



ENGINEERING EDUCATION IN TURKEY AND THE PLACE OF THE ENERGY SYSTEMS ENGINEERING

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Abstract

Human being works hard to make a life comfortable and sustainable. Many people working on social, physical and health sciences do research and study to make it possible. Among all these sciences, engineering cannot be excluded from the others because it is one of the executive parts. In this study, the departments under state and foundation universities which give the engineering education, and diploma are examined. For this aim, the departments actively giving education and their curriculum in our country are analyzed and their similarities and distinctions are evaluated. Among the engineering disciplines, the field of energy engineering, the number of expected graduates and working area are taken into consideration, and the proposals and reviews have been done.

Keywords: Engineering Education, Energy Systems Engineering

TÜRKİYE'DE MÜHENDİSLİK EĞİTİMİ VE ENERJİ SİSTEMLERİ MÜHENDİSLİĞİNİN YERİ

Özet

İnsanoğlu hayatı kolaylaştırmak, konforlu ve sürdürülebilir kılmak için her geçen gün çalışmakta ve uğraş vermektedir. Sağlık bilimleri, fen bilimleri, sosyal bilimler, mimarlık ve mühendislik alanlarından birçok bilim insanı bu erek için çalışmalar yürütmektedir. Bu bilimler içerisinde, "Mühendislik Alanı", teknolojik ve ekonomik gelişimin sağlanması için diğerlerinden ayrılmaz ancak yürütücü olma özelliği olan temel alanlardan bir tanesidir. Bu çalışmada, hâlihazırda devlet ve vakıf üniversitelerinde bulunan mühendislik eğitimi ve diploması veren bölümler üzerine bir araştırma yapılmıştır. Bunun için, ülkemizde eğitim öğretime devam eden bölümler ve ders planları incelenerek ortak yanları ve birbirlerinden ayrıştıkları kısımlar değerlendirilmiştir. Mühendislik disiplinleri içerisinde Enerji Sistemleri Mühendisliği'nin yeri, öngörülen mezun sayısı ve çalışma sahaları dikkate alınarak öneriler ve eleştiriler getirilmiştir.

Anahtar Kelimeler: Mühendislik Eğitimi, Enerji Sistemleri Mühendisliği.

1 Introduction

According to Turkish Language Institution, Engineer refers to "Person who educated in based on the meet all kinds of people's need such as civil public works -roads, bridges, public building-, food -agriculture, nourishment-, science -physics, chemistry, biology, electricity, electronics-, technical and social fields - plane, automobile, construction machines-[1].

The knowledge of Mathematics and science of nature that acquire with education, experience and application and natural forces and sources; which are designated to use for the benefit of humanity with a consideration of natural resources sustainability principles and ethics of engineering to development effort of methods is defined as engineering according to "Union of chambers of Turkish engineers and architects (TMMOB)" [2].

The feature of education of the engineering is expected to be listed as: Understanding of the fundamental scientific principles and gaining basic information; an understanding and can be able to apply of these engineering methods such as analysis, calculation, modeling, design and experimental control, to gain awareness of profession and perception of economics and social factors related to engineering.

Engineering has a very broad study, application field and work area. Energy and the sub-sectors of energy have an important place in this extensive work area. Today, when considering the power generation, energy supply security and environmental factors, etc., it is observed that, there is a trending interest and efforts on using the local and renewable-energy resources. And this leads to an increase in the importance of a new and multi-disciplinary bachelor program called Energy Systems Engineering day by day. Energy Systems Engineering is an engineering branch that can solve complex problems related to energy and environment in the stages of energy systems' design, installation and operation, and modeling and optimizing processes.

Energy Systems Engineer is the one who has sufficient knowledge in energy and an ability to internalize the education received from different engineering disciplines, also gained the engineering viewpoint and analytical thinking skills. He/she is capable of working on the topics such as power generation, energy conversion processes and energy auditing, etc. He/she has comprehensive knowledge of energy legislation and is qualified to run, manage, develop the engineering projects related to the fields of energy.

Energy Systems Engineers can be employed in governmental establishment such as; Republic of Turkey Ministry of Energy

and Natural Resources (ETKB), Republic of Turkey Energy Market Regulatory Authority (EPDK), General Directorate of Mineral Research and Exploration (MTA), Turkish Electricity Transmission Company (TEİAŞ), Electricity Generation Company (EÜAŞ) and can be employed in many other companies that in business of fields of energy and energy related sub-sectors. On the other hand, Energy Systems Engineering is a hybrid and multidiscipline program that has not been yet completed the process of development of the body of profession in Turkey. In this regard, more pronouncing the program name in terms of official scale and increasing the name recognition of the program in governmental and industrial companies and establishments is expected.

In this study, general assessment of engineering education in Turkey and identification of current problems of engineering education of energy-related programs has been done, and suggestions are tried to serve.

