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Improvement of Product Development Studies in Serbia and Bosnia and Herzegovina

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Work package WP1:

1.2 REPORT

UNIVERSITY OF KRAGUJEVAC

FACULTY OF ENGINEERING

State of the product development field at the

Faculty of Engineering University of Kragujevac

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Faculty of Mechanical Engineering in Kragujevac today called Faculty of Engineering University of Kragujevac was founded on October 1st 1960, as a section of the Faculty of Mechanical Engineering in Belgrade and started working on October 9th 1960. The Faculty of Mechanical Engineering in Kragujevac became an independent faculty, within the University of Belgrade on December 2nd 1971. Faculty of mechanical engineering is now part of the University of "Svetozar Marković" in Kragujevac, today called University of Kragujevac.

The study program Mechanical Engineering is adapted according to the Law of Higher learning and the Bologna declaration, at the Faculty of Mechanical engineering, and was formed on 05.05.2006. The changed study program was adopted on 07.02.2008.

Within the system of higher learning of the Republic of Serbia at the Faculty of Engineering there are three levels of studies:

- Bachelor academic studies,
- Master academic studies and
- Doctoral studies.

Classes are held on the following study programs:

- Mechanical Engineering (bachelor, master and doctoral studies),
- Military Industrial Engineering (four-year bachelor and one year master studies),
- Engineering Management (one-year master studies),
- Industrial Engineering - Business Informational Systems (one-year master studies),
- Automotive Engineering (bachelor and master studies),
- Urban engineering (four-year bachelor studies).

All study programs are accredited,

Study programs within Mechanical Engineering belong to the field of technical-technological sciences and have eight modules:

1. Production engineering,
2. **Mechanical constructions and mechanization,**
3. Motor vehicles and IC engines,
4. Energy and process engineering,
5. Applied mechanics and automatic control,
6. Industrial engineering,
7. Informatics in engineering and
8. Road traffic engineering.

Product development in the study programs at the Faculty of Engineering University of Kragujevac has not been defined as an independent entity, however it is represented in all modules

throughout various classes and subject contents. This field is the most developed on the Mechanical Constructions and Mechanization module.

Department for Mechanical Constructions was established in 1978, and the first students on the module enrolled in 1979/80. Later the department evolved into the Department for Mechanical Constructions and Mechanization, and the module into the same name.

The Mechanical Constructions and Mechanization (MKM) module prepares specialists for a variety of activities in the mechanical industry, starting from a concept to the implementation of a product. Knowledge necessary for work in interdisciplinary teams is gained, as well as in the field of innovation, research, design, entrepreneurship, consulting, management, informatics, etc. Through the curriculum and programs new conditions are met in accordance with the Bologna declaration and the conditions of wider surroundings.

The Department of Mechanical Constructions and Mechanization is in charge of classes in subjects on all levels of study which are shown in the table.

No.	Subject	Semester	# of classes L/P/O/S/OC*	ESPB
Mutual subjects on Bachelor academic studies				
1.	Strength of materials	2	2+2+0+0+1	6
2.	Technical drawing with computer graphics	2	3+0+2+0+1	6
3.	Machine elements	3	2+1+2+0+1	6
4.	Engineering tools	4	2+1+1+0+1	6
5.	Fundamentals of machine design	5	2+2+1+0+1	6
Subjects on the MKM module for Bachelor academic studies				
6.	Fundamentals of material handling machinery	5	3+1,6+0,4+0+1	6
7.	Metal structures	5	3+1,6+0,4+0+1	6
8.	Mechanisms of machines	6	3+1,6+0,4+0+1	6
9.	Machine elements II	6	3+1,6+0,4+0+1	6
10.	Mechanical transmitters	6	3+1,6+0,4+0+1	6
11.	Reliability of mechanical systems	6	3+1,6+0,4+0+1	6
12.	Technical practice I	6	0+0+0+8+2	6
Subjects on the MKM module for Master academic studies				
13.	Mechanical transmitters 2	1 M	2+1,6+0,4+0+1	6
14.	Reliability methods of mechanical systems	1 M	2+1,6+0,4+0+1	6
15.	Industrial design	1 M	2+1,6+0,4+0+1	6
16.	Examination of machine constructions	2 M	2+1,6+0,4+0+1	6
17.	Tribology of mechanical systems	2 M	2+1,6+0,4+0+1	6
18.	Material handling and conveying devices and machinery	2 M	2+1,6+0,4+0+1	6
19.	Technical practice 2	3 M	0+0+0+0+12	6
Elective subjects on the MKM module for Master academic studies **				
20.	Theory of elasticity	3 M	3+1,4+0,6+0+1	6
21.	Fracture mechanics	3 M	3+1,4+0,6+0+1	6
22.	Design methods	3 M	3+1,4+0,6+0+1	6
23.	Computer aided design	3 M	3+1,4+0,6+0+1	6
24.	Light-weight structures	3 M	3+1,4+0,6+0+1	6

