

UDC 658.8:164:378

JEL Classification: M 31, P 11

Okuyan Cemal^a, Chupryna Nataliia^b

A DIFFERENT APPROACH FOR ENGINEERING EDUCATION IN LINE WITH MODERN SCIENTIFIC DEVELOPMENTS

^a Balikesir University, Balikesir, Turkey

^b Ukrainian State University of Chemical Technology, Dnipro, Ukraine

This study examines what needs to be done to restructure engineering education to meet today's challenges. The need to modernize training in high-tech specialties due to the rapid development of science and technology is substantiated; a short period of time between innovation and its commercialization; short life cycle of high-tech goods; constant change in consumer needs. The needs of consumers change due to the influence of science and technology, changes in the external and internal environment, as well as changes in the psychosomatic state of the person himself. All these factors add fundamentally new requirements to the construction of the curriculum and breakdown by the special workload of students throughout the entire period of study. Modern universities should provide not only higher education, but also lay the foundation for the possibility of improving the qualifications of employees throughout their professional life. Also, additional courses should be formed that will help the university graduate to adapt to new conditions, if it is necessary to change the received qualification in a certain field. "Mechanical Engineering Education" in Turkey was chosen as an example. The importance of specialized mechanical engineering, developments in our public and private universities that create specialized engineering fields, survey results and criticisms on this were assessed, and a model proposal was created for the transition to specialized mechanical engineering in the short and long term. There is no longer any doubt about the need for distance education, which has become compulsory with the onset of the global pandemic. This is, first of all, an opportunity for students to independently choose the time and pace of study that is acceptable for them. Secondly, to choose an educational institution, in any corner of the world, thereby gaining knowledge of various scientific disciplines, which is quite effective from a practical point of view. This study also explains the distance education model in which professional universities will provide their members with the transfer of rapidly evolving academic industry knowledge.

Keywords: education, engineering, educational courses, modernization, specialization, graduates, qualification improvement.

DOI: 10.32434/2415-3974-2023-18-2-111-116

Introduction

The rapidly developing information and communication age has made sector employees and businesses that do not renew themselves unable to do business under competitive conditions. This situation becomes more important in professional groups that

use new and advanced technology. While in many European countries a profession requires updating after 24-26 months, this situation becomes important in a short time such as 18-24 months for the USA and Japan. Because; In order for employees with a diploma to receive a good standard of living and a high salary,

© Okuyan Cemal, Chupryna Nataliia, 2023



This article is licensed under Creative Commons Attribution 4.0 International License (CC-BY)

A different approach for engineering education in line with modern scientific developments

they need to constantly improve themselves and receive lifelong education.

This rapid development of technology has made it necessary for branches of science to specialize and be divided into sub-branches. Nowadays, areas of expertise that deal with more detailed issues are gaining importance.

Purpose of the article

The article aims to develop directions for the restructuration of engineering education to modern challenges.

Presentation of the main material

This study was conducted on Mechanical Engineering Education. In general, mechanical engineering addresses a very wide field. Over the years, specialist course plans and diploma fields have emerged to replace general mechanical engineering education. Generally, courses on general and common subjects are given in the first 3-4 semesters, and elective specialization courses are given in the following semesters. Students; At this stage, they focus on the subjects they are interested in, thus ensuring that the graduates specialize. In some cases, specialization occurs during master's and doctoral education.

Today, technological developments significantly affect engineering education. Developed universities are the pioneers of this change. Universities in Turkey,

known for their high quality of education, allocate significant budget resources to this change. However, some private universities prefer professional groups that require less investment instead of expensive fields that require high investment budgets. Fields such as energy engineering, mechatronics engineering and biomedical engineering, production systems engineering, materials engineering, telecommunications engineering and software engineering are of interest [1, 4-6].

Besides these, advanced technological equipment and computer-controlled systems are used in applications such as smart building applications, variable refrigerant flow rate (VRV), variable air flow rate (VAV) central systems, clean air quality rooms, full air conditioning systems, industrial air conditioning systems.

