TÜRKİYE'DEKİ MEKATRONİK ÖNLİSANS PROGRAMLARININ MÜFREDAT ANALİZİ

CURRICULUM ANALYSIS OF MECHATRONICS ASSOCIATE DEGREE PROGRAMS IN TURKEY

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ABSTRACT

In this study, course plans of 16 programs giving mechatronic associate's education in 17 universities out of 21 programs that published their course plans on their internet sites are reviewed. Similarities and differences of the course plans of these 16 schools were analyzed with several aspects. Weekly course hours, theoritical and application course hours were compared. Relationships and ratios of the course plans were investigated in the six categories as Electrical and Electronics, Computer and Control, Mechanics and design, Interdisciplinary, Fundemantal Sciences, and Culture. These categories forms the mechatronics education together. It was exposed quantitively that some schools have Electrical and Electronics tendency, others have Mechanical tendency according to the weights of the course programs. Disadvantages of the curriculum differences were discussed and it was suggested that the curriculums and education of mechatronics associate's education should be well standardized.

Keywords: Mechatronics, Associate's Education, Curriculum, Analysis, Standardization.

ÖZET

Bu çalışmada Türkiye'de 17 üniversite bünyesinde mekatronik önlisans eğitimi veren 21 programdan ders planlarını internet sayfalarında yayınlayan 16 okulun ders planları incelenmiştir. Okulların uyguladıkları ders programları arasındaki benzerlikler ve farklılıklar değişik boyutlarıyla incelenmiştir. Haftalık ders saatleri, teori ve uygulama saatleri karşılaştırılmıştır. Ders planları; Elektrik-Elektronik, Bilgisayar ve Kontrol, Mekanik ve Tasarım, Disiplinler Arası, Temel Bilimler ve Kültür olmak üzere altı kategoriye ayrılarak Mekatroniğin alt bileşenlerini oluşturan gruplar arasındaki ilişki ve oranlar incelenmiştir. Bazı okulların ders programlarının Elektrik-Elektronik ağırlıklı bazı okulların ise Mekanik ağırlıklı eğitim verdikleri sayısal verilerle ortaya konulmuştur. Müfredat farklılıklarının getireceği sakıncalar tartışılmış, mekatronik önlisans eğitiminde müfredatların ve eğitimin standartlaştırılması önerilmiştir.

Anahtar Kelimeler: Mekatronik, Önlisans Eğitimi, Müfredat, Analiz, Standartlaşma.

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1. INTRODUCTION

Mechatronics associate's education has started first in Kocaeli University Kocaeli Vocational School (VS) and Sakarya University Sakarya VS in 2001 in Turkey (OSYM Guides, 2000-2008). From this date the mechatronics program count and the student quotas has continous increasing trend.

Student quotas has reached to the number of 1925 in 21 mechatronic programs including one distance education VS considering April 2009. Becoming widespread of mechatronics programs was not planned well in Turkey. There are many significant differences between the currently available mechatronics curriculum of vocational schools for today.

The most widely mechatronics definition is "The synergistic integration of mechanical engineering with electronics and intelligent computer control in the designed manufacturing of industrial products and processes" (Harashima, 1996). Considering this definition, question about education standarts and course programs of mechatronics associate's education has not answered yet. After review of the mechatronics associate's programs it is seen that two main tendencies in Turkey. The first one is Electrical / Electronics education option and the second one is Mechanical education option. The main reason of the curriculum differences can be the available instructors and the laboratory equipments.

Due to lack of program integrity between VSs and institutions of vocational and technical secondary education, and the inability of vocational and technical education programs to be updated according to the demands of labor force market, the employment of vocational and technical education graduates can not be raised and this has reduced the demand for vocational education (DPT Development Plan, 2007-2013). Though there were problems in most of the VSs about theory – based education, lack of basic facilities, and curriculum difference with VHSs, an important attempt was made through the project of VSs program development by Turkish Higher Education Council (YÖK) in 2002 to solve these problems. In the project, the programs of 15 VSs were considered. Although this number constitutes 5% of VS programs, it covers 70% of the student studying in these schools (Balcı et.al.). In general, the advanced programs were prepared in accordance with international accreditation (ABET & SQA) (Gürbüz, 2004), but such a study hasn't been carried out for mechatronic programs yet.

Gürbüz (2004) has carried out probably the most detailed study ond Mechatronic Education in VSs in Turkey made significant suggestions about the system; howewer has not performed a comparative curriculum analysis not mentioned the latest developments after 2004.

