Josip Juraj Strossmayer University of Osijek

Mechanical Engineering Faculty in Slavonski Brod

POSTGRADUATE DOCTORAL STUDY PROGRAMME FOR MECHANICAL ENGINEERING

WITH THREE MODULES:

- **Modern Manufacturing Processes**
- **Modern Production Management**
- **Design and Numerical Modelling of Products**

CONTENTS

1. INTRODUCTION

1.1. Reasons for initiating the study

The needs of industry for personnel able to respond to the challenges of new technologies and become leaders of development and application of advanced scientific methods and technologies as well as the creation of conditions for education of masters and doctors of sciences at the Faculty resulted in the organisation of postgraduate study at the Faculty of Mechanical Engineering in Slavonski Brod.

Participating in the economy of Croatia, in the regions of Slavonia and Baranja in particular, with more than 80 research-development projects, having links with the laboratories of manufacturing systems, introducing new courses (CAD/CAM, Computer integrated manufacturing, New technologies, Management, Automation of companies and firms, etc.) the Faculty of Mechanical Engineering has enabled the transfer of technological knowledge to the economy and by master and doctoral theses has contributed to the development of engineering sciences.

By the technological core project an attempt has been made to keep up with the most recent technologies, manufacturing logistics and information technologies applicable to engineering sciences, thus widening the scope of activities of mechanical engineers, masters and doctors of sciences.

The postgraduate study at the Faculty of Mechanical Engineering in Slavonski Brod of Josip Juraj Strossmayer University in Osijek is organised as a full-time study for the acquisition of the academic title of a doctor of sciences pursuant to the regulations of the Act on Scientific Activity and Higher Education (Narodne novine 123/03) for candidates holding a master's degree or a graduate degree and at least 300 ECTS points.

The aim of this postgraduate scientific study is to award successful candidates the academic title of a doctor of technical sciences in the field of mechanical engineering and provide them with the knowledge and skills necessary for individual scientific research work in scientific research projects.

The scientists and researchers holding the degree should be able to carry on research projects and tasks by applying the most recent scientific methods and models and performing experiments and tests in the dynamic development of production sciences in Mechanical Engineering (new manufacturing technologies, new strategies in manufacturing logistics and new materials).

The postgraduate programme is designed on the model of similar programmes in developed countries and based on the experience of previous dissertations at Mechanical Engineering Faculty and Master's degree programmes.

The postgraduate degree programme at the Faculty of Mechanical Engineering in Slavonski Brod includes three modules:

- Modern Manufacturing Processes,
- Modern Production Management,
- Design and Numerical Modelling of Products.

1.2. Proposer's previous experience in postgraduate doctoral and other studies

Since 1960s when university education in Slavonski Brod began and 1998 when the Faculty was given the right to organise postgraduate studies, a lot of experience has been gained in managing the Faculty and its programmes.

Postgraduate study lasts four semesters. After the candidate has passed all his exams and defended his thesis he is awarded the title of a Master of technical sciences. The programme is based on engineering sciences which are also characteristic for undergraduate study. The leaders of development of Mechanical Engineering Faculty are the scientists with long experience and success in business and industry.

The postgraduate degree programmes are:

- Manufacturing Systems
- Manufacturing Processes.

On 27 April 2000 Josip Jukić, BME, became the first master of technical sciences. Eight more candidates have obtained the title so far.

After the permission to organise the postgraduate Master's degree programme the Faculty was given the right to organise Technical Science doctoral studies in the field of Mechanical Engineering. To obtain the title of a Doctor of sciences a Master of technical sciences (candidate for a doctor's degree) must first have his doctoral thesis accepted (define the topic and its contribution to science) and a mentor named, work on it and then defend it in public.

On 9 September 2002 Tomislav Šarić, M.Sc.M.E., became the first doctor of technical sciences from the Faculty of Mechanical Engineering. Five more candidates have been awarded the degree so far.

1.3. The study versus student mobility

Student mobility can be realised on the assumption that the postgraduate subjects are validated by ECTS points. Ratification and cooperation with other universities will be regulated by separate agreements, which will define the conditions and possibilities for student mobility.

To realise these agreements contacts have to be made and projects carried out with home and foreign universities.

1.4. Possibility for including the study programme (or its part) into a joint study programme with foreign universities

Preconditions for the possibility of including the study programme (or a part of it) into a joint study programme with other universities have been met by the fact that the proposed programme can be compared with the programmes of foreign universities and its subjects and courses validated by ECTS points.

Inclusion into and work on joint programmes with foreign universities will be defined by separate agreements. The prominent foreign experts will be hired for some courses (subjects) in order to make this cooperation a basis for the future joint programmes.

2. GENERAL OUTLINE

2.1. Title of the study, scientific area, field and branch it belongs to

Title of the study is **Postgraduate Doctoral Study** at the Faculty of Mechanical Engineering in Slavonski Brod, Josip Juraj Strossmayer University of Osijek.

It is organised as a full-time study pursuant to the regulations of the Act on Scientific Activity and Higher Education (Narodne novine 123/03) and the Amendments to the Act on Scientific Activity and Higher Education (Narodne novine 105/04).

The study is organised in the area of **Technical Sciences,** field **Mechanical Engineering** includes three modules: **Modern Manufacturing Processes**, **Modern Production Management**, **Design and Numerical Modelling of Products**; and it also includes the branches: Manufacturing, Materials, Work and Manufacturing Organisation, General Engineering (Design).

2.2. In charge of the study and cooperating institutions taking part in starting and carrying out doctoral programme

The study is in charge and carried out by the Mechanical Engineering Faculty in Slavonski Brod, Josip Juraj Strossmayer University of Osijek.

2.3. Doctoral programmes development strategy

The aim of this postgraduate doctoral study is to enable successful candidates to earn the academic title of a doctor of sciences in the area of Technical sciences, field Mechanical Engineering and provide them with the knowledge and skills necessary for individual scientific research work. The education of own staff ensures the reconstruction of the research and scientific potential for the forthcoming generations and the continuity of the scientific and research work in the field of mechanical engineering in the region of Slavonija and Baranja.

The postgraduate doctoral study at the Faculty of Mechanical Engineering in Slavonski Brod of Josip Juraj Strossmayer University in Osijek is organised as a full-time study pursuant to the regulations of the Act on Scientific Activity and Higher Education (Narodne novine 123/03) for candidates holding a master's degree or a graduate degree and at least 300 ECTS points. The current postgraduate students could also transfer to this postgraduate doctoral study.

Based on the shown interest for certain modules of the postgraduate doctoral study (Modern Manufacturing Processes, Modern Production Management, Design and Numerical Modelling of Products) the analysis of the study implementation will be done and the Faculty will decide whether to continue with these modules or not, keeping in mind the needs of this region.

2.4. Innovation quality of the doctoral programme (interdisciplinary and collaborationist character, partnership with industry and business sector in initiating and carrying out the study programme)

The Postgraduate students should be able to carry on research projects and tasks by applying the most recent scientific methods and models and performing experiments and tests within the scope of dynamic development of production sciences in Mechanical Engineering: product development, new manufacturing technologies, new strategies in manufacturing logistics and new materials.

The postgraduate programme is designed on the model of similar programmes in developed countries and based on the experience of previous dissertations at the Mechanical Engineering Faculty and Master's degree programmes.

The postgraduate study programme has been developed by taking account of the advances made in engineering sciences and their effect on curricula of leading educational institutions of developed countries.

Comparability of the modulus Modern Manufacturing Processes:

- Faculty of Mechanical Engineering, University of Maribor, Slovenia
- Faculty of Mechanical Engineering, Technical University of Liberec, Czech Republic

Comparability of the modulus Modern Production Management:

- University of Cambridge, England
- The University of Melbourne, Australia
- City University London, England
- Aston University Birmingham, England
- University of Technology, Sydney, Australia

Comparability of the modulus Design and Numerical Modelling of Products:

- University of Cardiff, Great Britain
- Technische Universität Berlin, Germany
- Faculty of Mechanical Engineering, University of Ljubljana, Slovenia
- Faculty of Mechanical Engineering, University of Maribor, Slovenia

Helped by the Centre for New Manufacturing and Information technologies – CEPIT, the Faculty will keep an eye on development of new manufacturing and information technologies and their application in production companies in the area. Care will be taken that the existing manufacturing technologies are being up-to-dated by the application of the triple helix model principle. Namely, by realising investment and development needs of the companies, their ability to compete will increase. The main tasks would be:

- Transfer of knowledge on new manufacturing and information technologies;
- Improvement of conventional technologies;

- Design of technological processes;
- Application of information and communication technologies (genetic algorithms, neural networks, expert systems, management of wall-system warehouses etc.), application of CAD (*Computer Aided Design*), CAPP (*Computer Aided Process Planning*), CAM (*Computer Aided Manufacturing*), CAP (*Computer Aided Production*), CAMS (*Computer Aided Material Selection)*, CAMI (*Computer Aided Maintenance*), ERP (*Enterprise Resource Planning*) systems, RP (*Rapid Prototyping*) in companies;
- Redesign of the shape and appearance of products by using modern 3-D scaners and packages for numerical analysis based on the numerical methods (e.g. finite element analysis);
- Research into and application of surface engineering to cutting tools and machine elements;
- Testing and application of new materials;
- Technical communication with companies (exchange of the CAD 2-D and 3-D models, exchange of the CAM programmes, transfer of the status of production etc.), help in creating preconditions for communication with the EU firms), modelling and simulation of processes and systems.

The following institutions would take part in the development and work of CEPIT:

1. Faculty of Mechanical Engineering (SF) in Slavonski Brod – project leader
2. Faculty of Electrical Engineering (ETF) in Osijek,
3. Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture (FESB) in Split,
4. Faculty of Agronomy (PF) in Osijek,
5. Faculty of Food Science and Technology (PTF) in Osijek and
6. Faculty of Engineering (TF) in Rijeka.

Expected results of CEPIT activity:

- research, application and monitoring of results in development of new manufacturing and information technologies aimed at intelligent production systems;
- possibilities of application under existing conditions and the rightfulness of implementation in production companies;
- presentation of possibilities of new manufacturing and information technologies in real operating conditions;
- research into and development of new methods and ecologically acceptable procedures in modernising conventional technologies and their application in companies;
- advancement in the application of conventional technologies: application of new tools, minor automation, ERP system, ERP-CAD linking, PDM - *Product Data Management* principle, quick development of a product, parallel engineering etc.

Expected results:

- organisation of workshops in order to train engineers to apply new manufacturing and information technologies;

- getting in touch with international scientific research and development institutions for joint research and transfer of knowledge.
- consulting services to companies when redesigning existing and developing new products (reversible engineering), introducing new technologies and reorganising activities in the planning of production and manufacturing process;

2.5. Admission requirements, in particular for candidates who obtained their degree under study system before 2005

Admission to the postgraduate doctoral study is by competition announced by the Academic Senate of the Faculty of Mechanical Engineering.

Admitted to the doctoral study are:

- graduate mechanical engineers,
- candidates with a Master's degree,
- those who completed their master's programme but did not defend their thesis and
- candidates who won their degree in compliance with the Scientific Activity and Higher Education Act (Narodne novine 123/03).

2.6. Criteria for selection of candidates

2.6.1. Admission requirements for mechanical engineers who graduated under the Institutions of Higher Education Act

Postgraduate study admission requirements for graduate mechanical engineers are:

- average marks $\geq$ 3,8, belonging to a group of 10% best students in the generation or a recommendation of two full professors,
- competence in one of the world languages, checked before enrolment.

The candidates holding a graduate degree from some other technical faculty may also be admitted after satisfying the bridging requirements. The bridging requirements are decided upon by the Committee for the postgraduate study.

The candidates who graduated according to the 'old programme' get 300 ECTS points and they have to enrol the 1st semester of the doctoral study.

2.6.2. Admission requirements for candidates holding a Master's degree

Masters of sciences in mechanical engineering winning their degree from a faculty in Croatia or abroad (in the equivalent field) are admitted.

Masters of sciences in other technical fields can also be admitted providing they fulfil the bridging requirements for Master' degree at the Faculty of Mechanical Engineering (Module Manufacturing Processes or Manufacturing Systems)

A master of sciences is recognised 300 ECTS points based on the graduate study and additional 60 ECTS points for the defence of the postgraduate thesis.

Master degree candidates are enrolled in semester 5 of the postgraduate doctoral study.

2.6.3. Admission requirements for candidates who completed their master's programme but did not defend the thesis

Only the candidates who completed their master's programme (but did not defend the thesis) with average marks ≥ 4,5 or with the recommendation of two full professors may be admitted.

The candidates who did not defend their thesis, but passed all their exams, are enrolled in semester 4 of the postgraduate doctoral study with 300 ECTS points and additional 52,5 ECTS points.

If the candidates did not pass all the exams, they get the proportional sum of ECTS points according to the exams passed. The bridging requirements are decided upon by the Committee for the postgraduate study and doctoral thesis of the Mechanical Engineering Faculty.

2.6.4. Admission requirements for candidates who won their degree in compliance with the Scientific Activity and Higher Education Act (Narodne novine 123/03 and Narodne novine 105/04)

Admission to the postgraduate doctoral study is allowed to graduate students from the Faculties of Mechanical Engineering in Croatia with at least 300 ECTS points earned as well as to the equivalent programme graduates from abroad with 300 ECTS points.

- To be admitted a graduate programme average marks are to be ≥ 3,8 and the candidate should be among 10% best students in the generation or have a recommendation of two full professors.
- Competence in one of the world languages is checked before the enrolment.

The graduate students from other technical faculties can also be admitted providing they fulfil the bridging requirements with regard to one of the existing Faculty of Mechanical Engineering graduate programmes (Structure Design, Technologies, Materials, Manufacturing Logistics).

2.7. Competences, possibility to continue scientific-research work and post-doctoral improvement, employment opportunities in public and private sector

The postgraduate doctoral study contains three modules (Modern Manufacturing Processes, Modern Production Management, Design and Numerical Modelling of Products) which allow the students to specialize in one of the fields.

The candidates are trained for:

- individual scientific-research work on scientific-research projects;
- work with new technologies;

- leaders of development and application of new scientific methods and technologies;
- performing research projects and tasks by applying advanced scientific methods and models, carrying out experiments and tests in the dynamic development of production sciences in Mechanical Engineering (development and redesign of products, new materials, new manufacturing technologies, new strategies in manufacturing logistics).

In specified laboratories and the CEPIT centre students can gain competences listed in item 2.4. Working in them, the doctors of sciences are given the possibility to continue their scientific research activities and post-doctoral improvement.

The doctors of science can find employment both in public and private sector. In the public sector the main purpose of this postgraduate doctoral study at the Faculty of Mechanical Engineering in Slavonski Brod is not only to educate the scientists (at the moment there are 13 candidates at the Faculty for this programme), but also to educate people who could run the major companies in this region. The doctors of science can make a great contribution to the development of companies (private or public companies), mainly in the field of transfer and application of modern manufacturing, information and IT technologies to our production companies, modernisation of the existing products and technologies, strategic and innovation management, human resources management, and also by starting so called *spill-over companies*, which are based on knowledge. One of the doctors' main tasks would be technical communication with the EU firms (e.g. exchange of the CAD 2-D and 3-D models, exchange of the CAM programmes, transfer of the status of production, etc.).

3. DESCRIPTION OF PROGRAMME

3.1. Structure and organisation of doctoral programme

All students are obliged to take core subjects and thematic subjects of the doctoral study specialised field in due time.

Core subjects

The core subjects are primarily meant to give students basic methodological and fundamental knowledge. The students are acquainted with different methodologies, philosophy of science, specific basic knowledge, particularly such that is continually necessary in engineering, i.e. mechanical engineering. The subjects are offered in the form of compulsory lectures, experimental work and seminars.

Thematic subjects

The purpose of the thematic subjects in modules is to ensure specialisation which students can choose at will. The emphasis is placed first of all on the theoretical and practical level of education, understanding of theoretical approaches and the most recent research results in a specific field of study. The selected option (module) enables the students to specialise in several directions and helps them in their research through various forms of work suitable for the specified theme (individual, seminars and short reports on the research, experimental work etc.). These subjects are meant to provide students with detailed knowledge of a specific field, helping them to carry on independent research and achieve original results.

The postgraduate programme is designed on the model of similar programmes in developed countries and based on experience of previous dissertations at the Mechanical Engineering Faculty and Master's degree programmes.

The postgraduate degree programme includes three modules:

- Modern Manufacturing Processes,
- Modern Production Management,
- Design and Numerical Modelling of Products.

3.1.1. Module: Modern Manufacturing Processes

The main purpose of the module is to provide students with knowledge and skills needed for independent scientific-research and professional work in the field of development and application of new engineering technologies.

Engineering technologies cover a broad area of conventional technologies: casting, deforming, chip-forming machining, welding, heat treatment, anticorrosive protection, and of new technologies: surface engineering, laser technologies, application of high-speed machining and machines, highly automated flexible manufacturing systems.

By experimental research into new areas of technology application and by mathematical modelling and simulation of machining operations, the students are trained for a systematic approach in solving technological problems.

3.1.2. Module: Modern Production Management

This programme is designed to prepare students for independent research and professional work in the management of production, materials, quality assurance, production planning and maintenance.