As an example, Turkey's most popular university in the field of engineering, Istanbul Technical University, offers the courses in Table 1 in its graduate education in plumbing engineering. After giving common courses to students studying in the mechanical engineering department in the fields of plumbing, energy, automotive and control, he wants the students to choose elective courses in the fields they want to specialize in the 6-7-8 semesters and thus specialize. Elective field courses are given in Tables 2 and 3.

Table 1

Courses Taught in the Plumbing Engineering Master's Program

Compulsory Courses		
Fall semester	Spring semester	Summer semester
Numerical Calculation Methods	Pump Installations and Pipelines	Environmental Control and HVAC Systems For Buildings
Fluid and Heat Transfer Principles in Installations	Heating Systems	Extinguishing Systems
Fundamentals of Air Conditioning	Air Conditioning Systems	Cooling Technique
Elective Courses		
Fall semester	Spring semester	Summer semester
Ventilation	Steam Installations and Devices	Smoke Evacuation and Pressurization
Alternative Energy Systems	Geothermal District Heating	Heat Economy in HVAC Systems

Table 2

Plumbing Option elective courses

Plumbing Option	Energy Option
Natural Gas Installation	Power Plants
Steam Boilers	Thermal turbo machines
Fire security	Steam Boilers
Building Automation	Energy Management

Table 3

Energy and installation option elective courses

Installation	Energy
Building Installation	Advanced Fluid Mechanics
Thermal System Design	Solar Energy
Process Technique	Gas Turbines
Solar Energy	Process Technique

When examining Balikesir University as a different university, in addition to Istanbul Technical University, which is Turkey’s most well-known university in the fields of engineering, in the Mechanical Engineering Department of the Faculty of Engineering;

Students who are allocated to the fields of thermodynamics, energy, mechanics, manufacturing and machine dynamics take the specialization courses in Table-4 in addition to the common general courses, starting from the 5th semester.

Table 4

Plumbing Field Courses Taught in the Department of Mechanical Engineering

5th semester	6th semester	7th semester	8th semester
Plumbing Environmental Technique Fuel and Combustion	HeatingVentilation2 Heat transfer	Mass Transfer Steam Boilers Steam Turbines Insulation Technique Cooling Technique HeatingVentilation2	Gas Turbines Air conditioning Energy Economy Boiler Assistants Various Cooling Systems Solar Energy Systems Natural Gas Systems

Some universities in the American school are structured with fewer comprehensive faculties and more departments within faculties. For example, Faculty of Engineering and Natural Sciences consists of the following departments, Material science and engineering, Energy Engineering, Production Systems Engineering, Mechatronic Engineering, Industrial Engineering, Micro Electronics Engineering, Electronic Engineering and Computer Science, Telecommunications Engineering, Computer Science and Engineering, Biological Sciences and Bioengineering.

The fact that courses for specialization in Mechanical Engineering departments are generally opened in the 7th and 8th semesters causes the number of courses and credits related to these fields to be insufficient or the courses to be integrated into each other. Some of our universities realized this situation and started branching out in the 5th or 6th semesters, as seen in Tables 1–4.

The need for expert mechanical engineering and the importance of this model can be seen in the results of a detailed survey we conducted for mechanical engineers working in the plumbing sector.

The majority of the mechanical engineers who participated in the survey we conducted across the country were selected from among those who graduated from the departments that mainly teach plumbing courses at universities (Heat Process, Energy and Thermodynamics) and are currently working in these sectors. Interviewers stated that the courses they took were not sufficient for the plumbing industry.

Mechanical engineers, who want to be divided into fields mostly in the 5th semester, say that the practical course hours during their education are

insufficient (refrigeration, air conditioning, plumbing, heating, solar energy, natural gas, fire installation), and that there are project courses at the end of each course taught about installation. They state that it is necessary.

They mostly want industrial internships to start in the 2nd semester and even to have internships in all semesters by adjusting the academic calendar. Thus, it becomes important for education and industry to coexist and for students to get to know workplaces in parallel with their education.

The importance of carrying out projects addressing the problems of the sector during training (80%) and rearranging lesson plans for specialization (75%) are emphasized in the survey results [2].

Two models can be considered in Specialist Mechanical Engineering. Short term model and long term model.