In this study, the analysis of 16 mechatronic programs published their course plans in websites was done and the differences between the programs were investigated. Course programs were categorized into six groups such as Electrical and Electronic, Computer and Controls, Mechanics and Design, Interdisiplinary, General Sciences and Culture. Accoring to this categorization, concentration of the above groups were determined and the option tendencies were defined. The present study discusses the mechatronics comparative curriculum analysis between VSs, necessity of branch education problems and solution suggestions.

2. VOCATIONAL EDUCATION MECHATRONICS CURRICULUM

The main problem related to the educational curriculum of VS is to what degree the courses of Electrical-Electronics, Machinery, Computer and Control forming the sub-components of Mechatronics reflected in the course plans. The other issues can be listed as follows: the difference in the courses of theory and practice, and the differences between total course credit and teaching hours. There is still not a standard or specific approach regarding the course programs in the mechatronics undergraduate education. When we have a look at today's schedule, we can see that there are specific course programs in each school concerned with mechatronics education, including serious differences with other schools. The most important factor about these differences is that the programs are not set up according to a certain plan and standard. When the detailed analyses of course programs were made, it was observed that these mechatronics undergraduate programs had serious differences depending on the school.

2.1. Total teaching hours with theoretical and practice rates

Since 2008, there have been 20 VSs continuing mechatronics undergraduate education and one distance education VS. In analyzing the course programs, sixteen schools giving their course schedules on internet pages were examined. This number seemed sufficient to make a general assessment. In Table 1, course schedules of sixteen mechatronics programs and one distance learning education program were compared. The course schedules of schools during four semesters were examined including optional courses and theirs predominance percentages in the whole course plan were estimated together with the theoretical and practical teaching hours. In this comparison, the percentage rates of theoretical and practical courses in the course schedules of schools were also estimated.

Table 1. Four Semester Total Weekly Course Hours

	Vocational Schools and Mechatronics Programs	Theory Hours	Theory %	Practice Hours	Practice %	Total Hours	Credit Hours
1	Celal Bayar University Soma VS	82	77,36	24	22,64	106	104
2	Çanakkale Onsekiz Mart University Çan VS	88	70,40	37	29,6	125	109
3	Dokuz Eylül University İzmir VS	82	70,08	35	29,92	117	100
4	Gaziantep University Gaziantep VS*	-	-	-	-	-	104
5	Gaziosmanpaşa University Turhal VS	84	73,68	30	26,31	114	112
6	Gaziosmanpaşa University Zile VS	86	78,89	23	21,10	109	106
7	Kadir Has University VS*	-	-	-	-	-	63
8	Karadeniz Technical University A. Kanca VS	89	78,76	24	21,24	113	99
9	Kastamonu University VS	81	81,00	19	19,00	100	89
10	Kocaeli University Gebze VS	85	79,44	22	20,56	107	96
11	Kocaeli University Karamürsel VS	88	78,57	24	21,42	112	96
12	Sakarya University Sakarya VS	75	81,52	17	18,47	92	92
13	Sakarya University Adapazarı VS	75	81,52	17	18,47	92	92
14	Selçuk University Kadınhanı Faik İçil VS	90	86,53	14	13,46	104	97
15	Selçuk University Ereğli VS	90	86,53	14	13,46	104	97
16	Uludağ University Technical Science VS	63	60	42	40	105	84

* ONLY COURSE CREDITS ARE GIVEN IN THE INTERNET SITES.

According to Table 1, the total teaching hours in the course schedules of schools vary between 92 and 125 hours, however credit hours vary between 63 and 112 hours. In the education system of Turkey, industry expects that VSs become practice-based schools (Balcı et.al, 2003 - Kasap et.al, 2006). In the current table, practice rates vary between

13.46% and 40%, and these rates increase 22.55% on average. It is seen that the rate of giving face-to-face education is below the rate in distance learning. The rate in the number of courses in formal education program and distance learning program in Sakarya University is the same. Same difference is seen in Zile and Turhal VSs of Gaziosmanpasa University. This situation can be considered as ‘’richness’’, but in the future it can lead to graduates who have the same associate’s degree but have much more different level of education.