By getting acquainted with new strategies, processes and methods in manufacturing logistics, computer aided production planning and management as well as with optimisation methods in manufacturing processes, the students are trained for research work in rationalisation of management and functioning of production systems.

3.1.3. Module: Design and Numerical Modelling of Products

The main purpose of this module is scientific upgrading of candidates and their training for independent scientific-research work and for application of new methods and ideas to design, analysis and synthesis of machine structures. The term design of machine structures implies the process which as a rule consists of idea, concept, project, construction and design of a structure.

This module broadens and deepens the knowledge connected with systematic creation and development of machine structures, design theory, application of numerical methods in mechanics, methods of theoretical and experimental analysis of structures, application of new methods to structural analysis of constructions in view of optimal design of machine structures.

3.2. List of compulsory and elective subjects and/or modules with workload in hours and number of ECTS points

The postgraduate degree programme contains the following groups of compulsory and elective subjects:

- core common subjects (TK)
- module subjects (KM)
- module seminar subjects (SM).

All subjects of the doctoral study are foreseen in duration of one semester with the same number of ECTS points that amounts to 7,5. Total number of compulsory and elective subjects is 8, so that the total number of ECTS points which the student could achieve by exams passing is 60.

In the 1st semester the student chooses three core common subjects, which serve for acquirement of fundamental and methodological knowledge necessary for the study continuation. Two of three subjects are obligatory for all candidates (PD101 and PD102), while the third subject should be chosen as one of three offered subjects (PD103, PD104 or PD 105) in agreement with the leader of the module of the doctoral study.

The module subjects serve for the knowledge profilation of the doctoral study candidate. All module subjects are foreseen as elective, but the student has to select 2 module subjects from the list in the 2nd and 3rd semester, and 1 module seminar subject from the list in the 4th semester. This selection should be supervised by the leader of the module and mentor of the PhD work. Semesters 5 and 6 are foreseen for the research related to the topic of the doctoral dissertation.

The schedule of subjects of the doctoral study arranged by semesters with assigned ECTS points is presented in the Table 1. It is specified that the students collect 1/3 of total of 180 ECTS points by fulfilling the obligations from the educational process, while remaining 2/3 of ECTS points have to be achieved on the basis of performed researches.

Table 1: Schedule of subjects of the postgraduate doctoral study by semesters

	Subjects						Number of subj.	ECTS points
Semester	1.	2.	3.	4.	5.	6.		
Core common subjects (TK)	3						3	22,50
Module subjects (KM)		2	2				4	30,00
Module seminar subjects (SM)				1			1	7,50
Work from the field of investigation	constantly through the study							90,00
Doctoral dissertation								30,00
Sum of ECTS points								180,00

3.2.1. Core common subjects

1. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Departm.
			P	E		
PD101	Prof.dr.sc. Dražan Kozak Prof.dr.sc. Marija Živić Prof .dr. sc. Katica Šimunović	Logistics of Scientific Research Work	30	0	7,5	SF SF SF SF
PD102	Prof.dr.sc. Rudolf Scitovski Prof.dr.sc. Kristian Sabo Prof.dr.sc. Mirta Benšić	Mathematics and Statistics	30	0	7,5	MO MO MO
PD103	Prof.dr.sc. Ivan Budić Prof.dr.sc. Pero Raos Prof.dr.sc. Ivan Samardžić	Modern Manufacturing Processes	20	10	7,5	SF SF SF
PD104	Prof.dr.sc. Goran Šimunović Prof.dr.sc. Tomislav Šarić Prof.dr.sc. Roberto Lujić	Applying of the Artificial Intelligence	20	10	7,5	SF SF SF
PD105	Prof.dr.sc. Franjo Matejiček Prof.dr.sc. Luka Sopta Prof.dr.sc. Marija Živić Prof.dr.sc. Jurij Avsec	Numerical Methods in Mechanics	30	0	7,5	SF TFR SF FEK

P – lectures, E - laboratory and experimental work

Abbreviations:

SF – Faculty of Mechanical Engineering - Slavonski Brod
FESB – Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture - Split
MO – Department of Mathematics - Osijek
TFR – Faculty of Engineering - Rijeka
EF – Faculty of Economics - Osijek
FSLJ – Faculty of Mechanical Engineering - Ljubljana
FSM – Faculty of Mechanical Engineering – Maribor
FEK- Faculty of Energy Technology - Krško
PMF – Faculty of Natural Sciences and Mathematics – Zagreb
MFB - Faculty of Mechanical Engineering - Beograd

3.2.2. Subjects of module: Modern Manufacturing processes

Module leader: Prof.dr.sc. Pero Raos

2. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Departm
			P	E		
PD201	Prof.dr.sc. Pero Raos Prof.dr.sc. Ivan Samardžić	High Efficiency Joining Processes	20	10	7,5	SF SF
PD202	Prof.dr.sc. Ivan Budić	Modern Casting Technologies	20	10	7,5	SF
PD203	Prof.dr.sc. Branko Grizelj	Deformation Manufacturing	20	10	7,5	SF
PD204	Prof.dr.sc. Pero Raos Prof.dr.sc. Milan Kljajin Doc.dr. sc. Tomislav Galeta	Rapid Prototyping and Manufacturing	20	10	7,5	SF SF SF
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

3. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Departm
			P	E		
PD301	Prof.dr.sc. Ivica Kladarić Prof.dr.sc. Ivan Budić Prof.dr.sc. Vlatko Marušić	Thermal Activated Processes	20	10	7,5	SF SF SF
PD302	Prof.dr.sc. Janez Kopač Prof. dr.sc. Antun Stoić	High Speed Machining Processes and Systems	20	10	7,5	FSLJ SF
PD303	Prof.dr.sc. Branko Grizelj Prof.dr.sc. Pero Raos Prof.dr.sc. Ivan Budić Prof.dr.sc. Milan Kljajin Prof.dr.sc. Ivan Samardžić Prof.dr.sc. Stjepan Aračić	Technology of the Product	20	10	7,5	SF SF SF SF SF SF
PD304	Prof.dr.sc. Dragomir Krumes Prof. dr.sc. Ivica Kladarić	Modifying Surface of Materials and Surface Engineering	20	10	7,5	SF SF
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

4. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Depart.
			P	E		
PD401	Prof.dr.sc. Ivan Samardžić Prof.dr.sc. Nedjeljko Mišina Prof.dr.sc. Vladimir Gliha	Welding – Selected Chapters	20	10	7,5	SF FESB FSM
PD402	Prof.dr.sc. Stjepan Aračić	Mechanism and Prevention of Corrosion Damages	20	10	7,5	SF
PD403	Prof.dr.sc. Vlatko Marušić Prof.dr.sc. Dragomir Krumes	Selected Chapters from Materials	20	10	7,5	SF SF
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

3.2.3. Subjects of module: Modern Production Management

Module leader: Prof.dr.sc. Goran Šimunović

2. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Depart.
			P	E		
PD501	Prof.dr.sc. Katica Šimunović	Operational Management	20	10	7,5	SF
PD502	Prof.dr.sc. Ivica Veža Prof.dr.sc. Roberto Lujić Prof.dr.sc. Katica Šimunović	Production, Project and Resource Management	20	10	7,5	SF FESB SF
PD503	Prof.dr.sc. Goran Šimunović Prof.dr.sc.Tomislav Šarić Doc.dr. sc. Tomislav Galeta	Computer Aided Design, Process Planning and Manufacturing (CAD/CAPP/CAM)	20	10	7,5	SF SF SF
PD504	Prof.dr.sc. Tomislav Šarić	New Maintenance Strategies	20	10	7,5	SF
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

3. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Depart.
			P	E		
PD601	Prof.dr.sc. Goran Šimunović Prof.dr.sc. Roberto Lujić Prof.dr.sc. Katica Šimunović Prof.dr.sc. Tomislav Šarić	ERP Systems	20	10	7,5	SF SF SF SF
PD602	Prof.dr.sc. Jože Balič Prof.dr.sc. Goran Šimunović	Intelligent Production Systems	20	10	7,5	FSM SF
PD603	Prof.dr.sc. Roberto Lujić Doc.dr. sc. Tomislav Galeta	Information Systems: Strategy & Management	20	10	7,5	SF SF
PD604	Prof.dr.sc. Maja Lamza-Maronić	Human Resource Management	30	0	7,5	SF
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculty	30	0	7,5	

4. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Depart.
			P	E		
PD701	Prof.dr.sc. Tomislav Šarić Prof.dr.sc. Marinko Stojkov	Diagnostics	18	12	7,5	SF SF
PD702	Prof.dr.sc. Tomislav Šarić Prof.dr.sc. Antun Stoić Doc.dr.sc. Tomislav Galeta Prof.dr.sc. Goran Šimunović	Flexible Manufacturing Systems	18	12	7,5	SF SF SF
PD703	Prof.dr.sc. Ivan Samardžić	Quality Management	18	12	7,5	SF
PD704	Prof.dr.sc. Maja Lamza-Maronić Prof.dr.sc. Roberto Lujić	Strategic Management	18	12	7,5	SF
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

3.2.4. Subjects of module: Design and Numerical Modelling of Products

Module leader: Prof.dr.sc. Milan Kljajin

2. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Depart.
			P	E		
PD801	Prof.dr.sc. Milan Kljajin Prof.dr.sc. Jože Duhovnik Prof.dr.sc. Željko Ivandić	Design Theory	30	0	7,5	SF FSLJ SF
PD802	Prof.dr.sc. Josip Brnić Prof.dr.sc. Franjo Matejiček	Elastomechanics and Plastomechanics	30	0	7,5	TFR SF
PD803	Prof.dr.sc. Dražan Kozak Prof.dr.sc. Franjo Matejiček Prof.dr.sc. Todor Ergić	Thin-Walled Structures	30	0	7,5	SF SF SF
PD804	Prof.dr.sc. Milan Kljajin Prof.dr.sc. Jože Duhovnik Prof.dr.sc. Željko Ivandić	Theory of mechanical engineering systems	30	0	7,5	SF FSLJ SF
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

3. semester

Code	Head lecturerr	Subject	Hours		ECTS	Faculty/ Depart.
			P	E		
PD901	Prof.dr.sc. Franjo Matejiček Prof. dr.sc. Dražan Kozak	Finite Element Method in Structural Analysis	26	4	7,5	SF SF
PD902	Prof.dr.sc. Milan Kljajin Prof.dr.sc. Nenad Gubeljak Prof.dr.sc. Željko Ivandić	Modelling of Design and Design Processes	26	4	7,5	SF FSM SF
PD903	Prof.dr.sc. Franjo Matejiček Prof.dr.sc. Nenad Gubeljak Prof.dr.sc. Dražan Kozak	Fatigue Strength and Fracture Mechanics	26	4	7,5	SF FSM SF
PD904	Prof.dr.sc. Milan Kljajin Prof.dr.sc. Željko Ivandić Prof.dr.sc. Božidar Križan	Selected Topics in the Area of Mechanical Engineering Elements	30	0	7,5	SF SF TFR
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

4. semester

Code	Head lecturer	Subject	Hours		ECTS	Faculty/ Depart.
			P	E		
PD951	Prof.dr.sc. Milan Kljajin Doc.dr.sc. LavoslavČaklović Prof. dr.sc. Željko Ivandić	Methodology for the Evaluation of Design Alternatives	30	0	7,5	SF PMF SF
PD952	Prof.dr.sc. Dražan Kozak Prof.dr.sc. Franjo Matejiček Prof.dr.sc. Marija Živić	Calculation, Design and Optimization of Mechanical Construction	30	0	7,5	SF SF SF
PD953	Prof.dr.sc. Milan Kljajin Prof.dr.sc. Jože Duhovnik Prof. dr.sc. Todor Ergić	Product Development and Ergonomics	24	6	7,5	SF FSLJ SF
PD954	Prof.dr.sc. Ivan Samardžić Prof.dr.sc. Dražan Kozak Prof.dr.sc. Željko Domazet Prof.dr.sc. Aleksandar Sedmak	Damages of Constructions	20	10	7,5	SF FESB BZ MFB
		Selected subjects from other modules	30	0	7,5	
		Selected subjects from other University faculties	30	0	7,5	

3.3. Obligatory and optional activities (taking part in seminars, conferences, round-table talks etc.) and criteria to express them in ECTS points

All postgraduate students must attend lectures at the Faculty (of Mechanical Engineering) whether they come from some higher education institution or from some scientific institution. Besides taking core subjects and thematic subjects of the specialised field (module) or compulsory and elective subjects of the basic module and elective subjects from other modules and other University faculties, the doctoral study also requires of all students to engage in some of the following compulsory or optional activities that are associated with the original scientific research like for example:

Compulsory activities:

- Attending lectures
- Taking part in seminars and preliminary exams (within a subject/module, etc.)
- Taking part in thematic round-table talks and workshops
- It is obligatory for all students to spend some time abroad
- Publishing in magazines

It is important to point out that all postgraduate students must spend some time in an adequate research centre abroad. The proposer of the study must provide the necessary data on scholarships and give the candidates the adequate support so that they can apply for these scholarships.

Optional activities:

- Taking part in conferences (actively)
- Presenting results of current researches at the Scientific Forum (at the Faculty)
- Participating in scientific-research projects
- Work on technological projects and projects for the economy

The listed activities bring the postgraduate doctoral study student additional **90 ECTS** points according to the following criteria:

ECTS	Activity	Criteria and explanation
2,5	Taking part in seminars	The student participates actively in seminars within the framework of the subject or the module. The seminars are thematic and the theme is either proposed by the student or initiated by the leader of the module or the subject lecturers. The theme need not necessarily be an integral part of the dissertation. The seminars result in written papers, marked at the end of the seminar. If the seminars are organised at another faculty the student must provide a certificate of his regular attendance and active participation in the seminar.

2,5	Taking part in round-table talks	Similar to seminars, the students participate in round-table talks which are thematically connected with the taken module. The round-table leader's report on active participation is sufficient for earning credit points.
2,5	Taking part in workshops	Workshops provide a number of opportunities for students to talk through ideas and discuss results of work assignments introduced in lectures of one or more modules. Taking part in other faculty workshops is also acknowledged if the topics discussed are related to the field of the student's study programme or his dissertation.
5	Presenting results of the researches at the Scientific Forum (at the Faculty)	Scientific Forum was founded at the Faculty of Mechanical Engineering so that researcher novices, assistants and postgraduate students could present their research results and share their ideas.
7,5	Publishing in journals	During the postgraduate study the student must publish in magazines (preferably in magazines with internationally accepted reviews or of the same quality as home magazines, or referred in well-known data bases etc.) either on his own or assisted by his mentor, leader of the module, course lecturer, or as a co-author.
15	Publishing in journals	If the student is the only author of a paper and the paper treats the dissertation topic (preliminary notes or original scientific paper) he is entitled to a doubled number of points.
7,5	Taking part in conferences	If the student participates in a scientific conference (at home, at home with international participation or international) and presents a paper as the author or co-author, with a document proving his participation and the paper published in the conference proceedings, he is entitled to additional ECTS points.
7,5	Participating in scientific-research projects	For an active participation as researcher in a scientific-research project which will also serve as a basis for the realisation of his dissertation.
15	Participating in international scientific-research projects	For an active participation in international scientific projects or independent leading of a smaller scientific project within a bigger project.
7,5	Participating in scientific-research projects	For an active participation in scientific-research projects for home industry, related to his dissertation topic.
20	Study stays abroad	If experimental or other scientific researches, related to the dissertation, require that the student stays abroad for 30 or more days, and he receives the EU or its members' financial support for it (such as TEMPUS, Fulbright, Humboldt, DAAD scholarship, etc.), if he can document it, he is entitled to additional ECTS points.

3.4. Description of every subject and/or module

PD 101 Logistics of Scientific - Research Work

Module: **Basic Common Subjects**

Course contents:
The term and definition of science, scientific work, technique and technology. Scientific methods and methodologies. The methods of the scientific work: analysis and synthesis, abstraction and to the point methods, generalisation and specialisation, inductive methods (observation, experiment, counting, measurement, statistical methods, causal inductions), deductive, achromatic, comparative, genetics and interview methods. The term of research and scientific research. The phases of the research. The construction of the proposal of the research project.

Planning and design of the experiment. Research hypotheses. Research strategies. Experiment design. The design of a factorial experiment. The evaluation of the hypotheses. Organisation of the scientific research work. The plan termination. Leading of the scientific project. Monitoring points of the project realisation.

Exploring the scientific information and sources. The way of writing the scientific and research works. How to write the dissertation. How to present and defend the dissertation work.

Learning outcomes and competences:
The methods of scientific research work present the basis for the introduction of the PhD students into world of science. The special accent will be given to the contents, form and style of writing and public presentation of the scientific work. Beside that the students should be trained to search through the publications in the library, to explore the scientific information on the CD ROMs and to surf the Internet searching for the relevant databases.

Teaching methods:
Topic units of the study course are presented through lectures and case study analyses. Insights gained through lectures will broaden and deepen the knowledge of the postgraduates of scientific research; knowledge of the fundamental, applicable and development research and steps in creating scientific and professional works, above all, seminars/papers and PhD theses, scientific discourses (articles), feasibility studies, expertise works etc. Case study analyses will enable the postgraduates to participate actively as researchers in scientific research. By simulating the stages in creating different types of scientific and professional works, the postgraduates will be trained in writing their scientifically founded and rational scientific research works.

