)	(0+4+0)	Ф	(5/2.3)
40.	Икономика на индустриалното предприятие		ТО		30	15	0	45	2+1+0	Ф	4/1.7
41.	Чужд език – специализиран курс II				0	60	0	60	0+4+0	Ф	5/2.3
	III курс, V семестър	***4 И***	***2ТО***	***2 КР***	***180***	***0***	***150***	***330***	***12+0+10=22***		***30/12.5***
	VI семестър									
42.	Технология на мехатронни системи	И			30	0	30	60	2+0+2	З	5/2.3
43.	Компютърен дизайн в мехатрониката	И			30	0	30	60	2+0+2	З	5/2.3
44.1	Хидрични пневмозадвижване		ТО		30	0	15	45	2+0+1	И	4/1.7
44.2	Електрозадвижване		ТО		30	0	15	45	2+0+1	И	4/1.7
45.	Автоматично регулиране и управление	И			30	0	30	60	2+0+2	З	5/2.3
46.	Регистриращи елементи и устройства в мехатрониката	И			30	0	30	60	2+0+2	З	5/2.3
47.	Компютърни методи за инженерен анализ		ТО		0	0	45	45	0+0+3	З	4/1.7
48.	Курсов проект по дисциплина 42		ТО							З	2/0
49.	Специализираща практика				0	0	0	(60)		З	(2/0)
50.	Чужд език – специализиран курс II		ТО		0	60	0	60	0+4+0	Ф	5/2.3
	III курс, VI семестър	***4 И***	***3ТО***		***150***	***0***	***180***	***330***	***10+0+12=22***		***30/12.6***
	VII семестър										
51.	Електроника		ТО		30	0	30	60	2+0+2	З	5/2.3
52.	Диагностика на мехатронни изделия	И			30	0	45	75	2+0+3	З	6/2.8
53.	Компютърна измервателна техника	И			30	0	30	60	2+0+2	З	5/2.3
54.	Офис техника	И			30	0	30	60	2+0+2	З	5/2.3
55.	Уреди за измерване на физико – механични величини	И		КР	45	0	30	75	3+0+2	З	7/2.8
56.	Курсов проект по дисциплина 54		ТО							З	2/0
57.	Физическо възпитание				0	(60)	0	(60)	(0+4+0)	Ф	(5/2.3)
	IV курс, VII семестър	***4 И***	***2ТО***	***1 КР***	***165***	***0***	***165***	***330***	***11+0+11=22***		***30/12.5***
	VIII семестър										
58.	Техническа безопасност		ТО		20	0	10	30	2+0+1	З	2/1
59.	Контролни и позиционирани системи		ТО		30	0	20	50	3+0+2	З	4/1.9
60.1	Оптоелектроника и лазерна техника	И			40	0	40	80	4+0+4	И	6/3
60.2	Оптомехатроника	И			40	0	40	80	4+0+4	И	6/3
61.1	Нанотехника и технологии	И			30	0	30	60	3+0+3	И	4/2
61.2	Макротехника и технологии	И			30	0	30	60	3+0+3	И	4/2
62.	Преддипломна практика										4/0
63.	Дипломна работа										10/0
	IV курс, VIII семестър	***2 И***	***2ТО***		***120***	***0***	***100***	***220***	***12+0+10=22***		***30/7.***
	Общо за курса на обучение	***30И***	***15ТО***	***10КР***	***1245***	***225***	***1075***	***2545***			***240/95***

ПРИЕТИ ОЗНАЧЕНИЯ:

З – задължителни учебни дисциплини
И – избираеми учебни дисциплини
Ф – факултативни учебни дисциплини

Учебни дисциплини	Аудиторна заетост	
Вид	Брой	Часове
З	42	2255
И	10	280
Общо	59	2535
Ф	7	405
		16

Забележка: В колона 11 с цифри под тиретата О/А са означени: О – общ брой кредити, А – кредити от аудиторна заетост.

Приет с решение на ФС, Протокол № 5/15.05.2012 г.