2.2. The predominance of courses in terms of disciplines

Mechatronics is defined as a synergic integration of Electronics, Computer and Machinery (Auslander, 1996). To study the extent to which these components in arranging course schedules are effective, the courses taught were analyzed in six categories. These are:

- **Computer and Control:** It covers the courses including Basic Computer Use, Programming, Controllers, and Classical and Modern Control Theory.
- **Electrics-Electronics:** The courses classified in this part are completely or predominantly composed of Electrics, Electronics Theory, and Circuit Designs.
- **Machinery and Design:** The courses classified in this part are completely or predominantly composed of machinery theory, practices and designs.
- **Interdisciplinary:** The courses in this part are composed of courses that cannot be completely classified and that are in the intersection of different disciplines in terms of mechatronics concept.
- **General Sciences:** This part is composed of courses of Mathematics, Physics, and Scientific Principles of Technology.
- **Culture:** It covers the courses such as History of Ataturk Principles and Reforms, Turkish language, Foreign Language, Sports, Communication, Fine Arts, Management, etc.

Table 2. Distribution of Courses According to the Disciplines

Electrical and Electronics	Computer and Controls	Mechanics and Design
- Measurement - Circuit Analysis (DC /AC) - Electronics - Digital Electronics - Electrical Machines and Control - Power Electronics - Sensors and Transducers - Electromechanic Control - Computer Aided Electronics Circuit Design	- Fundamental Computer Technologies - Computer / Visual Computer Programming - Computer Aided Data Acquisition and Control - Automatic Control / Process Control - Process Measurements - Artificial Intelligence / Fuzzy Control - Programming Logic Controllers - Microprocessors / Microcontrollers	- Materials - Mechanics - Static and Dynamics - Thermodynamics - Computer Aided Manufacturing [CAM] / CNC Machines - Computer Aided Design [CAD] - Pneumatics and Hydraulics - Mechanical Science and Components - Mechanical System Design - Energy Management - Engineering Science

Interdisciplinary	General Sciences	Culture
- Introduction to Mechatronics - System Analysis and Design (Projects) - Robotics - Mechatronic Practices - Mechatronics System Design - Bio-mechanic - Fault Detection in Mechatronic Systems - Servo Systems	- Mathematics - Physics - Scientific Principles of Technology	- History of Ataturk Principles and Reforms - Turkish Language - English - Sports / Fine Arts - General and Technical Communication - Quality Management Systems - Management Administration - Human Rights - Labor Law

The course programs of VSs are shown in Table 2 according to these six categories. Also, the percentages of these categories within the whole course plan are indicated in Table 3. In this analysis, no division of optional and compulsory courses is made and the course schedules are viewed as general.

Table 3. Percent Weight of Mechatronic Course Programs according to disciplines.

	Vocational Schools and Mechatronic Programs	Electrical & Electronics %	Computer & Control %	Mechanics & Design %	Interdisciplinary %	Fundamental Sciences%	Culture %	Total %	Branch %	Culture & Fundamental Sciences %
1	Celal Bayar University Soma VS	21,70	16,98	16,04	11,32	11,32	22,64	100	66,04	33,96
2	Çanakkale Onsekiz Mart University Çan	23,20	14,4	22,40	11,20	9,60	19,20	100	71,20	28,80
3	Dokuz Eylül University İzmir VS	28,77	17,26	17,26	15,83	5,75	15,10	100	79,15	20,85
4	Gaziantep University Gaziantep VS	25,40	20,50	13,93	12,03	9,84	18,03	100	72,13	27,87
5	Gaziosmanpaşa University Turhal VS	25,00	27,94	13,24	4,41	8,82	20,58	100	70,60	29,40
6	Gaziosmanpaşa University Zile VS	16,24	20,51	18,80	11,96	7,69	24,79	100	67,52	32,48
7	Kadir Has University VS	28,57	31,75	12,70	3,17	4,76	19,04	100	76,02	23,08
8	Karadeniz Technical University A.Kanca	30,97	21,24	13,27	10,62	7,96	15,94	100	76,01	23,90
9	Kastamonu University VS	21,00	18,00	30,00	4,00	8,00	19,00	100	73,00	23,00
10	Kocaeli University Gebze VS	16,41	21,64	11,20	26,86	5,22	18,66	100	76,12	23,88
11	Kocaeli University Karamürsel VS	26,68	23,21	16,07	10,71	8,04	14,29	100	77,67	22,33
12	Sakarya University Sakarya VS	11,54	17,30	25,00	8,65	8,65	28,85	100	62,50	37,50
13	Sakarya University Adapazarı VS	11,54	17,30	25,00	8,65	8,65	28,85	100	62,50	37,50
14	Selçuk University Kadınhanı Faik İçil VS	10,84	28,33	22,5	10,00	8,33	20,00	100	71,67	28,33
15	Selçuk University Ereğli VS	10,84	28,33	22,5	10,00	8,33	20,00	100	71,67	28,33
16	Uludağ University Technical Science VS	25,16	37,74	7,95	7,95	7,95	13,25	100	78,08	21,20