Recommended reading:

- Zelenika, R.: Metodologija i tehnologija izrade znanstvenog i stručnog djela, 4. izdanje, Ekonomski fakultet u Rijeci, Rijeka, 2000.
- Silobrčić, V.: Kako sastaviti, objaviti i ocijeniti znanstveno djelo, Medicinska naklada, Zagreb, Četvrto, dopunjeno izdanje, 1998.
- Žugaj, M.: Metodologija znanstvenoistraživačkog rada, Fakultet organizacije i informatike, Varaždin, 1997
- Težak, Đ.: Pretraživanje informacija na Internetu, Priručnik s vježbama, 2. izdanje, Hrvatska sveučilišna naklada, Zagreb, 2002.

Supplementary reading:

- Day, A. R.: How to write and publish a scientific paper, 5th edition, ryx Press, ISBN 1573561657, 1998.

- Bailey, C.A.: A Guide to Field Research, Pine Forge Press, Thousand Oaks, California, 1995

ECTS (Number of credits allocated):

7,5 ECTS

The course will be performed during the semester with 30 hours of lectures.

Number of credits will be allocated as follows:

30 hours of lectures = 1,5 ECTS

60 hours of individual work with consultations = 3 ECTS

45 hours of literature study = 1,5 ECTS

45 hours for the seminar work = 1,5 ECTS

Assessment methods:

Knowledge acquired through this course with its application should be evident through the work on the seminar, devoted to the topic of the dissertation, as a rule. Positive grade of the seminar work is the precondition for the oral part of the exam. The seminar work represents about 60 percent, and the oral part of the exam represents about 40 percent of the final grade.

Quality assurance methods:

The student evaluation is necessary, the evaluation from other professors and experts in this scientific area, the efficiency on partial exams; and if it is necessary, also the international supervision.

PD 102 Mathematics and Statistics

Module: **Basic Common Subjects**

Course contents:
The objective of this course is to make students familiar with the basic ideas and methods of numerical mathematics and statistics that are used for solving practical problems.
Errors. Interpolation problem. Spline interpolation. Eigenvalue problem. Solving a system of linear equations. Root finding and and solving nonlinear set of equations. Approximation of functions. Least squares problem. Numerical integration. Numerical methods for solving ordinary differential equations. Initial value problems. Two point boundary value problems. Numerical methods for solving partial differential equations.
Probability and properties. Random variable. Discrete and continuous probability distributions (hyper-geometric, binominal, Poisson, normal, uniform, exponential, Chi-squared, student's distribution). Numerical characteristic of distribution. Moments and correlations. Correlation and regression analysis. Samples and numerical characteristic of samples. Parameter estimation. Interval estimation. Statistical hypothesis testing. Examples of statistical models, statistical thinking and application of statistical programmes.

Learning outcomes and competences:
The aim of the course is to make students familiar with the basic ideas and methods of numerical mathematics and statistics that are used for solving practical problems.
Introduction to statistical terminology and laws, construction of statistical models and their application in: engineering, process control, quality control and other problems. To prepare the students for a lifelong learning process and for the use of mathematical tools in application.

Teaching methods:
Education process is combined as lecturing with exercises. Exercises include chapters that have been learned during lecturing. Monitoring of seminar project progress is continuous as a part of knowledge evaluation. Finally evaluation is performed by oral presentation and exam.
During the semester the students can take several tests which replace the written examination. This ensures a continuous assessment of the students' work and knowledge.

Recommended reading:
- Key, C. D.: Schaum's Outline of Tensor Calculus, McGraw-Hill Trade; (Schaum's Outline Series) edition, 1988.
- Parker, L. and Christensen; S. M.: Math Tensor: A System for Doing Tensor Analysis by Computer, Reading, MA: Addison-Wesley, 1994.
- Kurepa, S.: Konačno dimenzionalni vektorski prostori i primjene, Liber, Zagreb, 1992.
- Galić, R.: Statistika, ETF, Osijek, 2004.

Supplementary reading:
- Horn, R. and Johnson, C.: Topics in Matrix; Cambridge University Press, Cambridge 1995.
- Pauše, Ž.: Vjerojatnost i stohastički procesi, Školska knjiga, Zagreb, 2004.

ECTS (Number of credits allocated):
7,5 ECTS
The course will be performed during the semester with 30 hours of lectures.
Number of credits will be allocated as follows:
30 hours of lectures = 1,5 ECTS
60 hours of individual work with consultations = 3 ECTS

45 hours of literature study = 1,5 ECTS
45 hours for the seminar project = 1,5 ECTS

Assessment methods:
During the semester, knowledge, understanding and implementation will be tested by determined techniques. Frequent testing during the semester makes 50% and project presentation makes 50% of the final mark.

Quality assurance methods:
The student evaluation is necessary, the evaluation from other professors and experts in this scientific area, the efficiency on partial exams; and if it is necessary, also the international supervision.

PD 103 Modern Manufacturing Processes

Module: **Basic Common Subjects**

Course contents:
This course contains modern manufacturing processes from various technologies.

Casting into shells by means of automatic moulding equipment with vertical mould partition. Vacuum casting of products with small mass and dimensions. Centrifugal casting.

Rapid prototyping and rapid moulding (systematization and basics of technology), overview of established processes of rapid production. Construction ceramics processing (systematization of ceramic materials). Ceramics basic properties. Primary production processes. Injection moulding of ceramic mixtures. Basics of structural adhesive bonding (application of adhesive bonding in production of machinery). Nanotechnology (introduction in nanoscience and nanotechnology). Application of nanomaterials in techology. Production processes of nanoproducts.

Advanced welding processes: TIME (Transferred Ionized Molten Energy) single and twin welding process, GMAW-STT process (Gas metal Arc Welding – Surface Tension Transfer), FCAW and SS FCAW (Flux Cored Arc Welding and Self Shielded Flux Cored Arc Welding), FSW (Friction Stir Welding) process.

Learning outcomes and competences:
The aim of the course study is increasing the basic and specific knowledge of Modern Manufacturing Processes (as described in the course contents).
At the end of course, the student acquires knowledge for the independent work (science research, project management, expertise, laboratory research and other).

Teaching methods:
Teaching consists of lectures and a seminary work in which the students apply their knowledge. Knowledge verification is constant (preliminary exam). Verification of the seminar work (project) is continuous; with presentation of the seminar work at the end.

Recommended reading:
- Bonačić Mandinić, Z.; Budić, I.: Osnove tehnologije kalupljenja, Jednokratni kalupi - I dio, 253 str., Strojarski fakultet u Slavonskom Brodu, 2001, odobreno kao udžbenik od Senata Sveučilišta J. J. Strossmayera u Osijeku.
- Budić, I.; Bonačić Mandinić, Z.: Osnove tehnologije kalupljenja, Jednokratni kalupi - II dio, 264 str., Strojarski fakultet u Slavonskom Brodu, 2004, odobreno kao udžbenik od Senata Sveučilišta J. J. Strossmayera u Osijeku.
- Raos, P.; Lucić, M.: Postupci spajanja lijepljenjem, interna skripta, Strojarski fakultet, Slavonski Brod, 2003.
- Lukačević, Z. i suradnici: Nove tehnologije, interna skripta, Strojarski fakultet, Slavonski Brod, 1998.

Supplementary reading:
- Gebhardt, A.: Rapid Prototyping, Hanser Verlag, München, 2003.
- Poole, C.P., Owens, F. J.: Introduction to Nanotechnology, Wiley-Interscience, A John Wiley & Sons, Inc. Publication, Hoboken, New Jersey, 2003.

ECTS (Number of credits allocated):
7,5 ECTS
There are 20 hours of lectures and 10 hours of exercises during the semester.

20 hours of lectures + 10 hours of exercises = 1,5 ECTS
60 hours of individual work with consultations = 3 ECTS
45 hours of literature study = 1,5 ECTS
45 hours for the seminar project = 1,5 ECTS

Assessment methods:
Evaluation is continuous with preliminary exam, and presentation of the seminar work.
Preliminary exam represents 60%, and presentation of the seminar work represents 40% of the final mark.

Quality assurance methods:
Student evaluations, evaluations of professors who participate in successful performance of the study programme.

PD 104 Applying of the Artificial Intelligence

Module: **Basic Common Subjects**

Course contents:
This module provides an understanding of artificial intelligence philosophy, concepts, ideas, existing and new trends, and possible area where it could be applied. Knowledge: basic ideas, importance and knowledge based systems. Knowledge representation scheme. Knowledge organisation, collection and manipulation. Artificial intelligence languages: LISP and PROLOG. Syntax and semantic meaning of artificial intelligence languages. Examples.

Knowledge representation scheme. Symbolic Logic and Common Sense: predicate logic, syntax and semantic of the first-order. Roles of syntax and semantics in generating sentences. Reasoning rules. Non-deductive reasoning. Truth maintenance system. Closed world assumption. Modal, temporal, constructive and propositional logic. Probabilistic reasoning: Bayesian reasoning, world assumptions, Dempster-Shafer theory, ad-hoc and heuristic methods. Structural knowledge: graphs, frames etc. Object orientated representations: objects, classes, messages and methods. Object orientated languages and systems. Knowledge organisation and management.

Search strategies: concepts, examples, blind search, data-driven search, search tree. Comparison techniques: structure, measures, patterns, spreading activation. Knowledge organisation and manipulation: indexing, knowledge acquisition, knowledge database organisation.

The use and applying of artificial intelligence methods (neural network, fuzzy logic, genetic algorithm, and expert system) to solve the problems in the real time under circumstances of uncertainty, limitation of computer resources and unknown and unreliable information.

Learning outcomes and competences:
To provide comprehensive knowledge, analysis and investigation in the artificial intelligence area. To enable understanding of the system based on knowledge and the way to collect, organise and manipulate with knowledge. The use of artificial intelligence methods (neural network, fuzzy logic, genetic algorithm, expert system). The practical examples will be described.

Teaching methods:
Lectures. Experimental work. Project. During the project realisation, students will use knowledge that is acquired through lectures, experimental work, investigations that will be done in production systems and literature. Oral presentation of the project supported by certain presentation techniques will be used as the examination method

Recommended reading:
- Jović, F.: Expert Systems in Process Control, Chapman and Hall, London, Van Nostrand Reinhold Inc., New York, 1992., 175 str.
- Novaković, Branko; Majetić, Dubravko; Široki, Mladen: Umjetne neuronske mreže, FSB, Zagreb, 1998.
- Patterson, W. Dan: Introduction to Artificial Intelligence, Prentice Hall, New York, 1990, 448 str.
- Russell, S. J.; Norvig, P.. Artificial Intelligence: A Modern Approach (2nd Edition), Prentice Hall, 2002, 1132 pages, ISBN: 0137903952

Supplementary reading:
- Luger, G.: Artificial Intelligence: Structures and Strategies for Complex Problem Solving (5th Edition), Addison Wesley, 2004, 928 pages, ISBN: 0321263189

- Puppe, F.: Systematic Introduction to Expert Systems, Knowledge representations and Problem-Solving Methods, Springer-Verlag, 1993.

ECTS (Number of credits allocated):
7,5 ECTS
Module will be realised during 1st semester – 20 hours of lectures and 10 hours of experimental work.
20 hours of lectures = 1 ECTS
10 hours of experimental work = 0,5 ECTS
60 hours of individual with necessary consultations = 3 ECTS
45 hours of literature study = 1,5 ECTS
45 hours for the project = 1,5 ECTS

Assessment methods:
The exam contains two parts. The first will be done during the semester where knowledge will be checked continually (quiz, colloquy and test) with the intention to test the student's understanding and accomplishments.

The second part is the public presentation of the project that has to be done by the student under the mentor's supervision. The head of the module has to be present during the public presentation. Each part of the exam carries 50 % of the final mark.

Quality assurance methods:
Student's self-evaluation, supervisor's evaluation, test efficiency.

PD 105 Numerical Methods in Mechanics

Module: **Basic Common Subjects**

Course contents:
Ordinary differential equations based models. Dynamical systems and chaos. Numerical solutions using finite difference method. Runge-Kutta method.

Partial differential equations based models in fluid mechanics, thermodynamics and elasticity theory. Variation principles. Mass, momentum and energy conservation laws application on continuum mechanics problems. Boundary problems for Laplace and Poisson equation with applications. Heat diffusion and concentration equation. Wave equation. Sound equation and acoustics equations.

Solving of linear algebraic equations systems. Direct and indirect methods. Numerical solution of Laplace equation, heat conduction equation and wave equation by using finite difference method. Short introduction to finite element method and finite volume method.

Learning outcomes and competences:
Students gain knowledge of mathematical model definition in engineering practice, model application to typical engineering problems and problem solving, which makes them competent for the use of relevant methods for specific problem solving.

Teaching methods:
Course of the study: lectures, exercises, independent work, and consultations.

Recommended reading:
- Strang, G.: Introduction to applied mathematics, Wellesley-Cambridge Press, 1986.
- Aganović, I.: Uvod u rubne zadaće mehanike kontinuuma, Element, Zagreb, 2003.
- Chapra, S. C.; Canale, R. P.: Numerical methods for engineers, McGraw Hill Book, 1989.
- Sorić, J.: Metoda konačnih elemenata, Golden marketing, Zagreb, 2004.

Supplementary reading:
- Lucquin, B.; Pironneau, O.: Introduction to Scientific Computing, John Wiley&Sons, Chichester, 1998.
- Leveque, J. R.: Finite Volume Methods for Hyperbolic Problems, Cambridge University Press, 2002.

ECTS (Number of credits allocated):
7,5 ECTS
There are 30 hours of lectures during the semester.
30 hours of lectures = 1,5 ECTS
60 hours of individual work with consultations = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours for the seminar project = 1,5 ECTS

Assessment methods:
Manner of knowledge testing is class participation and seminar paper. The final grade is assessed as follows: lecture attendance 30%, exercise attendance 30%, seminar paper 40%.

Quality assurance methods:
Regular class attendance. Continuous dialogue with students. Quality control of the seminar papers.

PD 201 High Efficiency Joining Processes

Module: **Modern Manufacturing Processes**

Course contents:
Introduction. The significance of high efficiency joining processes from the standpoint of economy, reliability and quality, minimal consumption of material and energy, minimal pollution of human environment. Systematic illustration of modern high efficiency joining processes.

Adhesive bonding as a high efficiency joining technology. High efficiency hybrid joining processes (combination of adhesive bonding and mechanical joining by rivets, screws, etc.).

Modern adhesive bonding processes and sealing techniques of thread fastenings - application in gas equipment production and gas sealing and other installation.

High efficiency welding joining processes.
High efficiency welding processes in large European companies in steam boiler production (orbital automatic TIG welding of pipes in "pipes wall", automatic TIG butt pipes welding, automatic SAW pipes welding in "membrane pipes wall", arc stud welding, semiautomatic and automatic GMAW process with flux cored wire, robotized GMAW process).

High efficiency welding processes of thin wall bellows made of different types stainless materials, different types of high alloyed steels and Ni alloys (automatic TIG welding process with Cu backing, micro-plasma welding, electron beam welding, laser, seam and spot resistant welding).

High efficiency welding processes at pressure vessels production: single type production of double wall large cylindrical and spherical pressure vessels, and mass production of smaller pressure vessels for storage and transportation of liquefied petrol gas LPG (automatic electro-gas welding of vertical joints on cylindrical tanks and ship shells; so called "vertomatic process", automatic arc welding – SAW process in wall position at performing circular welded joints on cylindrical tanks; so called "circomatic process", automatic welding of thick wall sections by SAW process; so call "narrow gap welding", automated production lines for welding massive production of pressure vessels for storage and transportation of liquefied petrol gas in household).

High efficiency friction stir welding processes (FSW). New high efficiency automated welding process which is successfully applied in industrially developed countries.

Other modern high efficiency welding processes (processes used in Al alloys products manufacturing, GMAW and SAW processes with two wires for high deposit and welding speed rate achieving).

Learning outcomes and competences:
The aim of the course study is increasing the knowledge related to important chapters from the field of high efficiency joining processes. Those joining processes are significant due to modern quality and reliability requirements and other elements of effective manufacturing.

Teaching methods:
Lectures and experimental investigation. The educational process is combined with the seminar project. Monitoring of the seminar project progress is continuous as a part of knowledge evaluation. Finally, the public presentation and discussion related to the seminar project is predicted.

Recommended reading:

- Habenicht, G.: Kleben, Springer Verlag, Berlin, 2003.
- Raos, P.; Lucić, M.: Postupci spajanja lijepljenjem, interna skripta, Strojarski fakultet, Slavonski Brod, 2003.
- Lukačević, Z.: Zavarivanje, Strojarski fakultet u Slavonskom Brodu, 1998.
- Kralj, S.; Andrić, Š.: Osnove zavarivačkih i srodnih postupaka, Sveučilište u Zagrebu, 1992., ISBN 86-7819-043-4.