25.	Welded and cast structures	3 M	3+1,4+0,6+0+1	6
26.	Calculation of mechanical constructions	3 M	3+1,4+0,6+0+1	6
27.	Computer analysis of constructions	3 M	3+1,4+0,6+0+1	6
Doctoral studies				
28.	Reliability projecting for mechanical systems	3 D	5+0+0+5+0	15
29.	Optimization of mechanical systems	3 D	5+0+0+5+0	15
30.	Structural integrity	3 D	5+0+0+5+0	15
31.	Fracture mechanics	3 D	5+0+0+5+0	15
32.	Special power transmission	3 D	5+0+0+5+0	15
33.	Special gearing	3 D	5+0+0+5+0	15
*L – Lectures, P – Practical classes, O – other forms of lectures, S- Study research, O – other classes ** Choice one of the two subjects.				

Course objectives for MKM are:

1. **Strength of materials**: Enabling students to solve the problems from the Strength of Materials and to apply the acquired knowledge in practice and in solving problems from other areas that are the continuance of studies in structural strength and integrity (Strength of structures, Metal structures, Lightweight structures, Fracture mechanics and Damage mechanics).
2. **Technical drawing with computer graphics:** The course gives basic knowledge about presenting machine parts and other technical forms in a drawing in plane and space using manual sketching and drawing, as well as computer graphics.
3. **Machine elements:** Machine elements are the constitutive elements of all machines and devices. The aim of this subject is introducing of students with theoretical basics, applications, operating, calculation, constructional shapes and selection of standard elements according defined conditions. In this subject students will detail learn about kinematic parameters, and a little about dynamic of machine elements. The subject Machine Elements contains learning about real constructions with using theoretical knowledge.
4. **Engineering tools:** To introduce and interest students with the contemporary capability of computer application in product life cycle. Providing skills for part and assembly modeling and appropriate engineering documentation in commercial CAD software as well. To introduce students with potentials of using for structural analysis, computer aided engineering (CAE), planning, managing and control of production operations (CAM, CAPP), operational simulations(kinematic, dynamic, ...), visualization, application of standards and connection of models. Enable the students to chose and utilize software tools for solving key problems in the product lifecycle. Interest and introduce students to follow and accept improvements and modernization in this field.
5. **Fundamentals of machine design:** The aim of this course is to introduce students in mechanical systems design. Attainment will make students possible for further improvement in specific machine systems design. Knowledge of standardization, tolerances, constructs calculation and forming, rational design principles and of work capability condition amplification areas, is base for successful design of machine systems, and elementary level

for another engineering domains. Throughout creating of independent works, students should get know and fill steps through will get along in real machine systems design.

6. **Fundamentals of material handling machinery:** Introducing students with basic concepts from the area of material handling devices, ways of functioning and selection of material handling machinery mechanisms. Qualification of students for independent solving of problems from industry praxis.
7. **Metal structures:** Enabling student to solve the problems from the area of metal structures and to apply the acquired knowledge in practice in solving the problems of structural integrity and structures design.
8. **Mechanisms of machines:** Students should get acquainted with mechanisms as the basic parts of all the machines. They are being trained for independent solving the problems of analysis and synthesis of the simpler mechanisms. They study the kinematics and dynamics of the planar mechanisms, gear power transmitters, the cam mechanisms and mechanisms with variable motions.
9. **Machine elements II:** Students learn about machine elements in real working conditions. The aim is introducing students with possible shapes of machine elements with next aspects: usage, modernization, innovation, economy,… It means the introducing the students with dynamic dealing of machine elements. There is and modeling machine elements in dynamic working conditions.
10. **Mechanical transmitters:** The aim of this course is teaching students to independently solving the problems of transmission power and motion in complex of solving industrial products design.
11. **Reliability of mechanical systems:** Acquirement of knowledge from areas of reliability mechanical systems and creation of possibilities for practice use that of knowledge in all activities future mechanical engineers where's that necessary.
12. **Technical practice I:** Acquiring practical experience during the stay of students in companies or other working environments, where students expect realization of their professional career. Recognition of basic functions of business, production and technological systems in the area of design, development and production, as well as the role and the tasks of the mechanical engineer in such business system.
13. **Mechanical transmitters 2**: The aim of this course is teaching students to independently solving the problems of transmission power and motion in complex of solving industrial product design.
14. **Reliability methods of mechanical systems:** Acquirement knowledge, skills and competency necessary for using of methods theories of reliability in areas of mechanical engineering.
15. **Industrial design:** The basic aim of the course is achieving the necessary skills and knowledge related to design, and also developing students' creative skills. Students learn the methodology and the principles of product design from the aspect of functionality, aesthetic demands, reliability and safety, quality, productive characteristics, economic justification.
16. **Examination of machine construction:** The course gives basic knowledge about measuring and examination of machine systems, introduces students to the application of modern methods of examination, measuring equipment and installation, and the basics of technical diagnostics.