2.3. The differences in course programs

None of the course schedules of the current mechatronics undergraduate programs have a consistency of 100% with each other, except for Sakarya and Adapazarı VSs belonging to the same university and Kadınhanı and Eregli VSs. Though Turhal and Zile VSs of Gaziosmanpasa University belong to the same university, they have different course schedules. Other differences in course schedules can be summarized as follows:

- The differences in the titles of courses that have the same content, teaching hours, theory and practice classes.
- The differences in the weekly course schedules and credits of schools.
- The differences about whether the optional courses are included in course schedules.
- The differences about adding main courses, considered as compulsory ones, into optional courses.
- The differences in arranging the courses according to the situations of being prior and posterior and being in different teaching semesters

3. MECHATRONICS BRANCH EDUCATION

3.1. Present Situation of Branch Education

In Turkey, branch education is not applied in mechatronics associate degree. The students who have an education with different courses and programs and graduate from 21 different VSs have the same professional title and associate's degree. In a study on mechatronics VS

education in Turkey, a course schedule was suggested for the branch of Mechatronics-Manufacturing (Gürbüz, 2004). In the suggested program, it is seen that 61.66% of the courses are theoretical and 38.33% of them are applied courses.

When the courses in the suggested program are classified as shown in Table 3, their distributions according to scientific branches are shown in Figure 3. As seen, 66.65% of the courses is vocational, 33.35% of them is Culture and National Science courses.

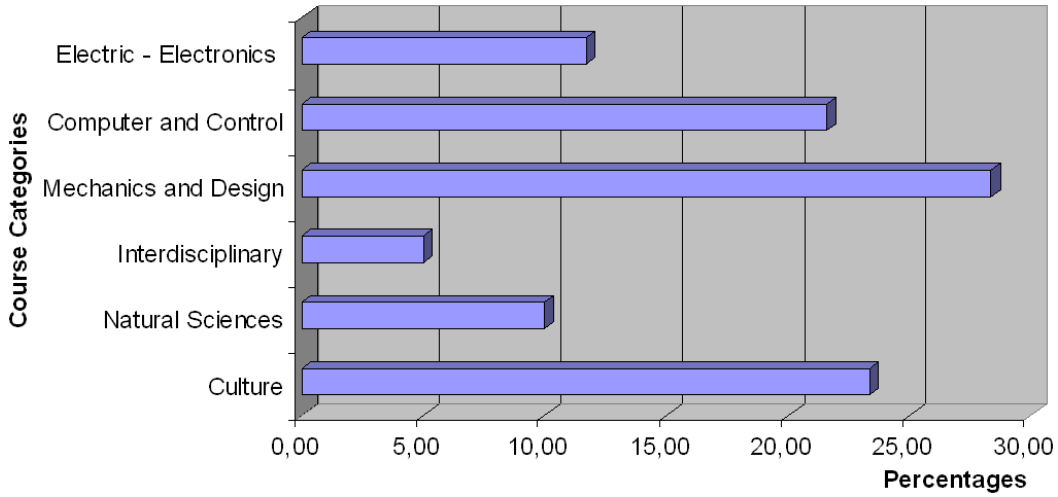

Figure 1. Suggested Percentages of Manufacturing Branch

The analysis in course schedule suggested for the program of Mechanics-Manufacturing Branch Education was carried out in 21 schools (Table 4) whose course schedules are found in internet and it was shown in Table 4 whether these programs are more suitable for Mechatronics-Electrics/Electronics Branch or Mechatronics-Manufacturing Branch. In preparing Table 4, the method followed is this: the ratios of courses in Electrical and Electronics group and the ones in Mechanics and Design group were estimated. As a result, it was thought that the group whose rate is over 50% shows to which branch education it is inclined.

According to the data in Table 4, Mechatronics associate's education in Turkey has two basic tendencies.

- *Electrical - Electronics branch education:* The schools whose courses of Electrics-Electronics are predominantly over 50% compared to Mechanic and Design courses. (Table 4 Row Numbers : 1,3,4,5,7,8,10,11,16).

- *Manufacturing branch education:* The schools whose courses of Mechatronics and Design are predominantly over 50% in comparison to Electrical-Electronics. (Table 4 Row Numbers : 6,9,12,13,14,15).

There is only one exception; Çan VS has a balanced program between Electrical - Electronics and Manufacturing branch. (Table 4 Row Number : 2).

Table 4. Branch tendencies according to Electrical-Electronics, and Mechanic and Design.