Supplementary reading:

- Conference proceeding of International conference Equipment for welding and allied techniques and its application, Croatian Society for Welding, 1995.
- Samardžić, I. i dr.: Analiza tehnologičnosti zavarenih konstrukcija. Digitalni udžbenik, http://www.sfsb.hr/kth/zavar/index.html, 2001.

ECTS (Number of credits allocated):

7,5 ECTS
Lecture 24 hours and Experimental investigation 6 hours.
24 hours Lecture + 6 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:

Written and oral.

Quality assurance methods:

Students evaluations, professors evaluations, evaluations of professors who participate in successful performance of study program.

PD 202 Modern Casting Technologies

Module: **Modern Manufacturing Processes**

Course contents:
Acquaintance of students with casting technology and simulation methods for the definition of parameters of the technological process.

Tasks and expectations se on foundries by the industry using castings intensively e.g. cars industry. Manufacturing procedures and casting allowances. Improvement of casting quality and foundries competitiveness by technological development. Castings/construction. Fast pattern manufacture. Calculation of pouring-in systems and simulation of castings solidification by corresponding programme packages. Streaming in the pouring-in system. Phenomenon of spring effect, of the mould at high-pressure moulding on HVAP equipment that causes castings dimensional changes.

Optimization of casting procedure. Application of computer modelling with the purpose of pouring-in and castings/filling-up optimization. Metals casting in slushy, (partly liquid) state. Modern casting technologies. Low-pressure casting in sand moulds. Precision casting technology. Shell moulding casting.

Learning outcomes and competences:
The aim of course study is increasing the basic and specific knowledge of Modern casting technologies (like low pressure casting in sand mould, precise and shell moulding casting).
At the end of course, student acquire knowledge for independence work (science research, project management, expertise, laboratory research and other).

Teaching methods:
Teaching is consisting of lecturing and seminary work in which student apply his knowledge. Knowledge verification is continuous with preliminary exam. Verification of Seminary work is continuous; with defend of seminary work on the end.

Recommended reading:
- Bonačić Mandinić, Z.; Budić, I.: Osnove tehnologije kalupljenja, Jednokratni kalupi - I dio, 253 str., Strojarski fakultet u Slavonskom Brodu, 2001, odobreno kao udžbenik od Senata Sveučilišta J. J. Strossmayera u Osijeku.
- Budić, I.; Bonačić Mandinić, Z.: Osnove tehnologije kalupljenja, Jednokratni kalupi - II dio, 264 str., Strojarski fakultet u Slavonskom Brodu, 2004, odobreno kao udžbenik od Senata Sveučilišta J. J. Strossmayera u Osijeku.
- Campbell, J.: Casting Elsevier Science Ltd., Linacre House, Jorda Hill, Oxford, second edition 2003.
- Tehnička Enciklopedija, Mehanizacija ljevaonica, Jugoslavenski leksikografski zavod Zagreb, Svezak 8, 1982.

Supplementary reading:
- Elliot, R.: Cast Iron Technology, Butterworths, London, 1988.
- www.castingsforindustry.com (2001.)

ECTS (Number of credits allocated):
7,5 ECTS
Lecture 24 hours and exercises 6 hours.
24 hours Lecture + 6 hours exercises = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS

45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:
Continuous with preliminary exam, and defend of seminary work.
Preliminary exam are 60%, defend of seminary work are 40% of final mark.

Quality assurance methods:
Students evaluations, professors evaluations, evaluations of professors who participate in successful performance of study program (also see suggestion of Samardžić-Maglić-Majdandžić).

PD 203 Deformation Manufacturing

Module: **Modern Manufacturing Processes**

Course contents:
Literature. Classification. Metal forming advantages and shortages. Machines for metal forming. Power and deformation work for 3D state of stress. Flow stress for 3D stress state. Deformation work calculation. Deformation work calculation at hammer forging. Deformation work calculation at squeeze forging. Heater and combustion. Block diagram for analytical solutions of metal forming. Material flow. Equations for solving metal forming. Local deformations and velocities. Homogenous forming. Material model. Transformation of stress state. Main axles and invariants. Deviator and flow condition. Motion. Continuity equation. Deformation velocities in tensor form. Flow law in tensor form. Balances equation in square and cylindrical coordinates. Solving examples from higher theory of plasticity. Fundamentals of Finite Elements Method (FEM). Application of FEM at bending and deep drawing. Application of FEM at forging. Application of FEM at extrusion. Precise bending. Model for compensation elastic return. One grade bending. Influence of machine on precise bending. Influence of tool on precise bending. Influence of part geometry and product property on improvement accuracy. Influence of friction on improvement accuracy. Precise bending in two grades. Improvement accuracy of shank. Laser. Fundamentals appliances of laser. Influence of geometry work piece, length of boundary bending, thickness of plate and shank length at laser bending. Laser application at deep drawing. Simulation of process and CAD/CAM methods for improvement accuracy of bending.

Learning outcomes and competences:
Aim of learning subject is to acquire a special knowledge's about deformation manufacturing, application of new technologies and flexibility concerning geometry of work piece.

Teaching methods:
Teaching is providing with combination of lectures and assigning seminary work in which student applying his knowledge. Accompany of making seminary work is continuously, like and examination.

Recommended reading:
- Grizelj, B.: Oblikovanje metala deformiranjem, Strojarski fakultet Slavonski Brod, 2002.
- Grizelj, B.: Alati i naprave, Strojarski fakultet, Slavonski Brod 2004.
- Math, M.: Uvod u tehnologiju oblikovanja deformiranjem, Zagreb
- Povrzanović, A: Odabrana poglavlja obrade metala deformiranjem, Fakultet strojarstva i brodogradnje, Zagreb, 1996.

Supplementary reading:
- Lange, K.: Umformtechnik, Band I-IV, Spring Verlag, 1989-1993.
- Musafija, B.: "Obrada metala plastičnom deformacijom", Svjetlost Sarajevo, 1988.

ECTS (Number of credits allocated):
7,5 ECTS
Subject is realizing through semester with total 30 hours of lectures.
30 hours of lectures = 1,5 ECTS
60 hours of independent work with consultations = 3 ECTS
45 hours of study literature =1,5 ECTS
45 hours making seminary work = 1,5 ECTS

Assessment methods:
Examination is a public and consist of defending seminary work which is student create independent with teacher leading. Leader of module is also participating to examination.

Quality assurance methods:
Student evaluation, evaluation by teachers and experts, success at partial exams, and if needful international supervision.

PD 204 Rapid Prototyping and Manufacturing

Module: **Modern Manufacturing Processes**

Course contents:
Introduction. History and perspectives. Rapid Prototyping (RP) – an integral part of Time Compression Engineering. CAD techniques of geometrical modelling.
Rapid prototyping processes. Classification of rapid prototyping processes. Processes involving a liquid. Solidification of a liquid polymer: stereolithography (SL), liquid thermal polymerization (LTP), beam interference solidification (BIS), tonographic process (solid ground curing - SGC), holographic interference solidification (HIS). Solidification of an electroset fluid: electrosettings (ES).
Solidification of molten material: ballistic particle manufacture (BPM), fused deposition modelling (FDM), 3D welding, shape deposition manufacturing (SDM). Processes involving discrete particles: fusing of particles by laser (selective laser sintering – SLS, laser engineering net shaping – LENS^{TM}, gas phase deposition - GPD).
Joining of particles with a binder: 3D printing, spatial forming (SF). Processes involving solid sheets: laminated object manufacture (LOM), paper lamination technology (PLT), solid foil polymerisation (SFP).
Technical characteristics of commercial systems for production of geometric and functional prototypes. Stereolithography Apparatus (3D Systems), Solid Ground Curing Systems (Cubital Ltd), Fused Deposition Modelling (Stratasys, Inc.), Selective Laser Sintering Systems (DTM Corp. and EOS GmbH).
Laminated Object Manufacturing Systems (Helisys, Inc.), Paper Lamination Technology (Kira Corp), Laser Engineering Net Shaping (LENS^{TM}) Systems (Optomec Design).
Technical characteristics of commercial systems for production of concept prototypes. 3D Systems ThermoJet^{TM} Printer, Sanders ModelMaker II (Inkjet Modelling Technology), Z-Corporation Z402 3D Printer (Three Dimensional Printing), Stratasys Genisys Xs 3D PrinterJP System 5, Objet Quadra System.
Application of rapid prototyping technology: functional models, pattern for investment and vacuum casting, medical models, art models, engineering analysis models.
Indirect methods for rapid tool production. Role of indirect methods in this production. Metal deposition tools. Silicon rubber moulds (RTV tools). Epoxy tools. Ceramic tools.
Cast metal tools, investment casting, fusible metallic core and sand casting. Keltool^{TM} process.
Classification of direct rapid tool methods. Direct ACES^{TM} injection mould (AIM^{TM}), laminated object manufactured (LOM)tols.
Processes DTM RapidTool^{TM}, SandForm^{TM} and EOS DirectTool^{TM}. Direct metal tooling using 3D printing (3DP^{TM}) and topographic shape formation (TSF).
Application of rapid tooling technology: insert design and insert finishing, rapid tooling inserts wear resistance, case studies.
Rapid prototyping process optimisation. Factors influencing accuracy (data preparation, part building and part finishing). Accuracy and errors of the SL process.
Accuracy of errors SLS process. Selection of part build orientation: orientation constrains of the SL and SLS process.

Learning outcomes and competences:
The aim of subjects study is to acquire special knowledge's about systematic approach in product development and product manufacturing, specially aimed on the rapid prototyping and rapid product manufacturing. Students make their master of knowledge and skills linked to the modern approach of prototypes or product manufacturing.

Teaching methods:
Teaching is leading by lectures combinating and seminar inflicting in which student lonely and/or in work group is applying acquiremented knowledges.

Recommended reading:
- Gebhardt, A.: Rapid Prototyping, Hanser Verlag, München, 2003.
- Pham, D.T.; Dimov, S.S.: Rapid Manufacturing, Springer, London, 2001.
- Raos, Pero; Čatić, I.: Razvoj injekcijski prešanih polimernih tvorevina, Društvo plastičara i gumaraca, Zagreb, 1993. (ISBN 86-7483-010-9)
- Bonten, Ch.: Produktentwicklung – Technologie-Management für Kunststoffprodukte, Hanser Verlag, München, 2002.

Supplementary reading:
- Wood, L.: Rapid Automated Prototyping: An Introduction, Industrial Press, 1993, ISBN 0-8311-3047-4.
- Chua C. K. and Leong K. F.: Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, Inc., 1998, ISBN 0-471-19004-7.

ECTS (Number of credits allocated):
7,5 ECTS
The course will be performed during the semester with the schedule of the 20 hours of lectures and 10 hours of experimental work.
Number of credits will be allocated as follows:
20 hours of lectures = 1,0 ECTS
10 hours of experimental work
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:
Test is slopping with seminar work presentation which student has lonely made beside teacher and assistant support. On public presentation is also modul leader. During the semester knowledge is checking (quiz, preliminary exam, test), understanding, use a new knowledge, analyticity and systematic with the system for knowledge evaluation. Continuing test wear 60 %, and end indication of project 40 % final mark.

Quality assurance methods:
Students evaluation, teacher evaluation and latitude professionals, efficiency on partial tests and if is necessary international supervision (see suggestion Samardžić-Maglić-Majdandžić).

PD 301 Thermal Activated Processes

Module: **Modern Manufacturing Processes**

Course contents:
Concept and basic of kinetic theory. Stable and metastable balance. The initiate force of the transformation. The speed of the processes. The energy of activation. The Arrhenius's equation. Interactatomic and interactmolecular connections. Crystallography. The crystallography defects. The sorts of thermal activated processes. Diffusion in metals. The Fick's laws. The diffusion mechanism's and sorts of diffusion. The gases in metals. Thermochemical treatment of iron alloys. The recovery, the growth and recristalisation of grains. The texture of deformation and annealing's texture. The theory of the crystalisation. The beginning of germ's and growing of the phases. The shape and arrangement of phases in solid bodies. Theory of precipitation. Nonbalances phase transformation. Precipitation hardening of alloys. Natural and artificial aging. The reactions of dislocations with disperse phases. Application on steels and heat treatment alloys of nonferreous metals. Thermal activated processes by other materials.

Learning outcomes and competences:
The aim of course study is increasing the knowledge related to selected chapters in thermal activated processes, which are important for manufacturing procedures, crystallisation and different thermal treatments of metals and alloys.

Teaching methods:
Lectures and experimental investigation. Education process is combined with seminar project. Monitoring of seminar project progress is continuous as a part of knowledge evaluation. Finally, the public presentation and discussion relating to seminar project is predicted.

Recommended reading:
- Grupa autora s FSB: Inženjerski priručnik IP4 – Proizvodno strojarstvo, prvi svezak MATERIJALI, Školska knjiga, Zagreb, 1998., 278 str.
- Vodopivec, F.: Kovine in zlitine, Inštitut za kovinske materiale in tehnologije, Ljubljana, 2002., 474 str.
- Bonačić-Mandinić, Z.; Budić, I.: Osnove tehnologije kalupljenja, Jednokratni kalupi-I dio, 253 str., Strojarski fakultet u Slavonskom Brodu, 2001.
- Budić, I.; Bonačić-Mandinić, Z.: Osnove tehnologije kalupljenja, Jednokratni kalupi-II dio, 263 str., Strojarski fakultet u Slavonskom Brodu, 2004.

Supplementary reading:
- Cahn, R.W.: The Coming of Materials Science, Pergamon, Sec. Impression, 2003, Amsterdam-London, etc. Tokyo, 571 str.
- Krumes, D.: Toplinska obradba, Strojarski fakultet, Slavonski Brod, 2000., 443 str.

ECTS (Number of credits allocated):
7,5 ECTS
Lecture 24 hours and Experimental investigation 6 hours.
24 hours Lecture + 6 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:
Seminar project.

Quality assurance methods:
Students evaluations, professors evaluations, evaluations of professors who participate in successful performance of study program.

PD 302 High Speed Machining Processes and Systems

Module: **Modern Manufacturing Processes**

Course contents:
Physical basis of machining processes. Mathematical modeling and simulation of chip removal processes. Advanced machining processes. High speed machining- HSM: basic characteristics. Cutting forces, temperature, machined surface roughness and tool life by HSM. High speed milling, grinding, reaming and broaching. Tools for high speed machining. Materials, coatings, shapes, dimensions and balancing of cutting tools. Fixing devices for cutting tools at high rotational speeds.

High-dynamic "cartesian and non-cartesian machines" for high speed machining. High accuracy main spindle drives, high rigidity and high rotational speeds, bearings, relation power/rotational speed, cooling and lubricating. Feeding systems for feeding speed and high acceleration. Control units (CPU) for high speed and high acceleration , errors compensation (geometrical, cinematic and thermal deformations). Digital CPU for HSM. Working speeds and functions of CPU developed for CNC Machine tools for HSM. Software. Some specifics for defining of tool paths for HSM.

Advantages of HSM. Results of application of HSM in different productions. Control possibilities of high dynamic machines in order to achieve settled accuracy level.

Compatibility of HSM with other trends in chip removal processes and systems, as well as with other production technologies.

Disturbance processes and delays at CNC machines and necessity of monitoring at machine tools with special emphasis on HSM. Monitoring methods. Sensors for monitoring certain parameters and its influence on HSM. Multi-sensing techniques and systems. Conventional and "smart" sensors. Diagnostics and advanced methods of signal analysis.

Basic remarks of high velocity machining. Advanced trends in chip removal processes. Laser machining. Water jet machining. Micro machining. Rapid prototyping. Minimal quantity lubrication systems. Hard machining. Trends in non-conventional machining processes.

Learning outcomes and competences:
The aim of course study is increasing the knowledge related to important chapters from the High speed machining which are important from standpoint of modern requirements on Machine tools and machining systems, reliability and production safety.

Teaching methods:
Education process is combined as lecturing with seminar project. Seminar include chapters that have been learned during lecturing. Monitoring of seminar project progress is continuous as a part of knowledge evaluation. Finally, the public presentation and discussion relating to seminar project is predicted.

Recommended reading:

- Schulz, H: Hochgeschwindigkeitsbearbeitung– High-Speed Machining, Carl Hanser Verlag, München, Wien, 1996.
- SME: High-speed Machining, ISBN087263-649-6, Society of Manufacturing Engineers, 2003.
- Cebalo, R.: Visokobrzinske obrade, HAZU, Zagreb
- Bert P. E.: New Dimensions in Manufacturing, Hanser Gardner Publications, ISBN 1569902453, 1998.

Supplementary reading:

- Isermann R., 1997, Überwachung und Fehlerdiagnose (Moderne Methoden und ihre Anwendungen bei technischen Systemen), VDI Verlag
- http://www.mmsonline.com/hsm/

ECTS (Number of credits allocated):

7,5 ECTS
Lecture 18 hours and Experimental investigation 12 hours.
18 hours Lecture + 12 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:

Presentation of seminar project, which was prepared by student with the help of Professor and assistants. Mentor will be present at seminar presentation. During semester, knowledge, understanding and implementation will be tested by determined techniques. Continual assessment has 60 % and project presentation has 40 % of final mark.

Quality assurance methods:

Student's evaluation's, professor's evaluations, evaluations of professors who participate in successful performance of study program.