In the short-term model, common courses in the first 2 years, and gradually increasing courses specific to the field of specialization in the next 2 years.

In the long-term model, opening departments in faculties directly related to specialization subjects may be considered. For example (in mechanical engineering subjects), Mechanical-Installation Engineering, Mechanical-Automotive Engineering, Mechanical-General Manufacturing Engineering, Mechanical-Materials Science and Engineering, Mechanical-Mechatronics Engineering, Mechanical-Production Systems Engineering.

Since establishing workshop and laboratory infrastructures in engineering education is expensive, the short-term model can be considered a more economical solution. In this case, the courses that should be given during the 4-year education period are seen in Tables 5 and 6.

Table 5

Courses that must be taught between 1-4 semesters in Specialist Mechanical Engineering

1st semester		2nd semester		3rd semester		4th semester	
Courses	T-P-L	Courses	T-P-L	Courses	T-P-L	Courses	T-P-L
Mathematics 1	3-2-0	Mathematics 2	3-2-0	Mathematics 3	3-2-0	Mathematics 4	3-2-0
Physics	3-0-1	Mechanic	2-2-0	static	3-1-0	Heat Transfer	3-1-0
General Chemistry	2-0-1	Dinamic	2-0-1	Thermodynamics	3-1-0	Material	3-0-1
Geometry	2-2-0	Technical Drawing	2-2-0	Fluids Mechanics 2	3-0-1	Machine Elements-1	3-0-1
Computer 1	2-0-1	Fluid Mechanics 1	3-0-1	Technical English-1	2-0-0	Technical English-2	2-0-0
Mechanical Engineering	2-0-0	Computer 2	3-0-0	Auto-CAD	2-1-0	Specialization course-3	2-0-0
History	4-0-0	English-2	2-0-0	Specialization course-2	3-1-0	Project-2	2-1-0
Turkish	4-0-0	Specialization course-1	1-2-0	Lab-1	3-0-0	Lab-2	0-0-3
English-1	2-0-0	Project-1	2-0-1	–	–	industry application-2	
-----		industry application-1		–	–		

(T-P-L: Theoretical, practical and laboratory)

Table 6

Courses to be taken between 5-8 semesters in plumbing engineering

5th semester		6th semester		7th semester		8th semester		
Courses	T-P-L	Courses	T-P-L	Courses	T-P-L	Courses	T-P-L	
Computer-1	2-1-0	Computer-2	2-1-0	Engineering Statistics	2-0-0	Quality control	2-0-1	
Energy Management	3-0-0	Business Economics	2-0-0	Business law	3-0-0	Factory organization	2-0-0	
Machine Elements-2	3-1-0	Manufacturing Procedures-1	3-0-1	Manufacturing Procedures-2	3-0-1	Specialization course-11	2-0-2	
Ekonomy	2-0-0	Specialization course-6	3-0-0	Specialization course-8	3-0-1	Specialization course-12	2-0-1	
Specialization course-4	3-0-1	Specialization course-7	2-0-1	Specialization course-9	3-0-1	Specialization course-13	3-0-1	
Specialization course-5	3-0-1	Lab-4	3-0-0	Specialization course-10	2-0-1	Specialization course-14	2-0-1	
Lab-3	2-0-2	Computer Aided. Project-2	2-2-0	Lab-5	3-0-0	Lab-6	3-0-0	
Computer Aided Project-1	1-2-0			industry application-3	Computer Aided. Project-3	2-2-0	Diploma Study	2-0-1
							industry application-4	

(T-P-L: Theoretical, practical and laboratory)

As seen in Tables 5 and 6, courses aimed at specialization were withdrawn until the 2nd semester to ensure that the courses did not overlap each other. Starting from the semester in which the specialization courses started, field laboratory courses have been included with the field courses in the same semester.

In addition to the general mechanical engineering courses, the specialist mechanical engineer candidate who studies the courses in eight semesters; He studies 14 specialization courses, 6 specialization laboratories,

5 specialization project courses and does 4 specialization industrial internships related to the specialization courses at the end of the spring semester.