2 Engineering Departments in Turkey

Tangible data on education in Turkey provide us important clues for the future and also for the past of the profession of engineering. There are 109 state universities and 76 foundation universities, and the total number of the universities in Turkey is 185 as of the academic year 2015-2016. Additionally, counting the eight foundation vocational college, there is a total of 193 higher-education institutions. Figure 1 shows that these higher education institutions in terms of their types [3].

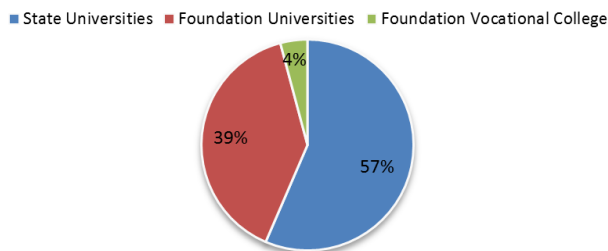


Figure 1. Types of universities in Turkey

In these universities (245 state university, 81 foundation unit are currently giving the degree of engineering. According to engineering quotas of 2015 university entrance by per program per student (except Faculty of Agriculture), the total number of quotas is 83,248. This number is corresponded to approximately %20 percent of the whole quota of higher-education programs of 2015.

Table1. Quotas and placed students for 2015 [4].

University Type	Total Quotas	Placed Students	Empty Quotas
State Universities	340.197	335.760	4.437
Foundation Universities	79.959	72.927	7.032
T.R.N.C. Universities	14.278	8.097	6.181
Total	434.434	416.784	17.650

Today, engineering education is given in many areas. As well as traditional engineering disciplines, there are also numerous multidisciplinary engineering education in our country. The list of the engineering programs in Turkey currently continuing their education is shown in Table-2 according to data derived from ÖSYS-2015 [5].

Table 2. List of the departments giving engineering education in Turkey.

Name of Department	Total Quotas	
	State Univ.	FDN Univ.
Computer Forensics Engineering	84	0
Woodworking Industrial Engineering	124	0
Fisheries Technology Engineering	0	22
Computer Engineering	5389	2820
Computer and Software Engineering	0	40
Information Systems Engineering	167	165
Biomedical Engineering	832	476
Bioengineering+Genetic and Bioengineering	694	265
Biosystems Engineering	142	0
Mineral Processing Engineering	43	0
Environmental Engineering	3042	23
Maritime Transportation Management Engineering	448	324
Leather Engineering	21	0
Electric Engineering	495	0
Electric and Electronic Engineering	7932	2741
Electronic Engineering	77	0
Electronic and Communication Engineering	729	338
Industrial Engineering	3270	3029
Industrial and System Engineering	0	118
Industrial Design Engineering	208	0
Energy Systems Engineering	1531	246
Energy and Material Engineering	20	0
Physics Engineering	206	0
Naval Architecture and Marine Engineering	170	105
Marine Engineering Operations	170	299
Shipbuilding and Ocean Engineering	36	0
Geomatic Engineering	1575	60
Food Engineering	4108	277
Aerospace Engineering	78	40
Hydrogeology Engineering	49	0
Manufacturing Engineering	458	25
Civil Engineering	8380	3131
Management Engineering	164	137
Geophysics Engineering	193	0
Geology Engineering	814	0
Chemical Engineering	1736	30
Chemical and Process Engineering	88	0
Chemical-Biology Engineering	0	36
Automation and Control Engineering	152	0
Fiber and Polymer Engineering	41	0
Mining Engineering	605	0
Mechanical Engineering	9754	1821
Mechanical and Manufacturing Engineering	200	0
Mechanical and Material Engineering	0	50
Material Science and Engineering	498	0
Material Science and Nanotechnology Engineering	41	65
Material Engineering	156	0
Mathematical Engineering	259	0
Mechatronics Engineering	1966	504
Mechatronics Systems Engineering	41	0
Metallurgical and Materials Engineering	2446	45

Meteorological Engineering	93	0
Jewelry Engineering	0	25
Engineering Programs	0	175
Engineering and Natural Science Programs	0	274
Nanotechnology Engineering	31	0
Nuclear Energy Engineering	88	0
Optic and Acoustics Engineering	31	0
Forest Industry Engineering	124	0
Forest Engineering	547	0
Automotive Engineering	1082	88
Petroleum and Natural Gas Engineering	329	85
Polymer Engineering	62	0
Railway Engineering	186	0
Aquacultural Engineering	109	0
Agricultural Machinery and Technology Engineering	219	0
Agricultural Genetic Engineering	31	0
Textile Engineering	569	30
Medical Engineering	16	40
Aircraft Engineering	224	0
Aircraft and Aerospace Engineering	72	0
Transportation Engineering	104	0
Aerospace Engineering	57	68
Software Engineering	443	577
Total Quotas	64049	18594
Final Total Quotas	82643	

Figure-2 indicates the share of the total quotas of some engineering programs in total quotas of engineering programs in 2015 [5].