PD 303 Technology of the Product

Module: **Modern Manufacturing Processes**

Course contents:
Technology of the product. Significance and view at consideration of technology. Influential factors at consideration product technology. Overview on technology of the product through phases conception, design, construction, production and using the product in exploitation and at the end of exploitation.

Analyses product technology in phase of design product. Quality and reliability requirements in product exploitation. Technological application of methods control quality in production and exploitation of the product.

Analyses product technology in production. Technology of the product in assembly (operative and work-site conditions).

Analyses technology in exploitation and at the end of exploitation. Expert system model for revitalization of product with damage observed in exploitation.

Analyses of technology have following criteria's: minimum costs (economy), required quality and reliability, minimum consumption of material and energy, and minimum pollution human environment.

Technology analyses examples for various processes and products. Casting technology, metal forming technology, tools and devices technology. Vessels (cylindrical and spherical tank, wagon tanks, vessels for propane / butane). Components earth moving machines. Bridges. Components of energy plant. Compensators.

Informatics technology application for analyses product technology. Simulation models and analyses product technology.

Learning outcomes and competences:
Aim of learning subject is to acquire a special knowledge's about product technology at different technologies.

Teaching methods:
Teaching is providing with combination of lectures and assigning seminary work in which student applying his knowledge. Accompany of making seminary work is continuously, like and examination.

Recommended reading:
- Grizelj, B.: Oblikovanje metala deformiranjem, Strojarski fakultet, Slavonski Brod 2002.
- Grizelj, B.: Alati i naprave, Strojarski fakultet, Slavonski Brod 2004.
- Zbornik radova 1. međunarodnog znanstveno-stručnog savjetovanja "Ekonomski i kvalitativni aspekti visokoučinskih postupaka zavarivanja", izdavač Đuro Đaković, Slavonski Brod, 2001.
- Samardžić, I. i dr.: Analiza tehnologičnosti zavarenih konstrukcija, digitalni udžbenik, http://www.sfsb.hr/kth/zavar/index.html

Supplementary reading:
- Bonten, Ch.: Produktentwicklung – Technologie-Management für Kunststoffprodukte, Hanser Verlag, München, 2002.
- Patrick D. T. OConnor.: A Concise Guide to Cost-effective Design, Development and Manufacture, 2001, ISBN: 0471498823, Edition: Hardcower. (www.amazon.com)

ECTS (Number of credits allocated):
7,5 ECTS
Subject is realizing through semester with total 30 hours of lectures.
30 hours of lectures = 1,5 ECTS
60 hours of independent work with consultations = 3 ECTS
45 hours of study literature =1,5 ECTS
45 hours making seminary work = 1,5 ECTS

Assessment methods:
Examination is a public and consist of defending seminary work which is student create independent with teacher leading. Leader of module is also participating to examination.

Quality assurance methods:
Student evaluation, evaluation by teachers and experts, success at partial exams, and if needful international supervision.

PD 304 Modifying Surface of Materials and Surface Engineering

Module: **Modern Manufacturing Processes**

Course contents:
Theory and application of hard steel modifications. Surface hardening with flame heating. Surface hardening with induction heating. Surface modifications with laser beam. Surface modifications with electrons beam. Students are introduced with termochemical treatment: carburizing, nitrocarburizing process, nitriding, ionitriding, boronizing and sulfonitro-carburizing processes.

Introduce students with coating (deposition) procedure from gas phaze. Procedure of PVD (Physical Vapour Deposition). Procedure of CVD (Chemical Vapour Deposition). CVD-procedure sustained by plazma. Deposition of thin coat with an influence of ion beam. Theory of wear. Tribology. Characteristics of some tribologic process. Abrasion, adhesion, chemical wear, etc.

Learning outcomes and competences:
The aim of course study is increasing the knowledge related to important chapters from the standpoint of modifying surface of materials and surface engineering.

Teaching methods:
Lectures and experimental investigation. Education process is combined with seminar project. Finally, the public presentation and discussion relating to seminar project is predicted.

Recommended reading:
- Krumes, D.: Površinske toplinske obrade i inženjerstvo površina, Strojarski fakultet, Slavonski Brod, 2004.
- Krumes, D.: Toplinska obradba, Strojarski fakultet, Slavonski Brod, 2000.
- Novosel, M.; Krumes, D.: Posebni čelici, Strojarski fakultet, Slavonski Brod, 1998.
- Novosel, M.; Cajner, F.; Krumes, D.: Alatni materijali, Strojarski fakultet, Slavonski Brod, 1996.

Supplementary reading:
- Holleck, H.: Surface Engineering, 2 (1991) 137.
- Vodopivec, F.: Kovine in zlitine, Inštitut za kovinske materiale in tehnologije, Ljubljana, 2002., 474 str.

ECTS (Number of credits allocated):
7,5 ECTS
Lecture 24 hours and Experimental investigation 6 hours.
24 hours Lecture + 6 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:
Written and oral (seminar project development and presentation).

Quality assurance methods:
Students evaluations and professors evaluations.

PD 401 Welding - Selected Chapters

Module: **Modern Manufacturing Processes**

Course contents:
Introduction. Assessment of current state and trends of welding technology development in Croatia and world industry.

Weldability of materials. Importance and methodology of weldability concerning. Influence variables on weldability of materials. Classification of failures according to HRN EN. Testing methods for determination of weldability (usage of accessible weldability data basis, analytic formulas for evaluation of weldability constructed based on experimental investigations, thermal cycled and real welded specimens of welded joints). Causes and mechanisms of failure appearing, methods and sensitivity of methods of non destructive testing methods for failure determination in welded joints, prevention due to failure avoidance. Achievements on the field of cracking phenomena understanding during welding using modern laboratory investigation equipments.

Repair welding. Specifics of repair welding regarding to "production" welding. Problems due to temperature fields non-stationary at beginnings ("cold starts") and ends of the weldments ("hot ends"). Technology for the repair welding of conditionally weldable materials and welded joints with more quality requirements. Reliability of repair welding. How many times and under what condition can repair welding be performed?

Residual stresses and deformations at welding. Their harmful influence on quality and reliability on welded product. Influencing variables, possibilities for residual stresses and deformation avoidance and reduction at welding. Modern approach to determination of residual stresses and deformations values at welding. Application possibilities and limitations of thermal deformations alignment at welding. Processes related to reduction of residual stresses (heat treatment, short penning due to introduction of compression stress, hydro-test).

Welded products behaviour in different service conditions. Possible failures of welded joints and products in service. Causes and mechanisms of failure appearing. Welded joint failure analyse in service by the Fault Tree Analyse method. Influencing variables and activities for failure avoidance in service. Methods for reliability assurance due to individual failures in service.

Learning outcomes and competences:
The aim of course study is increasing the knowledge related to selected chapters in welding technique.

Teaching methods:
Lectures and experimental investigation. Education process is combined with seminar project. Monitoring of seminar project progress is continuous as a part of knowledge evaluation. Finally, the public presentation and discussion relating to seminar project is predicted.

Recommended reading:

- Kralj, S.; Andrić, Š.: Osnove zavarivačkih i srodnih postupaka, Sveučilište u Zagrebu, 1992., ISBN 86-7819-043-4
- Lukačević, Z.: Zavarivanje, Strojarski fakultet u Slavonskom Brodu, 1998.
- Suvremeni postupci zavarivanja i srodne tehnike zavarivanju: http://www.twi.co.uk/j32k/unprotected/band_1/tfindex.html
- Samardžić, I. i dr.: Analiza tehnologičnosti zavarenih konstrukcija. Digitalni udžbenik, http://www.sfsb.hr/kth/zavar/index.html, 2001.

Supplementary reading:

- Welding Process: http://www.key-to-steel.com/Articles/Art75.htm
- Postupci zavarivanja i srodne tehnike: http://www.esabna.com/html/eu.cfm

ECTS (Number of credits allocated):

7,5 ECTS
Lecture 24 hours and Experimental investigation 6 hours.
24 hours Lecture + 6 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:

Seminar project.

Quality assurance methods:

Students evaluations, professors evaluations, evaluations of professors who participate in successful performance of study program.

PD 402 Mechanism and Prevention of Corrosion Damages

Module: **Modern Manufacturing Processes**

Course contents:
There are different types of corrosion damages on metallic and non-metallic constructions in service (uniform corrosion, local corrosion, pitting, intercrystalline corrosion, stress corrosion, crevice corrosion,…). Due to different and specific initiation and propagation mechanisms of corrosion damages, the course covers state of the art in theoretical and experimental achievements as well as explanation of different types of corrosion damage mechanisms. The main aim is high quality determination of corrosion mechanism factors and selection of high quality and reliable technology of surface protection.

Reliability of surface protection is based on experimental laboratory and in-service methods, therefore accelerated corrosion tests for high quality and reliable control of surface protection on metallic and non-metallic constructions are explained.

Prevention activities for corrosion damages protection depend on expected corrosion mechanism on construction. Sometimes, processing technology is the most important factor influencing initiation of corrosion damage (for example stress corrosion, intercrystallline corrosion), but the most dominant factor is the quality of surface protection coating. Types of modern metallic, inorganic, non-metallic and organic coatings and coatings technologies are explained in detail. At the end of the course, knowledge and achievements on reliability improvement area and service life increasing by the protection measures (for example-inhibitor addition) and procedures (for example-condition change – elimination of corrosion harmful products: SO_2, O_2, …) are explained.

Learning outcomes and competences:
To provide a comprehensive examination of the corrosion and corrosion protection with the possibility to apply scientific approach during the projecting process and according to the specific conditions.

Teaching methods:
Lectures. Experimental work. Project. During the project realisation, students will use knowledge about corrosion protection that is done through lectures, experimental work and literature.

Recommended reading:
- Uhlig, H.H.; Revie, R.W.: Corrosion and Corrosion Control, Third Edition, John Wiley and Sons, 1985.
- Fontana, M. G.: Corrosion Engineering, Third Edition, McGraw-Hill Book Company, 1988.
- Esih; I.; Dugi, Z.: Tehnologija zaštite od korozije I, Školska knjiga, Zagreb, 1990.
- Roberge, P. R.: Handbook of corrosion engineering, McGraw Hill, New York, 1999.

Supplementary reading:
- Jones, D. A.: Principles and prevention of corrosion, Prentice hall, New York, 1996.
- Grupa autora s FSB: Inženjerski priručnik IP4 – Proizvodno strojarstvo, prvi svezak MATERIJALI, Školska knjiga, Zagreb, 1998., 278 str.

ECTS (Number of credits allocated):
7,5 ECTS
Module will be realised through semester – 25 hours of lectures and 5 hours of experimental work.

25 hours of lectures = 1 ECTS
5 hours of experimental work = 0,5 ECTS
60 hours of self-work with necessary consultations = 3 ECTS
45 hours of literature studying = 1,5 ECTS
450 hours of self-work on project = 1,5 ECTS

Assessment methods:
Exam contains the public presentation of project that have to be self-made by student under the mentor supervision. Head of module has to be attended during the public presentation.

During the semester knowledge will be checked continually through applying of quiz, colloquy and test with the intention to explore students understanding and acquirements.

Quality assurance methods:
Student self-evaluation, supervisors and experts evaluation, adjustment efficacy.

PD 403 Selected Chapters from Materials

Module: **Modern Manufacturing Processes**

Course contents:
Necessary knowledges and methods during development materials through history. Evolution of materials. Technical materials-technical properties-ability of processing and accessible with the price. Special grades of iron alloys. Metallic materials for low temperatures. Semicondutors. Advanced batteries with ionic conductors. Superconductivity materials. Electrical ceramics. Magnetical ceramics. Optical glasses and fibres. Liquid crystals. Materials in extreme conditions: metallic glasses, materials with nanostructures, very thin layers and metallic multilayers, quasicrystals. Special polymeric materials. Composites: polymer matrix composite – PMC, metal matrix composite – MMC, ceramic matrix composite – CMC, intermetallic composite. Shape memory alloys – SMA, biomimetic materials. Metallic foams. Materials with cellstructures. Fullerenes and carbon nanotubes.

Learning outcomes and competences:
The aim of course study is increasing the knowledge related to selected chapters in materials science, properties, microstructures and applications of modern materials.

Teaching methods:
Lectures and experimental investigation. Education process is combined with seminar project. Monitoring of seminar project progress is continuous as a part of knowledge evaluation. Finally, the public presentation and discussion relating to seminar project is predicted.

Recommended reading:
- Novosel, M.; Krumes, D.: Posebni čelici, Strojarski fakultet, Slavonski Brod, 1998., 458 str.
- Filetin, T.: An overview of the development and application of advanced materials, Croatian Welding Society, Zagreb, 2001, 44 str.
- Grupa autora: Novi materijali i pripadne tehnologije, Bilten br. 1 Razreda za tehničke znanosti HAZU, Zagreb, 1998., 51 str.
- Filetin, T.; Kovačiček F.; Indof, J.: Svojstva i primjena materijala, FSB, Zagreb, 2002., 302 str.

Supplementary reading:
- Cahn, R.W.: The Coming of Materials Science, Pergamon, Sec. Impression, 2003, Amsterdam-London, etc. Tokyo, 571 str.
- Grupa autora s FSB: Inženjerski priručnik IP4 – Proizvodno strojarstvo, prvi svezak MATERIJALI, Školska knjiga, Zagreb, 1998., 278 str.

ECTS (Number of credits allocated):
7,5 ECTS
Lecture 24 hours and Experimental investigation 6 hours.
24 hours Lecture + 6 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:
Seminar project.

Quality assurance methods:
Students evaluations, professors evaluations, evaluations of professors who participate in successful performance of study program.

PD 501 Operational Management

Module: **Modern Production Management**

Course contents:
Introduction to Operational Management. Management: strategic, tactical and operational.

Management models: Preparation management, Production management, Resource management (capacity, material, tools). Equipment management. Cost management. Intellectual management. Applying of operational research in Management models.

Contents of Management Information System (MIS).

Optimisation and improvement of business processes (speed, flexibility, costs, operability, virtual accessibility, production according to customer demands).

Role of Integrated Information System in Business Management.

Conventional and modern management approaches. Strategic planning and control management. Comparison between MIS (Management Information System) and DSS (Decision Support Systems).

Learning outcomes and competences:
The main goal of this course is providing knowledge about management models for overall system (equipment, human and financial resources, process). One of the objectives of this course is to show how the application of management methods influence competitive position of company. Special attention is given to application of operational research methods and information systems in management.

Teaching methods:
Combination of lectures and experimental work, distance learning and individual project. Individual project includes work on appropriate problem of selected company by using knowledge of this course and consulting the professor. Public presentation of individual project results will finish the course.

Recommended reading:
- Barković, D.: Uvod u operacijski management, Sveučilište Josipa Jurja Strossmayera u Osijeku, Ekonomski fakultet, Osijek, 1999.
- Barković, D.: Operacijska istraživanja, Sveučilište Josipa Jurja Strossmayera u Osijeku, Ekonomski fakultet, Osijek, 2001.
- Majdandžić, N.: Izgradnja informacijskih sustava proizvodnih poduzeća, Sveučilište Josipa Jurja Strossmayera u Osijeku, Strojarski fakultet, Slavonski Brod, 2004.
- Majdandžić, N.: Računalom integrirana proizvodnja, Sveučilište Josipa Jurja Strossmayera u Osijeku, Strojarski fakultet, Slavonski Brod, 1997.

Supplementary reading:
- Barković, D.: Teorije proizvodnje i troškova, Sveučilište Josipa Jurja Strossmayera u Osijeku, Ekonomski fakultet, Osijek, 1996.
- Majdandžić, N.; Lujić, R.; Matičević, G.; Šimunović, G.; Majdandžić, I.: Upravljanje proizvodnjom, Strojarski fakultet, Slavonski Brod, 2001., 357 str.

ECTS (Number of credits allocated):
7,5 ECTS
This course is performed through 2nd semester in addition with 20 hours of conventional 45-minute lectures in class and 10 hours of experimental work.

20 hours of lectures = 1 ECTS
10 hours of experimental work = 0,5 ECTS
60 hours of individual work with consulting the professor = 3 ECTS
45 hours of literature reading and understanding = 1,5 ECTS
45 hours of working on individual project = 1,5 ECTS

Assessment methods:
Public presentation of individual project results. Module head must be attendant also. Continuous examination through semester is performed (colloquy). Knowledge application, analyticity and systematises by the proved knowledge evaluation system is verifying also. Continuous examination through semester is 55% and public presentation of individual project results is 45% of final evaluation.

Quality assurance methods:
Student evaluation, professors and field experts evaluation, partial exams efficacy, international supervision if needed.

PD 502 Production, Project and Resource Management

Module: **Modern Production Management**

Course contents:
Production types. Production and assembly management characteristics in continual and small-scale production according to three decision levels: strategic, tactical and operational. Conventional and computer aided production management methods. Applying of operational researches in management. New mathematical methods necessary for solving problems in production. Production management concept that is based on modern management theory and established on applying of Information systems.

Controlling, theory determination, development, generation and concepts. Control strategies and systems. Management systems as controlling objects: planning, control, information, organisation, human resource. Controlling methods and techniques. Controlling towards enterprise functions: researches and development, purchasing and inventory, production, sales and calculation, financing and accounting.