Conclusion and recommendations

The increase in the number of options in Mechanical Engineering departments has led to an increase in the number of courses taught in areas of specialization. However, allocation to options usually starts in the 7th semester and courses that should have been taught one or two semesters ago are taught

in the same semester, causing the courses to overlap with each other. This situation causes the issues to be poorly understood.

In the model proposal for transition to specialist mechanical engineering in the short and long term, prerequisite courses are determined in both general mechanical engineering courses and specialization courses, ensuring that the courses do not overlap each other. In order to understand the specialization courses properly, project and laboratory courses are recommended in both models.

Widespread application in the world; After undergraduate education, postgraduate and doctoral studies are carried out for specialization. Universities and professional organizations should organize courses and practical training at certain periods in order to transfer the rapidly developing technology to their former graduates. Thus, it will be possible to eliminate the generation gap in graduates.

Although this study was conducted on mechanical engineering, it should be done for all professional groups. Having expert employees in business life is very important in terms of introducing technology to businesses faster and modernizing businesses.

REFERENCES

1. Graduate school of informatics (n.d.). www.ii.metu.edu.tr. Retrieved from <http://www.ii.metu.edu.tr/EMK/2001BCREDIT.html> [in English].
2. Okuyan, C., & Ve Erturk, M. (2005). Bilim – Teknoloji ve Bilgi Cagindaki Uzman Makine Muhendisligi Egitimi Icin Farkli Bir Yaklasim [A Different Approach to Specialist Mechanical Engineering Education in the Age of Science – Technology and Information]. TMMOB Muhendislik Egitimi sempozyumu, 17-18 Kasim, Ankara [in Turkish].
3. MDBF Diploma Programlari Ve Dereceleri [MDBF Diploma Programs And Degrees]. (n.d.). www.sabanciuniv.edu.tr. Retrieved from <http://www.sabanciuniv.edu.tr/?DiplomaProgramlari/MDBFDiplomaProgramlariVeDereceleri.html> [in Turkish].
4. Baskent university (n.d.). www.baskent.edu.tr. Retrieved from <http://www.baskent.edu.tr/> [in English].
5. ITU Graduate School (n.d.). www.fbe.itu.edu.tr. Retrieved from <http://www.fbe.itu.edu.tr/> [in English].
6. Balikesir University (n.d.). www.balikesir.edu.tr. Retrieved from <https://www.balikesir.edu.tr/class1234.htm> [in English].

Received 20.09.2023.

Revised 30.09.2023.

Accepted 20.10.2023.

Published 25.12.2023.

ДИФЕРЕНЦІЙОВАНИЙ ПІДХІД ДО ІНЖЕНЕРНОЇ ОСВІТИ НА ОСНОВІ СУЧАСНИХ НАУКОВИХ РОЗРОБОК

Окуян Кемаль, Чуприна Наталія

У цьому дослідженні розглядаються напрями реструктуризації інженерної освіти відповідно до сучасних проблем. Обґрунтовано необхідність модернізації навчання високотехнологічних спеціальностей через швидкий розвиток науки та технології; невеликий проміжок часу між новацією та її комерціалізацією; малим життєвим циклом високотехнологічних товарів; постійною зміною потреб споживачів. Потреби споживачів змінюються через вплив науки і технології, зміни зовнішнього і внутрішнього середовища, а також зміни психосоматичного стану самої людини. Всі ці фактори додають принципово нових вимог до побудови навчального плану та розбивки за спеціальним навантаженням студентів на протязі всього періоду навчання. Сучасні університети повинні надавати не лише вищу освіту, але і закладати підґрунтя для можливості підвищення кваліфікації працівників на протязі всього їх професійного життя. Також, мають бути сформовані додаткові курси, які допоможуть випускнику університету адаптуватися до нових умов, при необхідності зміни отриманої кваліфікації у певній галузі. «Механічна інженерна освіта» в Туреччині були обрані як приклад. Було оцінено важливість спеціалізованого машинобудування, розробки в наших державних і приватних університетах, які створюють спеціалізовані інженерні галузі, результати опитування та критику з цього приводу, і було створено модельну пропозицію для переходу до спеціалізованого машинобудування в короткостроковій і довгостроковій перспективах. Необхідність в дистанційній освіті, яка примусова стала масовою з початком світової пандемії, вже не має сумнівів. Це, по-перше можливість студентам самостійно обирати прийнятний саме для нього час і темп навчання. По-друге, обирати навчальний заклад, в будь-якому куточку світу, тим самим отримуючи знання різних наукових шкіл, що є досить ефективним з практичної точки зору. У цьому дослідженні також пояснена модель дистанційної освіти, в якій професійні університети забезпечуватимуть своїм членам передачу академічних галузевих знань, які розвиваються швидкими темпами.