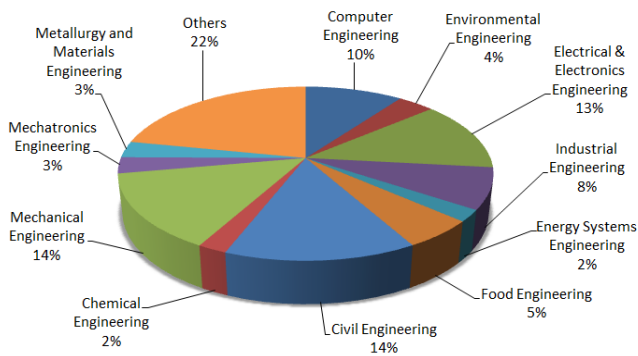


Figure 2. The share of the total quotas of some engineering programs in 2015 (%)

2.1 Common Characteristics of the Curriculum of the Engineering Departments

There are significant common characteristics in the curriculum of the engineering departments, which are capable of developing engineering point of view to students. Some lectures in curriculums can be categorized and can be classified as follows:

- Main Science Courses (Mathematics, physics, chemistry)
- Courses based on Mathematics (Differential Equations, Linear Algebra, Engineering Mathematics, Statistics, Probability, Numerical Methods, Experimental Design, etc.)

- Main Engineering Courses (Technical Drawing, Engineering Mechanics, Thermodynamics, Electrical-Electronics, Science of Material, Engineering Economics)
- Council of Higher Education (YÖK) Courses
- Technical Elective Courses (Courses about Works of Departments)
- Social Elective Courses

Courses which are mandatory for minimum of two semesters in regards of the 2547 Higher Education Act and Law (Turkish, Principles of Atatürk, History, Fundamentals of Information Technology, Foreign Languages, Occupational Health and Safety) defined as YÖK Courses [6].

A person with engineering title has to be open mind for development, perspective questioning the ideas, innovation and wide point of view. Engineering is a field that requires the skill of design, modeling, analyzing and optimizing of mostly operative systems but also static systems. Therefore, some lectures are considered to be inevitable in the Engineering education. In regards of these considerations an engineer should take Engineering Thermodynamics for understanding of energy and its conversion processes; Basic Principles of Electricity and Electronics for the designing engineering systems; Material Science for selecting construction / production materials; Engineering Economics for making healthy decisions for designing a process or a product. Additionally, the course of Introduction to (relevant field of) Engineering should be given for evaluating of job opportunities, describing the program and understanding the differences from the other programs. Introductory course is also needed for learning International System of Units and basic laws of engineering.

2.2 Bologna Process in Engineering Education and Main Frameworks of Higher Educations Qualifications Regulations in Turkey

Currently in Turkey, most of the bachelor's degree programs are compliance with the Bologna Treaty and Turkey Higher Education Qualifications Framework (TYYÇ) [7]. This four-year study plan contains 240 European Credit Transfer System (ECTS) which consist of courses and internship that has a certain number of mandatory and varying working days relevant to program. Energy Systems Engineering Program requires complete success on these 240 ESTS credits and cumulative grade-point average (GPA) 2.00 of 4.00 for graduating and obtaining the bachelor's degree as same as many other engineering disciplines.

When sum up the credit of mentioned courses above, which are Main Science Courses, Mathematical Courses, YÖK Courses, and Fundamental Engineering Courses, the sum is obtained approximately as 90 - 120 ECTS's. It is noticed that these courses and their numbers are similar between Energy Systems Engineering and other engineering programs. In other words, this similarity has a percentage of 37-50%. When evaluating the dissimilar courses, it appears that these dissimilarities consist of courses that specific to related discipline.

2.3 Current Status of Energy Systems Engineering Departments

Energy Systems Engineering is a hybrid and multidisciplinary engineering program that has established in our country and worldwide with increasing numbers. Although, it is established as the name of Energy Systems Engineering with the guidance of Council of Higher Education (YÖK) in Turkey, the department

itself has many other names in other countries; for instance; Energy Engineering, Energy and Process Engineering, Energy Systems Engineering, Renewable Energy Engineering, etc.