Project management methods. Processes in Project management. Project goals (duration, costs, quality). Project planning. Risk management (identification, classification, risk analysis, response according to risk, monitoring system and risk management). Project monitoring. Accomplishment probability according to due dates. Cost evaluation and management. Rebalance models.

Scheduling methods and models. Resource management models (materials, capacities, tools and equipment) in single, serial and continual production. Cost management.

Learning outcomes and competences:
To provide a comprehensive examination of the management of both goods-producing and service-producing processes. To enable understanding of different production types. To teach students about enterprise business, preparation and production/service processes. The module will cover existing and new trends in organisation of production, concepts, ideas and content of project management, controlling and scheduling. Resource management and its models will be explored. The final block describes cost management.

Teaching methods:
Lectures. Experimental work. Project. During the project realisation, students will use knowledge that is done through lectures, experimental work, investigations that will be done in production systems and literature. As examination method will be used oral presentation of project supported with certain presentation techniques.

Recommended reading:

- Majdandžić, Niko; Lujić, Roberto; Matičević, Gordana; Šimunović, Goran; Majdandžić, Igor: Upravljanje proizvodnjom, Strojarski fakultet, Slavonski Brod, 2001., 357 str.
- Burke, R.: Project management: planning and control techniques, third edition, John Wiley & Sons, 1999.
- Kerzner, H.: Project management: A systems approach to planning, scheduling and controlling, eight edition, John Wiley & Sons, 2003.
- Majdandžić, Niko: Upravljanje proizvodnjom – Informacijski sistem planiranja ISOT, Zagreb, 1988., 263 str.

Supplementary reading:

- Marušić, S.: Upravljanje i razvoj ljudskih potencijala, Ekonomski institut Zagreb Adeco Zagreb, Zagreb, 2001.

- http://crm.ittoolbox.com/, 23.02.2004.

ECTS (Number of credits allocated):
7,5 ECTS
Module will be realised through 2nd semester – 24 hours of lectures and 6 hours of experimental work.
24 hours of lectures = 1 ECTS
6 hours of experimental work = 0,5 ECTS
45 hours of self-work with necessary consultations = 2 ECTS
45 hours of literature studying = 2 ECTS
60 hours of self-work on project = 2 ECTS

Assessment methods:
Exam contains two parts. The first will be done during the semester where knowledge will be checked continually through applying of quiz, colloquy and test with the intention to explore students understanding and acquirements.
The second is public presentation of project that have to be self-made by student under the mentor supervision. Head of module has to be attended during the public presentation. Each part carries 50 % of the final mark.

Quality assurance methods:
Student self-evaluation, supervisors and experts evaluation, adjustment efficacy.

PD 503 Computer Aided Design, Process Planning and Manufacturing (CAD/CAPP/CAM)

Module: **Modern Production Management**

Course contents:
General characteristics of CAD/CAPP/CAM systems. Introduction to Computer Aided Design - CAD systems. Application of CAD systems for generating a feature based parameter models. Different phases of Computer Aided Process Planning – CAPP systems. Different approaches to CAPP systems. Application of Artificial intelligence (neural networks and expert systems) in CAPP systems. Integrated CAPP systems. Overview and characteristics of certain applied CAPP systems. Characteristics of NC machines. Driving and measurement systems of NC machines. NC code generation. CAD modelling influence on NC code generation. CAD/CAM interface. Adaptive control – AC, Direct Numerical Control – DNC and control systems. Programmable Logic Controllers – PLC. NC forming machines. Automated shelf storages, robots and manipulators. CAD/CAPP/CAM integration.

Learning outcomes and competences:
The objective of this course is improving of knowledge about computer aided design, computer aided process planning and computer aided manufacturing as well as acquiring recent theoretical and practical knowledge in CAD, CAPP and CAM systems and CAD/CAPP/CAM integration.

Teaching methods:
Teaching method is composed from lectures, experimental work and assignment of project in which the student provides parts of course that are given on lectures. Observation of project work is continually. Public presentation of project is final test of knowledge.

Recommended reading:
- Tien-Chien, C.; Richard, A.W.; Hsu-Pin, W.: Computer-Aided Manufacturing, Prentice Hall; 2nd edition, 1997.
- Altintas, Y.: Manufacturing Automation, Cambridge University Press, Cambridge 2000.
- Zhang, H.; Alting, L.: Computerized Manufafturing Process Planning, Chapmann & Hall, London, Glasgow, New York, Tokyo, Melbourne, Madras, 1994.
- Lee, K.: Principles of CAD/CAM/CAE, Prentice Hall, 1999.

Supplementary reading:
- Mcmahon, C.; Browne, J.: CAD/CAM: Principles, Practice, and Manufacturing Management (2nd Edition), Prentice Hall; 2 edition, 1999.
- Kalpakjian, S.; Schmid, S. R.: Manufacturing Engineering and Technology, Prentice Hall, 4th edition, 2000.

ECTS (Number of credits allocated):
7,5 ECTS
This course is performed through 2nd semester in addition with 20 hours of conventional 45-minute lectures in class and 10 hours of experimental work.
Number of credits will be allocated as follows:
20 hours of lectures = 1 ECTS
10 hours of experimental work = 0,5 ECTS
60 hours autonomous works supported with consultations = 3 ECTS
45 hours study of references = 1,5 ECTS
45 hours project work = 1,5 ECTS

Assessment methods:
The final exam is laying down by public presentation of project which the student has made under leading of the lecturer and the associates which are participating in performance of course. Through the course semester proficiency in the topics of course listed above will be assessed by performance on quiz show, preliminary exam, test. Continual examination is carrying the 40 percent, and the final defending of project is carrying the 60 percent of the final grade.

Quality assurance methods:
The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams.

PD 504 New Maintenance Strategies

Module: **Modern Production Management**

Course contents:
To provide a comprehensive knowledge of the maintenance as a part of complete production process. To analyze changes in the maintenance, and applying of new informatics and production technologies. According to main maintenance goals and strategies, modern organization maintenance structure will be defined. The new maintenance strategies, approaches and methods will be explored. The final block describes and analyses practical maintenance examples.

Learning outcomes and competences:
The objectives of this course are acquirements about modern strategies, methods and approaches in the asset maintenance with possible implementation in maintenance plans. The students will obtain knowledge about cost effective control and monitoring of maintenance plans with the retrospection on optimization models of maintenance plans.

Teaching methods:
Teaching method is composed from lectures, experimental work and assignment of project. During the project realisation, students will use knowledge that is done through lectures, experimental work and literature. As examination method will be used oral presentation of project supported with certain presentation techniques.

Recommended reading:
- Majdandžić, Niko: Strategije održavanja i informacijski sustavi održavanja, Sveučilište u Osijeku, Strojarski fakultet Slavonski Brod, 1999., 341 str.
- Sebastijanović, Slavko: Osnove održavanja strojarskih konstrukcija, Sveučilište u Osijeku, Strojarski fakultet Slavonski Brod, 2002., 278 str.
- Dhillon, B.S.: Engineering Maintenance – A Modern Approach, CRC Press LLC, Boca Raton, Florida, USA, 2002.
- B.K.N. RAO: Handbook of Condition Monitoring, Elsevier Science Ltd, Oxford, 1996, 589 str.

Supplementary reading:
- Willmott, P.: Total Productive Maintenance, The Western Way, Oxford 1999, 252 str.
- Moubray, J.: Reliability-centered Maintenance, Industrial Press Inc., Ney York, 1997. 418 str.

ECTS (Number of credits allocated):
7,5 ECTS
Course will be realised through 2nd semester – 20 hours of lectures and 10 hours of experimental work.
20 hours of lectures = 1 ECTS
10 hours of experimental work = 0,5 ECTS
60 hours of self-work with necessary consultations = 3 ECTS
45 hours of literature studying = 1,5 ECTS
45 hours of self-work on project = 1,5 ECTS

Assessment methods:
The final exam is laying down by publicly presentation of project which the student has made under leading of the lecturer and the associates which are participating in performance of course. Through the course semester proficiency in the topics of course listed above will be assessed by

performance on preliminary exam, test; the apprehension, the uses accomplishment; the analyticity and systematic with fortified system for the evaluation of the knowledge. Continual examination is carrying the 50 percent, and the final defending of project is carrying the 50 percent of the final grade.

Quality assurance methods:
The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams.

PD 601 ERP Systems

Module: **Modern Production Management**

Course contents:
Idea of ERP (Enterprise Resource Planning) system. Integration of functions and data. Planning and schedule of function works and necessary resources. Management of preparation, production and service activities in enterprises. Structure of ERP system: Integrated Information System, communication system and computer. Data organization: relation data base and data warehouse. ERP subsystems: sales and calculation, product structure and technology, work order launching, purchasing and inventory, production, production planning and monitoring, quality management, asset maintenance, financing and accounting, bookkeeping and delivery.

Management (preparation and production) and selection models (suppliers, process planning variant, plan variant). Management subsystems.

Specifics of ERP system for different production types (single, serial) and designs (metal, construction, process, electro, wood, food) and services (transport, maintenance, energy and gas distribution etc.).

ERP II system. Integration among CAD, CAM, CAPP and ERP. Idea of CRM (Customer Relationship Management), ERM (Enterprise Resource Management) and EAI (Enterprise Application Integration).

Applying of new IT solution in ERP (RF terminals, Internet WAP, e-bussines).

Learning outcomes and competences:
The objective of this course is providing knowledge about projecting, development, and implementation of Enterprise Resource Planning systems, and application of particular ERP systems at different production and service companies. One of the objectives of this course is to show how the application of ERP systems influences production preparation, manufacturing and service activities as well as possibility of linking with CAD, CAPP and CAM system.

Teaching methods:
Combination of lectures, experimental work and individual project. Individual project includes work on appropriate information system problem of selected company by using knowledge of this course and consulting the professor. Observation of project work is continually. Public presentation of individual project results will finish the course.

Recommended reading:

- Majdandžić, N.: Izgradnja informacijskih sustava proizvodnih poduzeća, Sveučilište u Osijeku, Strojarski fakultet, Slavonski Brod, 2004., 460 str.
- Majdandžić, N.: Kompjuterizacija poduzeća, Sveučilište u Osijeku, Strojarski fakultet, Slavonski Brod, 1994., 371 str.
- Mello, A.: "ERP fundamentals", http://www.zdent.com/enterprise, 07.02.2002.
- Bilderbeek, Pim: Trans forming Enterprise. Communications, http:/www.idc.com, 10.10.2002.

Supplementary reading:

- O'Leary, D.E.: Enterprise Resource Planning Systems: Systems, Life Cycle, Electronic Commerce, and Risk, Cambridge University Press, 2000.
- Gupta, M.: Elements of a Successful Enterprise Application Integration, www.syntelinc.com 05.2002.

ECTS (Number of credits allocated):
7,5 ECTS
This course is performed through 3rd semester in addition with 20 hours of conventional 45-minute lectures in class and 10 hours of experimental work.
Number of credits will be allocated as follows:
20 hours of lectures = 1 ECTS
10 hours of experimental work = 0,5 ECTS
60 hours autonomous works supported with consultations = 3 ECTS
45 hours study of references = 1,5 ECTS
45 hours project work = 1,5 ECTS

Assessment methods:
Public presentation of individual project results which the student has made under leading of the lecturer and the associates which are participating in performance of course. Continuous examination through semester is performed. Knowledge application, analyticity and systematises by the proved knowledge evaluation system is verifying also. Continuous examination through semester is 40% and public presentation of individual project results is 60% of final evaluation.

Quality assurance methods:
Student evaluation, professors and field experts evaluation, partial exams efficacy, international supervision if needed.

PD 602 Intelligent Production Systems

Module: **Modern Production Management**

Course contents:
Fundamentals of the philosophy of technology. Product as the materialisation of an idea. Evolution of the production systems. Development line: classic manufacturing systems - flexible manufacturing systems - intelligent manufacturing systems. Development line of product design. Intelligent manufacturing: system components, architecture and data flow, system operations. Flexible machining and assembly systems. Process planning for flexible assembly systems. Design of products for automated assembly. Design of parts for automated assembly. Learning and machine learning. Scheduling: philosophy, strategies, models and algorithms. Knowledge - based system. Introduction to Artificial Life. Main characteristics of life (Pattern in spacetime; Self-production; Information storage of a selfrepresentation; A metabolism; Functional interactions with the environment; Interdependence of parts; Stability under perturbations; The ability to evolve.) Biological inspired Manufacturing Systems. Self-organisation. The principle concepts of ALife which are applicable to the engineering field. ALife and automatic evolution of complexity, self-organization. Emergence of intelligence without explicit design. A Life and next (r)evolution of engineering. Emergent processes, and a dynamic embodiment with the environment.

Increasing complexity and uncertainty arise from factors such as 1) individualization of lifestyle, 2) diversification of culture, 3) globalization of industrial activities, and 4) growing consideration toward natural environment, on the other hand, they bring about practical and theoretical difficulties in all the domains of artifactual activities from the planning phase up to post sales such as nonlinear phenomena, incomplete data and knowledge, the combinatorial explosion of possible states, the dynamic changes in environment, the frame problem, etc.

BMS (Biological Manufacturing Systems): In order to deal with such difficulties, the concept of BMS was proposed by K. Ueda. The BMS is a next generation manufacturing system which dynamically adapts to non-predeterministic changes in both internal and external environments based on biologically-inspired ideas such as self-organization, evolution and learning. The functions of living organisms are displayed by expressing two types of biological information of DNA (genetic)-type information that evolves through generations, and BN (neuron)-type information that are individually learned, and acquired during lifetime of a single organism.

Emergent Synthesis; The basic theory for BMS is "Emergent Synthesis". Synthesis is a necessary component of problem solving processes in almost all phases of the artifacts' lifecycle that starts with design, goes through the phases of planning, production, consuming and ends with the disposal of the product. The central question is how we can solve the problem of synthesis: how to determine the system’s structure in order to realise its function to achieve a purpose under the constraints of the environment.

Learning outcomes and competences:
To provide a comprehensive knowledge of the possibility of automation of manufacturing systems and managing of flexible manufacturing systems based on biologically-inspired ideas (Biological Manufacturing Systems).
The intelligent manufacturing systems based on knowledge database will be analysed. Applicability of the intelligent manufacturing systems in concrete manufacturing systems will be shown.

Teaching methods:
Lectures. Experimental work. Project. During the project realisation, students will use knowledge that is done through lectures, experimental work and literature. As examination method will be used oral presentation of project supported with certain presentation techniques.

Recommended reading:

- Katalinić, B.: FUNDAMENTALS OF CNC, Hardware, Software and Programming. Euro Laser Academy, Wien, Europewide Post Graduate Studies, Supported by the COMETT Programme of the Commission of the European Communities, 1995.
- Katalinić, B.: AUTOMATION. Euro Laser Academy, Wien, Europewide Post Graduate Studies, Supported by the COMETT Programme of the Commission of the European Communities, 1995.
- Toshio, S.; Toshimichi, M.; Kanji, U.: General Automation Philosophy, Innovative Produktionstechnik F.L.Krause / E.Uhlmann, Hanser, pp.380-390 (1998).
- Matsumura, Y.; Ohkura, K. and Ueda, K.: The Effect of Multi-parent Recombination on Evolution Strategies for Noisy Objective Functions, Computational Intelligence in Control IDEA Group Publishing, pp. 262-278, (2003)

Supplementary reading:

- Katalinić, B.; Janas, A.; Velisek, K. INDUSTRIEROBOTER UND MANIPULATOREN. Slowakische Technische Universität Bratislava, Fakultät für Matrialkunde und Technologie, Trnava, 1996.
- Sobei, H.; Oda, K. M.; Kanji, U. and Yasunori, B.: The application of cellular-automata and agent medels to network externalities in consumers' theory a generalization-of-life game, COMMERCE, COMPLEXITY, AND EVOLUTION, Cambridge University Press, pp. 351-371, (2000)

ECTS (Number of credits allocated):
7,5 ECTS
Module will be realised through 3rd semester – 20 hours of lectures and 10 hours of experimental work.
20 hours of lectures = 1,5 ECTS
10 hours of experimental work = 0,5 ECTS
60 hours of self-work with necessary consultations = 3,5 ECTS
45 hours of literature studying = 1 ECTS
45 hours of self-work on project = 1 ECTS

Assessment methods:
Exam contains the public presentation of project that have to be self-made by student under the mentor supervision. Head of module has to be attended during the public presentation. The project mark is the final mark.

Quality assurance methods:
Student self-evaluation, supervisors and experts evaluation, adjustment efficacy.

PD 603 Information Systems: Strategy & Management

Module: **Modern Production Management**

Course contents:
Idea and development of information systems. Applications. Integrated Information Systems (IIS), ERP systems. Projecting technology: BSP, SADT, SSA, ISAC, HIPO, Informational engineering. CASE tools. Data organisation: data base, data warehouse. Objective approach of Integrated Information Systems development.

Contents of Integrated Information System project. Process analysis. Improvement suggestions. Documentation and code system analysis. Suggestion of computer basis. Subsystems and modules. Integration among CAD, CAPP and CAM. Data security. Applying of new IT in IIS.