17. **Tribology of mechanical systems:** The aim of this course is teaching students in knowledge tribological characteristics of mechanical systems and application this knowledge's. in design process.
18. **Material handling and conveying devices and machinery:** Introducing students with ways of functioning of material handling devices and machinery. Qualification of students for independent solving of problems from industry praxis.
19. **Technical practice II:** Acquiring practical experience during the stay of students in companies or other working environments, where students expect realization of their professional career. Recognition of basic functions of business, production and technological systems in the area of design, development, production and testing, as well as the role and the tasks of the master in mechanical engineer in such business system.
20. **Theory of elasticity:** Enabling student for solving problems from the area of the elasticity theory and for applying the acquired knowledge in practice in solving problems of the non-circular cross-sections torsion and basic problems from the plates and from the shell theory.
21. **Fracture mechanics:** Introducing with the fracture mechanics and material fatigue theory. Acquiring the knowledge related to engineering skills for estimates of the working life of structures that contain cracks. Estimates of the remain strength and damages of structures by application of the numerical methods.
22. **Design methods:** The aim of this course is to introduce students in mechanical systems design process. Attainment will make students possible for further improvement in specific machine systems design. Knowledge of system design area, design process and phases of design process is base for successful design of machine systems. Throughout creating of independent works, students should get know and fill steps through will get along in real machine systems design.
23. **Computer aided design:** The aim of this course is to introduce students in advanced possibilities of applied computers and software in machine systems design, to capacitate students for modeling real machine parts and assemblies and for generating design documentation in chosen CAD software. The aim is, also, to capacitate students to watch for and accept news and improving in this area.
24. **Light-weight structures:** Introducing the students with properties and types of the lightweight structures. Enabling students to calculate and design the light-weight structures.
25. **Welded and cast structures:** Getting students acquainted with properties and types of the welded and cast structures. Enabling students to calculate and design both types of structures.
26. **Calculation of mechanical constructions:** Introducing students with use of analytic as well as modern numerical methods and software tools in analysis of mechanical construction. Qualification of students for independent solving of problems from industry praxis.
27. **Computer analysis of constructions:** Appliance of FEA software in calculating and analysis of machine constructions.
28. **Reliability projecting for mechanical systems:** Providing knowledge related to the current achievements in the field of reliability projecting for mechanical systems and which enable attaining a high level of quality products and production processes while decreasing costs and development times for products.

29. **Optimization of mechanical systems:** Introducing students to: the basic terms of mathematical optimization and the benefits of achieving optimal solutions; traditional and modern methods and software for mathematical optimization; multi-criterion optimization; practical use of solutions to specific mechanical system optimization problems**.**
30. **Structural integrity:** Presenting the students with new knowledge and developments in the field of structural integrity (Fracture mechanics and damage mechanics).
31. **Fracture mechanics:** To convey onto the students knowledge and developments in the field of fracture mechanics.
32. **Special power transmission:** Introducing students to: modern design solutions in the field of power transmission; analysis of stress and deformational states of transmission elements using FEA; basic principles and methods of making dynamic models of power transmission.
33. **Special gearing:** Introducing students with: application of various types of gearing, their advantages and disadvantages, principles and problems in the field of gears from a theoretical standpoint, analysis and synthesis of coupled profiles, characteristics of coupled kinematic pairs, possibility of practical use of gearing theory in solving specific problems.

Aside from the aforementioned subjects on the Mechanical Constructions and Mechanization module, other modules and study programs subjects and contents which are related to product development, management of product development or Eco-design. The Faculty constitution allows students to choose subjects from other modules.

There are two more ways in which students acquire knowledge and experience in the product development field, and they are:

- **Vocational practice:** The department for Mechanical Constructions and Mechanization tries to provide vocational practice in design and development biros or in product development departments of companies, as much as possible within the capabilities of the department and cooperation regional companies.
- **Final and Master theses:** A large number of thesis subjects for final and master theses are related to development of more or less original products or systems. Students are able to choose thesis themes independently from this field, based on their interests, capabilities and needs. Through completion of final and master thesis in this field students practically go through the development process. From these theses a large number of products have been made or are in phases of completion.

Conclusion

Faculty of Engineering University of Kragujevac in its current plan has a large number of courses which are based on product development and similar fields. Much of the content of this subject matter is taught within other courses.

The field of product development is most represented on the Mechanical Constructions and Mechanization module. There is no clearly defined entity (module or study program) which is exclusively dedicated to product development. There is a need for improvement of the current state in this field.