Ключові слова: освіта, інженерія, освітні курси, модернізація, спеціалізація, випускники, підвищення кваліфікації.

A DIFFERENT APPROACH FOR ENGINEERING EDUCATION IN LINE WITH MODERN SCIENTIFIC DEVELOPMENTS

Okuyan Cemal ^a, Chupryna Nataliia ^b

^a Balikesir University, Balikesir, Turkey

^b Ukrainian State University of Chemical Technology, Dnipro, Ukraine

*e-mail: cemalokuyan@hotmail.com

Chupryna Nataliia ORCID: <https://orcid.org/0000-0002-4035-8934>

This study examines what needs to be done to restructure engineering education to meet today's challenges. The need to modernize training in high-tech specialties due to the rapid development of science and technology is substantiated; a short period of time between innovation and its commercialization; short

life cycle of high-tech goods; constant change in consumer needs. The needs of consumers change due to the influence of science and technology, changes in the external and internal environment, as well as changes in the psychosomatic state of the person himself. All these factors add fundamentally new requirements to the construction of the curriculum and breakdown by the special workload of students throughout the entire period of study. Modern universities should provide not only higher education, but also lay the foundation for the possibility of improving the qualifications of employees throughout their professional life. Also, additional courses should be formed that will help the university graduate to adapt to new conditions, if it is necessary to change the received qualification in a certain field. “Mechanical Engineering Education” in Turkey was chosen as an example. The importance of specialized mechanical engineering, developments in our public and private universities that create specialized engineering fields, survey results and criticisms on this were assessed, and a model proposal was created for the transition to specialized mechanical engineering in the short and long term. There is no longer any doubt about the need for distance education, which has become compulsory with the onset of the global pandemic. This is, first of all, an opportunity for students to independently choose the time and pace of study that is acceptable for them. Secondly, to choose an educational institution, in any corner of the world, thereby gaining knowledge of various scientific disciplines, which is quite effective from a practical point of view. This study also explains the distance education model in which professional universities will provide their members with the transfer of rapidly evolving academic industry knowledge.

Keywords: education, engineering, educational courses, modernization, specialization, graduates, qualification improvement.

REFERENCES

1. Graduate school of informatics (n.d.). www.ii.metu.edu.tr. Retrieved from <http://www.ii.metu.edu.tr/EMK/2001BCREDIT.html> [in English].
2. Okuyan, C., & Ve Erturk, M. (2005). Bilim – Teknoloji ve Bilgi Çağında Uzman Makine Mühendisliği Eğitimi İçin Farklı Bir Yaklaşım [A Different Approach to Specialist Mechanical Engineering Education in the Age of Science – Technology and Information]. TMMOB Mühendislik Eğitimi sempozyumu, 17-18 Kasım, Ankara [in Turkish].
3. MDBF Diploma Programları Ve Dereceleri [MDBF-Diploma Programs And Degrees]. (n.d.). www.sabanciuniv.edu.tr. Retrieved from <http://www.sabanciuniv.edu.tr/?DiplomaProgramlari/MDBFDiplomaProgramlariVeDereceleri.html> [in Turkish].
4. Baskent university (n.d.). www.baskent.edu.tr. Retrieved from <http://www.baskent.edu.tr/> [in English].
5. ITU Graduate School (n.d.). www.fbe.itu.edu.tr. Retrieved from <http://www.fbe.itu.edu.tr/> [in English].
6. Balıkesir University (n.d.). www.balikesir.edu.tr. Retrieved from <https://www.balikesir.edu.tr/class1234.htm> [in English].