Intelligent information systems. Applying of Artificial Intelligence in information systems.

Learning outcomes and competences:
To provide a sound understanding of the fundamental concepts of modern computer systems; design of industrial information systems including hardware selection, software design, human/machine interface, and data processing. The students will be introduced to the broad concept of information systems and the way of data organisation. The students will learn about Integrated Information system and its subsystems. In the final block, new information technology and applying of artificial intelligence in information systems will be shown to students.

Teaching methods:
Lectures. Experimental work. Project. During the project realisation, students will use knowledge that is done through lectures, experimental work and literature. As examination method will be used oral presentation of project supported with certain presentation techniques.

Recommended reading:

- Majdandžić, N.: Izgradnja informacijskih sustava proizvodnih poduzeća, Sveučilište u Osijeku, Strojarski fakultet, Slavonski Brod, 2004.
- Šimundić, S.: Funkcijska informatika u društvenim sustavima, Sveučilište u Splitu, Pravni fakultet, Split, 2000.
- Majdandžić, N.: Primjena računala, Sveučilište u Osijeku, Strojarski fakultet, Slavonski Brod, 1996.
- Majdandžić, N.: Kompjuterizacija poduzeća, Sveučilište u Osijeku, Strojarski fakultet, Slavonski Brod, 1994., 371 str.

Supplementary reading:

- CASE 8, Osmo savjetovanje o metodama i alatima za projektiranje informacijskih sustava, Opatija, 1996.
- Varga, M.: Baze podataka – konceptualno, logičko i fizičko modeliranje podataka, DRIP, Zagreb, 1994.

ECTS (Number of credits allocated):
7,5 ECTS
Module will be realised through 3rd semester – 20 hours of lectures and 10 hours of experimental work.
20 hours of lectures = 1 ECTS
10 hours of experimental work = 0,5 ECTS
60 hours of self-work with necessary consultations = 3 ECTS

45 hours of literature studying = 1,5 ECTS
45 hours of self-work on project = 1,5 ECTS

Assessment methods:
Exam contains two parts. The first will be done during the semester where knowledge will be checked continually through applying of quiz, colloquy and test with the intention to explore students understanding and acquirements.

The second is public presentation of project that have to be self-made by student under the mentor supervision. Head of module has to be attended during the public presentation. Each part carries 50 % of the final mark.

Quality assurance methods:
Student self-evaluation, supervisors and experts evaluation, adjustment efficacy.

PD 604 Human Resource Management

Module: **Modern Production Management**

Course contents:
Organisation clime and structure: similarity and differences, Development scientist knowledge about clime and culture, Measurement and dimensionality: causes and consequence, Theory of competition values- unique model for research organisational success, managing and organisational clime and culture, Role of manger in motivation and design enterprise culture.

Managing people in organisation and economics, organisational success, Management and leadership, Leader in contents of management, managing theories, cost effectiveness, HRM implementation. Efficiency analysis, improvement of efficiency, Information system for HRM, Models of Human resource management

Knowledge explosion and concentration, technical knowledge and technological science, Innovation, incubation time, techno- polis, information – new resource, Interactive form of information, Information and technology, People as competitive advantage, specific and creativity an practice of knowledge, Conception of human resource capital

Demand for human resources, analysis and design of work places as base for HRM, human resource planning, utilisation of human resource, Internal vs. external supply, Appraisal techniques, Written report, interview, tests, Recruitment, debate in recruitment and selection validity and reliability.

HRM and organisational performance, determination of educational needs, scope of education, contents and educational program, methods and educational technique, employee development, careers life cycle, the organisation role in career development, manager career

Learning outcomes and competences:
Is an integrative course in human resources management (HRM). Emphasis is on human resources issues of strategic importance to an organization's top management. As such, a broader perspective is taken on human resources management policy and practice, which incorporates the critical roles of context in addition to functions and outcomes. These cases give students the opportunity to apply concepts and exercise diagnosis and analytical skills.

Teaching methods:
Class time will be a combination of lecture and discussion (individual research report and presentation of it). Preparation of the reading material is essential for meaningful and beneficial class discussion.

Recommended reading:

- Bahtijarević-Šiber, F.: Management ljudskih potencijala, Golden marketing, Zagreb, 1999.
- Marušić, S.: Upravljanje ljudskim potencijalima (Human Recources Management), Adeco d.o.o., Zagreb, 2001.
- Ferris, G.; Buckley M. & Fedor, D.: Human Resource Management: Perspectives, Context, Functions, and Outcomes. 4th Edition, 2002, Prentice-Hall, Upper Saddle River, NJ
- Ferris, G.R.; Rosen, S.D. & Barnum, D.T.:Handbook of human resource management, Oxford, UK: Blackwell Publishers, 1995.

Supplementary reading:

- Noe, R. A.; Hollenbeck, J. R.; Gerhart, B.; Wright, P. M.: Human Resource Management – Gaining a Competitive Advantage, Irwin, McGraw-Hill, Boston, 2002.

- Mathis, R. L.; Jackson, J. H.: Human Resource Management: Essential Perspectives, 3rd edition, South-Western College Pub., Mason, 2004.

Assessment methods:
Exam's type:
Evaluations Overview:

Chapter Exams (2 tests x 15 % ea.)	30 %
Final Exam	20 %
Case Presentation	16 %
Written Paper	20 %
Participation/Professor's judgment/Peer evaluation	8 %
Participation at Case Presentations	6 %
Total	100 %.

All exams will be multiple choices. Your chance to show me your writing skills and ability to integrate the course's knowledge will be shown in your class paper, and oral presentation.

There will be two (2) exams. Each exam will be worth 15 % towards the final grade. The exam will cover the information discussed in class and information from the book.

The final exam will be comprehensive drawing from the previous exams. The material will be similar to the first two exam information.

ECTS (Number of credits allocated):
The course will be realised through 3 th semester – 30 hours of lectures
30 hours of lecturers=3 ECTS in addition with
45 hours of individual research with consultation =1, 25
45 library research =1, 25 ECTS
60 hours plan design=2 ECTS
Total 7, 5 ECTS

Quality assurance methods:
Student evaluates classes during the lecturers and on the end of module. Participation requires that students not only attend class, but come prepared to contribute to class discussion. Student evaluate: teaching methods, communications with teacher and own activities during classes.

PD 701 Diagnostics

Module: **Modern Production Management**

Course contents:
Technical diagnostics tasks (control of operating abilities, failure mechanisms, validity control of technical systems, analyzing failure causes, classification of diagnostics). Modeling failure distribution (methods: deterministic and stochastic). Models of technical condition diagnostics (Baldin-Govoruščenko model; Harzova-Krivenka model; Gertsbaki model and other).

Prediction of system behavior: application of operational research (analysis of condition and wear), applying statistical mathematics methods, probability theory.

Scientific principles in technical diagnostics (the subject of technical diagnostics developing in two directions: determining the condition with the goal of discovering and removing the failure; determining the condition with the goal of process control). Developing process control and developing diagnostics resources. Scientific origins of modern diagnostics. Diagnostics systemization (according to the goal, according to results, according to the method, according to execution, according to preparation, according to the scope, etc.). Principles and techniques of diagnostics (subjective and objective). Diagnostics of new technological systems (flexible technological modules, flexible technological cells, flexible technological systems, flexible automated factories, intelligent technological systems). Functional analysis of new technological systems.

Diagnostic systems of new technological systems: Basic definition and characteristics of diagnostic systems; Hardware structure of diagnostic systems (central computer, diagnostic computers, control unit of an engineering system, etc.); Software structure of diagnostic systems (system and user software and diagnostic routines).

Expected trends of diagnostic system development in new technological systems (hardware and software support, etc.). Procedures in condition testing (chemical, physical, mechanical, technological). Diagnostic conclusions based on diagnostics of lubricant condition. Procedures for the control of operating parameters (vibration-acoustics, geometrical control, nondestructive testing, corrosion testing, electrical control, etc.). Estimating the useful life of technical system components. Organization of executing technical diagnostics. Monitoring the system for technical diagnostics. Applying of artificial intelligence methods in the technical diagnostics.

Learning outcomes and competences:
The objectives of this course are acquisition of special knowledge about modern methods and approaches in the diagnosing of technical systems. Also, the students will give knowledge bases about the defining, description, classification and development of diagnostic systems with the possible applying of methods of artificial intelligence.

Teaching methods:
Teaching method is composed from lectures, experimental work and assignment of project. During the project realisation, students will use knowledge that is done through lectures, experimental work and literature. As examination method will be used oral presentation of project supported with certain presentation techniques.

Recommended reading:

- Majdandžić, N.: Strategije održavanja i informacijski sustavi održavanja, Sveučilište u Osijeku, Strojarski fakultet Slavonski Brod, 1999., 341 str.
- Sebastijanović, S.: Osnove održavanja strojarskih konstrukcija, Sveučilište u Osijeku, Strojarski fakultet Slavonski Brod, 2002., 278 str.

- Emert, R.; Jurić, T.; Filipović, D.; Štefanek, E.: Održavanje traktora i poljoprivrednih strojeva, Sveučilište u Osijeku, Poljoprivredni fakultet Osijek, 1996.
- Levitt, J.: Preventive and Predictive Maintenance, Industrial Press, Inc., USA, 2003.

Supplementary reading:
- Willmott, P.: Total Productive Maintenance, The Western Way, Oxford 1999, 252 str.
- Dhillon, B. S.: Engineering Maintenance – A Modern Approach, CRC Press LLC, Boca Raton, Florida, USA, 2002.

ECTS (Number of credits allocated):
7,5 ECTS
Module will be realised through 4th semester – 18 hours of lectures and 12 hours of experimental work.
18 hours of lectures = 0,9 ECTS
12 hours of experimental work = 0,6 ECTS
60 hours of self-work with necessary consultations = 3 ECTS
45 hours of literature studying = 1,5 ECTS
45 hours of self-work on project = 1,5 ECTS

Assessment methods:
The final exam is laying down by publicly presentation of project which the student has made under leading of the lecturer and the associates which are participating in performance of course. Through the course semester proficiency in the topics of course listed above will be assessed by performance on preliminary exam, test; the apprehension, the uses accomplishment; the analyticity and systematic with fortified system for the evaluation of the knowledge. Continual examination is carrying the 50 percent, and the final defending of project is carrying the 50 percent of the final grade.

Quality assurance methods:
The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams.

PD 702 Flexible Manufacturing Systems

Module: **Modern Production Management**

Course contents:
Term - flexible manufacturing system (FMS). Structure of FMS. FMS classification. Module flexibility. Module principle of FMS (machining, forming, assembly systems). Types of material flow in product technological complexity function and spatial constraints. Transport flow flexibility. Layout flexibility. Transport system flexibility.

FMS organization models. FMS reengineering. Fractal factory. FMS and new manufacturing philosophy. FMS control levels. Integration of control subsystems. Flexible automation. Virtual manufacturing systems. New demands on FMS. Reconfigurable manufacturing systems. Mathematical modelling of FMS. Simulation. FMS diagnostics.

Learning outcomes and competences:
The objectives of this course are acquisition of specifically knowledge relating to development and application of automated (intelligent) manufacturing systems. Also the objective of this course is to teach students about modelling FMS and to analyse application of FMS in production company.

Teaching methods:
Combination of lectures, experimental work and individual project. Individual project includes work on appropriate problem of FMS modelling by using knowledge of this course and consulting the professor. Observation of project work is continually. Public presentation of individual project results will finish the course.

Recommended reading:
- Katalinić, B.: Flexible Manufacturing Systems, Engineers Handbook, Školska knjiga, Zagreb, Croatia, 2000, Poglavlje u knjizi
- Katalinić, B.: Fleksibilni proizvodni sustavi. Praktičar, 16. poglavlje, Sv. 4, Školska knjiga, Zagreb, 1996.
- Tufekčić, Dž.; Jurković, M.: Fleksibilni proizvodni sistemi, Univerzitet u Tuzli, Mašinski fakultet u Tuzli, 1999., 237 str.
- Jurković, M.: Matematičko modeliranje inženjerskih procesa i sistema, Mašinski fakultet Bihać, 1998., 400 str.

Supplementary reading:
- Cornelius, L. T.: Computer Aided And Integrated Manufacturing Systems: Manufacturing Processes. World Scientific Publishing Company, 2003.
- Anderson, E. J.: The Managemant of Manufacturing Models and Analysis, Addison-Nesley, 1994.

ECTS (Number of credits allocated):
7,5 ECTS
This course is performed through 4th semester in addition with 18 hours of conventional 45-minute lectures in class and 12 hours of experimental work.
18 hours of lectures = 0,9 ECTS
12 hours of experimental work = 0,6 ECTS
60 hours autonomous works supported with consultations = 3 ECTS
45 hours study of references = 1,5 ECTS
45 hours project work = 1,5 ECTS

Assessment methods:
Public presentation of individual project results which the student has made under leading of the lecturer and the associates which are participating in performance of course. Continuous examination through semester is performed. Knowledge application, analyticity and systematises by the proved knowledge evaluation system is verifying also. Continuous examination through semester is 40% and public presentation of individual project results is 60% of final evaluation.

Quality assurance methods:
The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams.

PD 703 Quality Management

Module: **Modern Production Management**

Course contents:
ISO 9001 management systems: purpose, advantages and principles of Quality management. Role of management. Requirements of ISO 9001. Structure of ISO 9001 system. Implementation, certification and application of ISO 9001 management systems. Continuous improvement of this system.

ISO 9001 and modern methods of management. Implementation of strategic management and other methods of management at ISO 9001 management systems. Situation analysis. Shaping business strategy. Script and check of strategy. Realization of strategy by method of Balanced Scorecard. Establishing of System for characteristics measurement (business metrics) and efficiency measurement. Customer relationship management.

Other management systems. Importance of ISO 14000 Environmental Management Systems.

Structure of this system, implementation and application of OHSAS Health and Safety management systems. SA 8000 Social accountability norm.

ISO 17799 Information Security Management. Form, channels and consequences of endangering of information in business system. Security risk assessment. Security policy. SSS CMM safety model. Establishing and implementation of ISO 17799 Information Safety systems.
Integrating of particular management systems: ISO 9001 and strategic management. Integrating ISO 9001 and ISO 14001 systems and ISO 17799. Integration of OHSAS Health and safety systems and SA 8000 Social accountability systems to one integrated system.

Learning outcomes and competences:
The aim of course study is increasing the knowledge related to important chapters from the Quality management which are important from standpoint of modern requirements to quality, reliability and product and service safety.

Teaching methods:
Education process is combined as lecturing with seminar project. Seminar include chapters that have been learned during lecturing. Monitoring of seminar project progress is continuous as a part of knowledge evaluation. Finally, the public presentation and discussion relating to seminar project is predicted.

Recommended reading:
- HRN EN ISO 9001:2000: Sustavi upravljanja - Zahtjevi
- HRN EN ISO 9004:2000: Sustavi upravljanja – Smjernice za poboljšanje sposobnosti
- HRN EN ISO 14001:2000: Environmental Management System
- HRN EN ISO 17799:2000: Information technology – Code of practice for information security management

Supplementary reading:
- Ishikawa, K.: Guide to Quality Control. Quality resources, New York, 1996.
- Juran, J. M.: Quality Control Handbook, McGraw-Hill, New York, 1988.

ECTS (Number of credits allocated):
7,5 ECTS
Lecture 18 hours and Experimental investigation 12 hours.

18 hours Lecture + 12 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:
Presentation of seminar project, which was prepared by student with the help of Professor and assistants. Mentor will be present at seminar presentation. During semester, knowledge, understanding and implementation will be tested by determined techniques. Continual assessment has 60 % and project presentation has 40 % of final mark.

Quality assurance methods:
Student's evaluation's, professor's evaluations, evaluations of professors who participate in successful performance of study program.

PD 704 Strategic Management

Module: **Modern Production Management**

Course contents:
The Strategic Management: an Overview, Establish Company direction: Developing a strategic Vision, Mission, Setting Objectives, Components of the Strategic Management Model, Internal Analysis of the firm, SWOT Analysis, PEST analyze, Scenario planning, The External environment, Global environment, Industry and competitive Analysis, Strategy analysis and choice, The BCG Growth Matrix, the Portfolio Matrix, Model of Grand Strategy cluster, Formulating Long term Objectives. Evaluating Company Resources and Competitive Capabilities, Strategy and Competitive Advantage, Horizontal Integration, Vertical Integration, Joint Ventures, Strategic Alliances, Just in time, Keiretsus, Consortia and Chaebols, Implementing strategy through the business functions, Strategies in Marketing, Finance, Research and development and HRM, Strategy through Structure, Leadership Culture and Rewards, Learning organisation, Social responsibility of Company, Strategy control, Evaluating the Strategy, Implementing Cases in Strategic Management,

Learning outcomes and competences:
Course is designed to motivate students on strategic critical thinking and the firm's case analyses. Students have to careful diagnosed organisations' conditions and recommend the appropriate strategic action. The aim of course is double: to learn and understand the strategic thinking theory and to put the theory in the action. Strategic management in practice: Cases provide students with opportunities to identify and solve organizational problems. Thus, by analysing situations that are describes in cases and presenting the results, students become skilled at effectively using the tools, techniques, and concepts that combine the form the strategic management process.