Table 3. State Universities that situate Energy Systems Engineering

Name of University	Faculty Name	Quotas	Education Language
Batman University	Faculty of Technology	104	Turkish
Erciyes University	Faculty of Engineering	94	Turkish
Fırat University	Faculty of Technology	188	Turkish
Gazi University	Faculty of Technology	70	Turkish
Giresun University	Faculty of Engineering	82	Turkish
Karabük University	Faculty of Technology	126	Turkish
Karadeniz Technical University	Faculty of Technology	45	Turkish
Karamanoğlu Mehmet Bey University	Faculty of Engineering	62	Turkish
Kırklareli University	Faculty of Technology	63	Turkish
Kocaeli University	Faculty of Technology	64	Turkish
Mehmet Akif Ersoy University	Faculty of Engineering and Architecture	31	Turkish
Mersin University	Faculty of Technology	63	Turkish
Muğla Sıtkı Koçman University	Faculty of Technology	63	Turkish
Necmettin Erbakan University	Faculty of Engineering and Architecture	41	Turkish
Osmaniye Korkut Ata University	Faculty of Engineering	104	Turkish
Recep Tayyip Erdoğan University	Faculty of Engineering	41	Turkish
Sinop University	Faculty of Engineering and Architecture	41	Turkish
Süleyman Demirel University	Faculty of Technology	146	Turkish
Şırnak University	Faculty of Engineering	41	Turkish
Yalova University	Faculty of Engineering	62	%30 English
Total Quotas		1531	

Table 4. Foundation Universities that situate Energy Systems Engineering

Name of University	Faculty Name	Quotas	Education Language
Atılım University	Faculty of Engineering	25	English

Bahçeşehir University	Faculty of Engineering and Natural Science	56	English
Girne American University	Faculty of Engineering	35	English
İstanbul Bilgi University	Faculty of Engineering and Natural Science	50	English
Okan University	Faculty of Engineering and Architecture	20	English
National Cyprus University	Faculty of Engineering	30	English
Yaşar University	Faculty of Engineering	30	English
Total Quotas		246	

2.3.1 Problems Related to Energy Systems Engineering Departments

Currently, Energy Systems engineering bachelor's degree is given by different curriculum by individual universities, in Turkey. This differentiation is caused an incompatibility. One of the reasons behind this incompatibility, founding chair of Energy Systems Engineering department comes from different academic disciplines, such as mechanical, electrical, chemical and environmental engineering. In order to reach an ideal structure, the curriculum of Energy Systems Engineering department should be 75% computable each other.

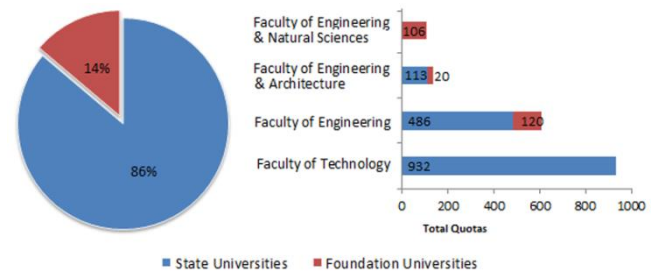


Figure 3. Distribution of Energy Systems Engineering Departments' quota

In order to eliminate these differences, several workshops should be done, and the similarity should be provided substantially. According to the profession of lecturers and geographic characteristic of the area where the university located, the curriculum can differ only a certain amount. Energy Systems Engineering Departments should have similar curriculums. This should be applied to Energy Systems Engineering and all other engineering departments. For instance, there is not a degree such as "...University Energy Systems Engineering" or "University Mechanical Engineering" only there is the degree such as "Energy Systems Engineering" and "Mechanical Engineering".

Similar programs have to offer similar curriculums are an important step to increase the quality of graduates. Well established universities demonstrate their quality with well-

developed structure and mechanism of education. However, for our country's progress and development not only major universities but also all universities must develop progress and run.

All engineering disciplines make the effort to ease human life without breaking the basic law of nature. In short, they serve a common purpose. Their basic philosophy and goal are common. Although the engineering disciplines seem separate from each other, they are parts of a whole. Each engineering discipline reveals expertness of their fields. Undergraduate curriculums of different disciplines become different from these points or specialize. If it is explained by an example, many projects can be found employing of engineers that graduated from energy, chemical, civil, environmental, electrical, mechanical etc. engineering by subject at engineering projects/works. Engineers from different disciplines can be seen obligation to work together in most projects.

3 Conclusions

In this study, general assessment of engineering education in Turkey and identification of current problems of engineering education of energy-related programs has been investigated.

On the basis of findings obtained, it is proposed that the courses such as describing the Fundamentals of Thermodynamics, Basic Principles of Electricity and Electronics, Material Science, Engineering Economics should be considered to be ineluctable common required courses during engineering education.

As a result of the examinations upon Energy Systems Engineering departments, the attention should be attracted to the rate of similarity in curriculums. In order to solve dissimilarity problems, a range of workshops should be done including the sector representatives, and the similarity should be provided substantially by regulating the curriculums.

Engineering programs should only be provided to differ from certain rate depending upon academics' professions, and the characteristic area where the university located.

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