Ръководител катедра МУ:
/доц. дтн инж. Д. Дачев/

Декан ФМУ:
/доц. дтн инж. П. Неделчева/

Figure 5. *Curriculum of a Bachelor's degree program in Mechatronics*

Current projects of research and applications in nanotechnology quantum dots (semiconductor nanosized) carbon nanotubes (CNTs), fullerenes (formations of carbon atoms), nanocomposite materials for advanced technology, metal nanoparticles (mainly precious metals, gold, silver, platinum) magnetic nanoparticles (for diagnostics in medicine.), polymeric nanoparticles (as carriers of medicinal products for targeted treatment), nanostructured ceramic materials for sensors and for TU-Gabrovo - nanopowders, materials, packaging and others purposes. Based on the research conducted by the Department „MU"of the Technical University of Gabrovo, a three coordinate measuring machine was developed using the elemental basis of modular construction system for automation Heron ROBOTUNITS (fig. 6). The machine has a PLC-control and connection with CAD-CAM-system, operating in 1000 x 700 x 660 mm, with precision 10-20 μm. Measurement results are automatically recorded in the minutes in English. The management system is built using controllers from company MITSUBISHI ELECTRIC. The Microcontrollers FX2N and FX3U the MELSEC FX family of MITSUBISHI provide a good basis for economical solutions to problems of governance and regulation requiring from 10 to 256 inputs and outputs built for industrial applications and automation applications, likewise the use of the GT1150-QLBD - connection module, MR-E-20A-QW003 – servo power, HF-KE23KW1-S100 - servo motor. They can be expanded to respond to changes in schedules and increasing demands of consumers. The FX3U and FX2N controllers can communicate with other PLC-systems and controllers and interfaces for management and control panels. These two controllers have the opportunity for modular expansion and can be used to solve complex applications and tasks that require special features such as analog-digital and digital to analog conversion and the capability for networking (fig.7).