	Vocational Schools and Mechatronic Programs	Electrical Electronics%	Mechanic and Design%	Option Tendency
1	Celal Bayar University Soma VS	**57,49**	42,51	Electrical–Electronics
2	Çanakkale Onsekiz Mart University Çan VS	50,88	49,12	**Balanced**
3	Dokuz Eylul University Izmir VS	**63,50**	36,50	Electrical–Electronics
4	Gaziantep University Gaziantep VS	**64,58**	35,42	Electrical–Electronics
5	Gaziosmanpaşa University Turhal VS	**65,38**	34,62	Electrical–Electronics
6	Gaziosmanpaşa University Zile VS	46,35	**53,65**	Manufacturing
7	Kadir Has University VTS	**67,58**	32,42	Electrical–Electronics
8	Karadeniz Technical University A. Kanca VS	**70,00**	30,00	Electrical–Electronics
9	Kastamonu University VTS	36,17	**63,83**	Manufacturing
10	Kocaeli University Gebze VS	**59,43**	40,57	Electrical–Electronics
11	Kocaeli University Karamürsel VS	**62,40**	37,60	Electrical–Electronics
12	Sakarya University Sakarya VS	31,58	**68,42**	Manufacturing
13	Sakarya University Adapazarı VS	31,58	**68,42**	Manufacturing
14	Selçuk University Kadınhanı Faik İcil VS	32,51	**67,49**	Manufacturing
15	Selçuk University Eregli VS	32,51	**67,49**	Manufacturing
16	Uludağ University Technical Science VS	**77,78**	22,22	Electrical–Electronics

3.2. The possible results of the present situation

- In view of the analyses made as of today, almost for every school there is a different understanding and application of mechatronics education given in the so-called VSs. The present situation causes the students to be trained with the same professional name, but with different educational level and variety. This will also bring about discussions related to the term 'Mechatronics Technician'. These data show the necessity and obligation of standardization in Mechatronics undergraduate education.
- Mechatronics associate's education started in 2001 in Turkey is gradually becoming widespread. If the industrial condition of the regions and the basic facilities of universities are not taken into consideration while opening new mechatronics programs, it is likely to have problems of employment and quality in further steps.
- As a whole the problems of VSs giving mechatronics education are not independent from the other problems in Turkey. The most important ones of these issues are lack of sufficient sources and application. Unless certain improvements are made on this subject, it will become difficult to train and graduate Mechatronics technician suitable for the expectations of industry (Kasap et.al., 2006).

4. RESULTS

It is obvious that mechatronics education requires an important infrastructure whether thought that the mechatronics discipline become a synergistic combination of electrical / electronics, computer / control and mechanical disciplines. It is required that the laboratory equipments and teaching staff of mechatronic programs of VSs must be quite robust. The limited sources will be used efficiently if Electrical-Electronics, Computer and Mechanical programs that forms main disciplines of mechatronics exist in the VSs has mechatronics program. In this study, it is seen that this condition is not provided fully in the reviewed mechatronics programs.

There are significant differences between theoretical and practical hours, and also weekly course hours and credits if the course curriculum of mechatronics associate's education were researched. Also, there are significant differences in the distribution rates of the courses forms the sub-disciplines of mechatronics. After all these data are examined, it

appears that there are two main tendencies in the mechatronics associate's education as electrical – electronics and mechanical (manufacturing) branches. It is clearly seen that branch education has needed in VSs, otherwise the students come from different programs get different kind of knowledge and experience during the mechatronics education in VSs but will get the same associate's degree despite their differences and this situation will cause unpredicted problems in the future.

Suggestions to overcome all of these problems are stated as;

- The professional and educational standards of mechatronics technician must be determined on a national level that compatible with the international standards and the curriculum of the schools must be in parallel with these standards.
- Curricula must be reviewed and updated through a dynamic structure for certain periods according to technological changes, industrial demands, and regional needs. The curriculum varieties for the regional and industrial needs must be provided by the well defined optional courses without changing the main structure of the existing curriculum and this also gives an opportunity to meet the new developments on the technology.
- Practice hours are very important in VSs, hence the theory and practice course hours in curriculum must be close to each others.
- VSs must perform two mechatronic branch educations as Electric-Electronic and Manufacturing according to their own facilities.
- In the transfers of students from high school to VSs who are encouraged to attend mechatronics programs, the ones graduated from Machinery department must be encouraged to VSs giving Mechatronics-Manufacturing Branch Education and the ones graduated from Electrics-Electronics department, on the other hand, must be encouraged to VSs giving Mechatronics-Electrics/Electronics Branch Education.

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