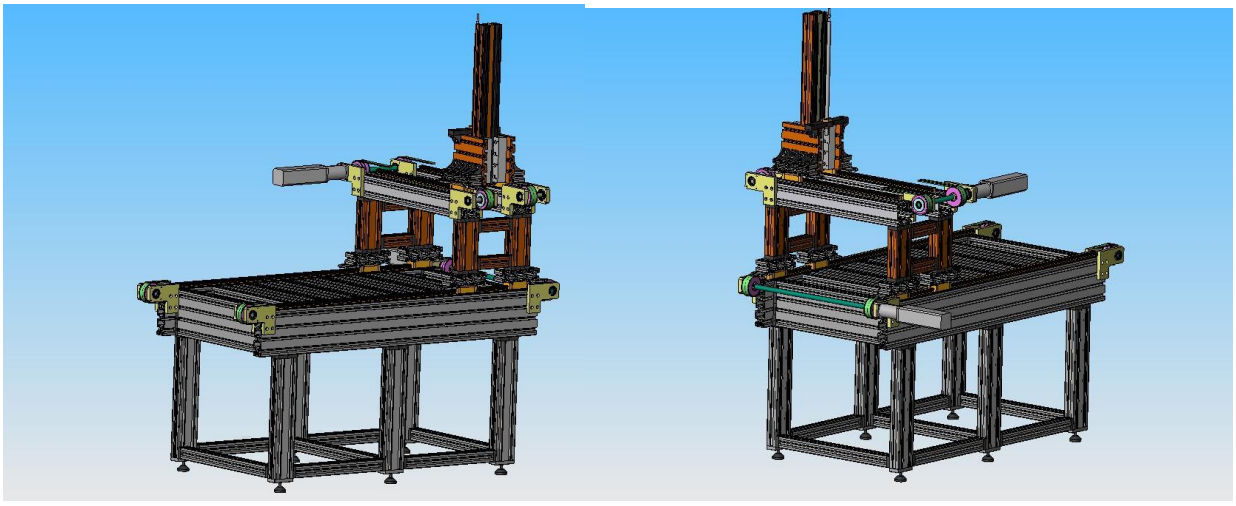

Figure 6. *Three coordinate measuring machine*

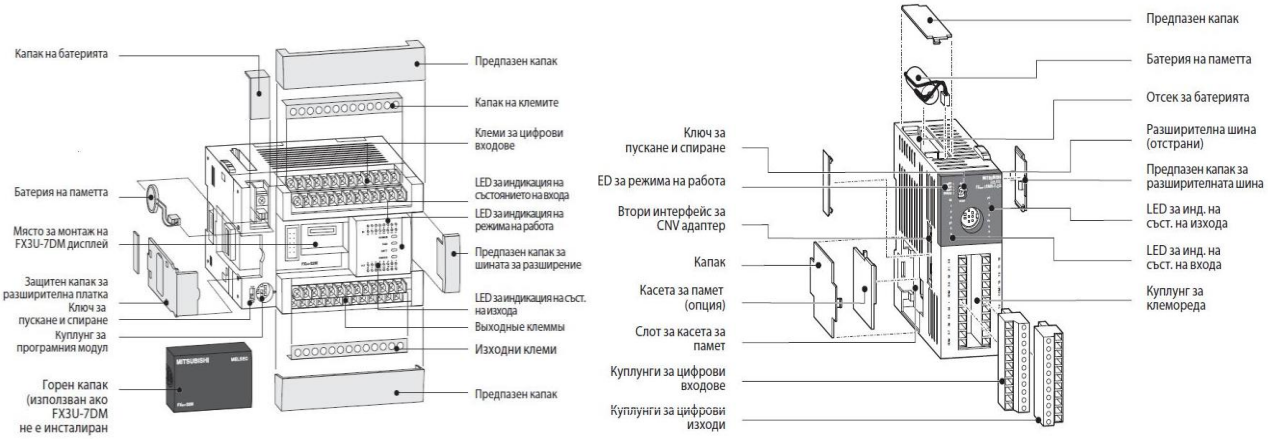

Figure 7. *PLC-programmable logic controllers FX2N and FX3U (in Bulgarian)*

Computerization in the mechatronic industry requires constant miniaturization and automation. Therefore, the author has developed the following products and software. It is basic to have an integrated system for automated design of functional elements of the micro-technique and selection processes for their preparation [9, 10], which sets out several examples of production of micronutrients. Moreover, in the front conference in Kaunas a microsensor for pressure was presented [11]. Here I want to focus on joint development in the form of a thesis on the Erasmus program, EMK Institute at the Technical University Darmstadt, Germany "Delta-Robot invasive surgery" (fig. 8). The first option was used with an external gear mesh, but not reduced weight of the robot. The second option is applied to the internal gear meshing and slight changes the suspension because the mechanism becomes more compact. The range of work is complemented by optical elements, miniature gears with asymmetric profile of engagement, dosimetry devices and other modifications. The aim of the training and development is to develop products for the market or to develop "Market Mechatronics". Additional information on the research can be drawn from the publications [14, 17, 18, 19, 20, 39, 40].

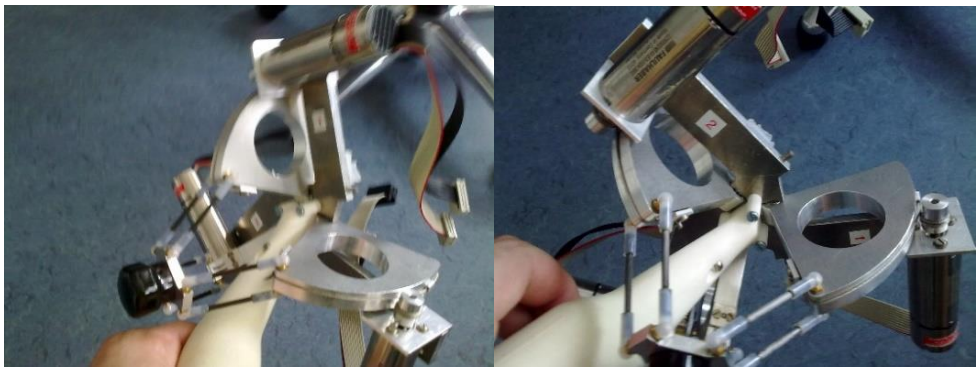

Figure 8. *An invasive surgical robot developed jointly with TU – Darmstadt, Germany*

My participation in a number of Mechatronics conferences has enabled me to express my view of its development in the publications [21, 22]. In articles [23, 24, 26] are proposed model and engineering-pedagogical techniques of training of technological disciplines in engineering specialties of TU – Gabrovo has been developing in the last 20 years. The training is divided into 8 thematic cycles and is oriented towards self-awareness as Bulgarian specialists in the profession. Specific developments in mechatronics are presented in publications [25, 27, 28]. Apply didactic approach that is very modern in the learning process for students of specialty Mechatronics. With Lego Mindstorms easily can be developed a small model of industrial robot or some system that is used in real life. These options are very diverse (fig. 9).

Figure 9. *Examples of robots - Stairclimber, Gyro Boy, Color Sorter and Robot Arm*

Research work on projects is presented in articles [29–35, 38] and includes Contract Reports 1308-M/2013 "Research and Modeling of Optical, Optoelectronics and Production and Organization Systems and Devices", 1636-C /2016 and 1722-M/2017 "Study of nanocomposites of silicon structures for application in mechatronics" at the University Centrum of Research and Technology in TU-Gabrovo. The bibliography on the topic of mechatronics will end with the textbook "Robotic modules and production systems" [36], developed new curricula in 2017 [41] and issued papers on educational project [37, 42].

3. CONCLUSION

The essence of a mechatronic approach is to merge into a single module / s the constituent elements in varying degrees of integration. To achieve the above mentioned goal, the rubber plant training was taken and research work was conducted. The curriculum for Master's and Bachelor's degree in Mechatronics at the Technical University of Gabrovo and are described in lectures, seminars and practical lessons (refer to the author). Topics related to practical implementation are as follows: pressure micro sensor, robotic invasive surgery, micro mechanisms and other. Research works on the subject are discussed in the University of Gabrovo. Proposed information can be used not only in the educational process of students inspecialty „Mechatronic", but also specialists in practice. The author is open for discussion, consultation and presentations on the topic.

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