Teaching methods:
Continuous (plan design, test theoretical questions)
Exercises: Development business plan, case study

Recommended reading:
- Grupa autora: Strategijski management (red. Buble, M.), Ekonomski fakultet - Split, 1997.
- Johnson, G.; Scholes, K.: Exploring Corporate Strategy: Sixt edition text and cases, Prentice Hall, England, 2004.
- Collins, E.; Devanna M. A.: Izazovi menadžmenta u XXI. Stoljeću, Mate, Zagreb, 2002
- Gopinath, C.; Siciliano, J.: Strategize! Experiential Exercises in Strategic Management, Thomson, 2005

Supplementary reading:
- Hitt, M. A.; Ireland, R. D.; Hoskinsson, R.: Strategic management, Competitiveness and Globalization, cases, Thomson, 2003.
- Costin, H. I.: Strategies for Quality Improvement, The Dryden Press, Harcourt Brace College Publichers, Forth Worth, TX, 1999.

Assessment methods:
Exam's type:
Evaluations Overview:

Chapter Exams (2 tests x 15 % ea.)	30 %
Final Exam	20 %
Case Presentation	16 %

Written Paper	20 %
Participation/Professor's judgment/Peer evaluation	8 %
Participation at Case Presentations	6 %
Total	100 %

All exams will be multiple choice. Your chance to show me your writing skills and ability to integrate the course's knowledge will be shown in your class paper, and oral presentation.

There will be two (2) exams. Each exam will be worth 15 % towards the final grade. The exam will cover the information discussed in class and information from the book.

The final exam will be comprehensive drawing from the previous exams. The material will be similar to the first two exam information.

ECTS (Number of credits allocated):
The course will be realised through 4 th semester – 18 hours of lectures and 12 of workshop
18 hours of lecturers=1,75 ECTS in addition with
12 hours of workshop= ECTS 1,25
60 hours of individual research with consultation =1,5 ECTS
45 library research =1,5 ECTS
45 hours case design=1,5 ECTS

Quality assurance methods:
Students evaluate lecturers during and on the end of classes. Participation requires that students not only attend class, but come prepared to contribute to class discussion. Student evaluate: teaching methods, communications with teacher and own activities during classes.

PD 801 Design Theory

Module: **Design and Numerical Modelling of Products**

Course contents:
Introducing basic concepts in design. Basic theory of technical systems. Theory of product. Product as a system. Structure, composition and decomposition in process of product design. Various information genesis and information system of product in design. Structure and organization of data bases in design process. Shaping product as a technical system. Theory of design process. Technology of process design. Phases of process design. Types of design. Grades of design work out. Models and methods transformation of design features. Basic mathematical copying and transformation consistency of design features. Computer models in design process. Design knowledge base of product. Modeling design development of product. Organizing design process. Information flow in design process.

Learning outcomes and competences:
The goal of this class is acquiring special knowledge in design and possibility of scientific approach in design process, with reference to method which enable to perceive product as a system. Acquiring basic mathematical copying and transformation consistency of design features, which enable understanding of computer models in design process.

Teaching methods:
Classes are conducted via combined lectures and projects in which student works through material previously done in class, implementing on existing or new technical system given in project. The follow-up during the project is constant, as is examining of acquired knowledge, with a public presentation of the project final testing is conducted.

Recommended reading:
- Suh, N. P.: The Principles of Design, Oxford University Press, New York, 1990.
- Pugh, S.: Total design: Integrated Methods for Successful Product Engineering, Prentice Hall, 1991
- Pugh, S: Creating Innovative Products Using Total Design, Addison Wesley, 1996
- Ullman, D. G.: The Mechanical Design Process, McGraw-Hill, 2002

Supplementary reading:
- Frankenberger, E.; Badne-Schaub, P.; Birkhofer, H.: The Designers Key to Successfull Product Development, Springer 1998.
- Pahl, G.; Beitz, W.: Engineering Design: A Systematic Approach, Edited by Ken Wallace, Springer-Verlag, 1996.

ECTS (Number of credits allocated):
7,5 ECTS
This course is performed through semester in addition with 30 hours (of conventional 45-minute lectures in class).
30 hours of lectures = 1,5 ECTS
60 hours autonomous works supported with consultations = 3 ECTS
45 hours study of references = 1,5 ECTS
45 hours project work = 1,5 ECTS

Assessment methods:
The course is passed through public presentation that is made independently by the student with guidance from professor and associates included in project. Public presentation is also attended by module leader. During the semester knowledge is tested (quiz, preliminary exam, test), understanding, application of acquired knowledge, analyticity and systematic via established system for knowledge evaluation. Continuous evaluation brings 60 %, and final presentation 40 % of final grade.

Quality assurance methods:
Student evaluation, evaluation by professor and experts in that area, success in partial tests, and if necessary international supervision (see the preposition of Samardžić-Maglić-Majdandžić).

PD 802 Elastomechanics and Plastomechanics

Module: **Design and Numerical Modelling of Products**

Course contents:
Stress analysis, equations of equilibrium. Stress transformation and stress state in a point. Diplacements and strains, strain analysis. Compatibility conditions, strain transformations. Materials and their mechanical properties. Constitutive laws, general Hooke's law. Elasticity constants. Equilibrium equations by displacements (Lame's equations). Compatibility equations by stresses (Beltrami-Michell equations). Index notation, tensors and matrices. Boundary condtions and theory of elasticity problems solving, uniqueness of solution. Plane problems of theory of elasticity, plane stress, plane strain. Airy's stress function. Biharmonic functions. Plane problems in polar coordinates, axisymmetrical bodies. Virtual work principle. Theory of elasticity equations.

Theory of plasticity. Eksperimental data about plastic deformation. Cyclic plastic deformation. Stress vs. strain diagrams analysis. Plastic deformation analyis at spatil stress state. Yield surfaces of isotropic materials. Material hardening and Drucker law. Constitutive equations of ideal plastic materials. Tresca and von Mises yield criteria. Plastic analysis of rods. Axial loading and torsion of rods. Symmetrical bending of beams. Limit stress analysis.

Learning outcomes and competences:
The aims of this course are acquisition of specific knowledge related to elastomechanics and plastomechanics, application of analytical methods of theory of elasticity and theory of plasticity as well as possibility of scientific approach to numerical modeling and product design.

Teaching methods:
Teaching is composed of lectures and assignment of project in which student elaborates parts of course that are given on lectures, and applying those on existing or new technical system set in project. Observation of project work is continuous, as well as evaluation of acquired knowledge. Publicly oral presentation of project is final test of knowledge.

Recommended reading:
- Brnić, J.: Elastomehanika i plastomehanika, Školska knjiga, Zagreb, 1996.
- Jecić, S.; Semenski, D.: Jednadžbe teorije elastičnosti, Skripta Sveučilišta u Zagrebu, AJA, Zagreb, 2001.
- Alfirević, I.: Uvod u tenzore i mehaniku kontinuuma, Bibiloteka: Tehnička mehanika, Knjiga – 6, Golden marketing, Zagreb, 2003.
- Alfirević, I.; Pustaić, D.: Teorija plastičnosti , Inženjerski priručnik IP1, Zagreb 1997.

Supplementary reading:
- Brnić, J.: Elastoplasticity and Elastoviscoplasticity, Monografija, Interuniversity Network, PAMM Centre, Budapest, 1998.
- http://www.engnetbase.com/books/645/1138_pdf_toc.pdf, 15.2.2004.

ECTS (Number of credits allocated):
7,5 ECTS
The course is performed in 3rd semester with 30 hours of conventional 45-minute lectures in class.
Number of credits will be allocated as follows:
30 hours of lectures = 1,5 ECTS
60 hours autonomous works supported with consultations = 3 ECTS

45 hours study of references = 1,5 ECTS
45 hours project work = 1,5 ECTS

Assessment methods:
The final exam is carried out by publicly presentation of project made by student under supervision of the lecturer and the associates which are participating in performance of course. The leader of module is present at publicly presentation of project. Through the course semester, proficiency in the topics of course listed above will be assessed (quizzes, preliminary exam, test) understanding, use of accomplished knowledge, the analyticity and systematics using existing system for the evaluation of the knowledge. Continuous examination carries 60 percent, and the final presentation of project is carries 40 percent of the final grade.

Quality assurance methods:
The student evaluation, the evaluation of professors and the experts in this scientific area, the efficiency on partial exams. International supervision is possible if necessary.

PD 803 Thin-Walled Structures

Module: **Design and Numerical Modelling of Products**

Course contents:
Torsion of noncircular shafts with solid, and elliptical cross section. The Prandtl elastic-membrane analogy for torsion of shaft. Torsion of thin-walled shafts with closed, and open cross sections. Bending of closed ring. Stress analysis and deformations. Line structures; frameworks. State of stress and strain. Statically determinate structures. Statically indeterminate line structures. Basis of analytical methods for numerical solutions. Solution method of initial parameters. Matrix formulation of problem. Force vector and displacement vector. Influential functions. Structure compliance matrix and stiffness matrix. Transformation matrix. Force method and displacement method. The finite element method for structural analysis of statically indeterminate line structures. General theory of elastic plates. Bending of thin flat circular plates; analysis of deflections, deformations and stresses. Analysis of plates in rectangular coordinates. Solution methods for bending of thin flat rectangular plates. Navier's formula for bending of thin rectangular plates. General theory of shell of revolutions. Definition of surface in orthogonal curvilinear coordinates. Kirchhoff-Love's hypothesis. Lamé's parameters. Gauss-Codazzi's conditions. Displacements and deformations. The compatibility equations. Forces and moments. Equilibrium equations. Constitutive equations. Boundary conditions. Membrane forces of axisymmetric shells: cylindrical, conical, spherical and torus shells. Membrane stresses of cylindrical shells. The equilibrium equations. Displacements and deformations. Boundary conditions. Membrane forces and stress function. Bending of thin cylindrical shells. Exponential-trigonometric functions. Differential equation of bending of cylindrical shell. Long cylindrical shells. Generalized forces and displacements, influential coefficients. Krylov's function. Short cylindrical shells. Bending of axisymmetric shells: spherical shell, shallow spherical shell and conical shell. Bending of steep axisymmetric shells. Fundamental equations of linear theory of shells in tensor formulation. Basic equations of geometrically non-linear theory of shells in tensor formulation. Application of Lagrange's formulation. Application of the finite element method to analyses of thin plates and shells.

Learning outcomes and competences:
The objectives of this course are acquisition of specifically knowledge relating to design of think-walled structures and possibilities of scientific approach in design process of think-walled structures. Too, the students will be given experience for application of equations of the theory of elasticity in calculation process of think-walled structures, and possibility and understanding of numerical model in design process of think-walled structures.

Teaching methods:
Teaching method is composed from lectures and assignment of project in which the student provides parts of course that are given on lectures, and applying those on existing or new technical system which is setting in project. Observation of project work is continually; too verification of accomplishments, and publicly presentation of project is final test of knowledge.

Recommended reading:

- Alfirević, I.: Linearna analiza konstrukcija, FSB-Zagreb, Zagreb 1999.
- Sorić, J.: Ljuske i ploče, Inženjerski priručnik IP1, Zagreb 1996.
- Pavazza, R.: Tankostjeni štapovi, Inženjerski priručnik IP1, Školska knjiga, Zagreb 1996.
- Senjanović, I.: Teorija ploča i ljuski, FSB-Zagreb, Zagreb 1998.

Supplementary reading:

- Boresi, A. P.; Schmidt, R. J.; Sidebottom, O. M.: Advanced mechanics of materials, J. Wiley, New York 1993.
- Bull, J. W., ed.: Finite Element Analysis of Thin-Walled Structures, Elsevier, New York 1988.

ECTS (Number of credits allocated):

7,5 ECTS

This course is performed through 2nd semester in addition with 30 hours of conventional 45-minute lectures in class.

Number of credits will be allocated as follows:

30 hours of lectures = 1,5 ECTS

60 hours autonomous works supported with consultations = 3 ECTS

45 hours study of references = 1,5 ECTS

45 hours project work = 1,5 ECTS

Assessment methods:

The final exam is laying down by publicly presentation of project which the student has made under leading of the lecturer and the associates which are participating in performance of course. The leader of module is present at publicly defending of project. Through the course semester proficiency in the topics of course listed above will be assessed by performance on quiz show, preliminary exam, test; the apprehension, the uses accomplishment; the analyticity and systematic with fortified system for the evaluation of the knowledge. Continual examination is carrying the 60 percent, and the final defending of project is carrying the 40 percent of the final grade.

Quality assurance methods:

The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams; and if is necessary also the international supervision is possible.

PD 804 Theory of Mechanical Engineering Systems

Module: **Design and Numerical Modelling of Products**

Course contents:
Introduction. Basic terms. Mechanical engineering systems in a technical process. Models and transformation of knowledge systems into material characteristics of a technical system. Partial goals in realization of knowledge transformation in the process of modeling technical systems. Origins of a technical process. Technical process theories. Technical system definitions, presenting operating structure and properties. Structure of a technical process. Secondary input and output values. Technical process operators. Process characteristics. Technical process specification. Technical process organization. Technical system and process, degree of abstraction and interaction with environment. Operating activities related to the process. Defining technical system functions based on the definition of technical process functions. Classification of engineering systems. Classification of engineering systems according to their function. Classification of systems according to operating principles. Classification of technical systems according to the complexity level. Classification of engineering systems according to similarities in technical completion. Classification of engineering systems according to design difficulty. Classification of engineering systems and engineering groups according to production methods and the degree of standardization. Classification of engineering systems according to design originality. Engineering system models and models of transformation (of substance and energy) in systems. Classification of engineering systems according to the importance of individual properties and limitations for individual application areas, development methods, innovation, and other. Classification of engineering systems according to: function and implementation area (operating tools, mining, civil, transport, etc), principles of operation (mechanical, electrical, pneumatic, hydraulic, and other), complexity (complexity level of parts, components, groups, machines, devices, complex engineering systems), complexity and convenience for manufacturing, design difficulty, standardization level, originality and quality. Structure of engineering system properties according to monitoring methods, importance for technical systems, correlation, possibility of quantifying, importance, scientific and technical basis. Relationship between internal and external system properties, their influence on engineering system properties. Development of engineering (technical) systems based on the design process theory.

Learning outcomes and competences:
The aim of subjects study is to acquire special knowledges in analysis and synthesis structural features of product as the technical system. Through the scientific methods students gain knowledge's for application through objective formalized models theory of systems in product analysis in any phase emerging and/or application with the aim fast realization placed structural feature.

Teaching methods:
Teaching is leading by lectures combinating and project inflicting in which student lonely and/or in work group is applying acquiremented knowledges, by deepending through the analysis established and/or solving new constructional tasks. Folowing project make is continuous, as and check new knowledge. Whith the project presentation students get final mark.

Recommended reading:

- Hubka, V.; Eder, W.E.: Theory of Technical systems, Springer, New York 1988.
- Hubka V.: Theorie der Maschinesysteme, 1994.
- Suh, N.P.: The Principles of Design, Oxford Univ. Press, New York 1990.

- Ehrlenspiel, K.; Kiewert, A.; Lindeman, V.: Kostengünstig Entwickeln und Konstruiren, Springer 1999.

Supplementary reading:
- http://www.iso.ch/iso/en/ISOOnline.frontpage/
- http://www.bfi.org/designsc.htm/

ECTS (Number of credits allocated):
7,5 ECTS
Subject is representing during semester with collectively 30 lecture lessons.
30 lecture lessons = 1,5 ECTS
60 lessons substantive work beside consultations = 3 ECTS
45 lessons literature study = 1,5 ECTS
45 lessons work on project= 1,5 ECTS

Assessment methods:
Test is slopping with project presentation which student has lonely made beside teacher and assistant support. On project presentation is present modul leader. During the semester knowledge is checking (quiz, preliminary exam, test), understanding, use a new knowledge, analyticity and systematic with the system for knowledge evaluation. Continuing test wear 60 %, and end indication of project 40 % final mark.

Quality assurance methods:
Students evaluation, teacher evaluation, and latitude professionals, efficiency on partial tests, and if is necessary international supervision (see suggestion Samardžić-Maglić-Majdandžić).

PD 901 Finite Element Method in Structural Analysis

Module: **Design and Numerical Modelling of Products**

Course contents:
The finite element method generally. The basic types of finite elements with their field of applicability. Direct formulation of finite element concept. Construction of the global stiffness matrix. Variational formulation of the finite element method. The basic equation of finite element for the three-dimensional problem. Setting of boundary conditions and stress calculation. Global formulation of the finite element method. The convergence of the solution. One-dimensional elements: trusses and beam elements. Elements for two-dimensional analysis: triangular and rectangular elements. Lagrange interpolation polynomials. Serendipity elements. Elements for three-dimensional analysis: tetrahedral and hexagonal finite elements. Axysymmetric elements. Isoparametric elements. Elements for plate bending. Elements for analysis of shell structures. The examples of variety of problems solved by commercial package "ANSYS" based on finite element method.

Learning outcomes and competences:
Finite element method as the numerical procedure for solving of engineering problems is one of the most used tools by analysis, design and optimising of structures today.

There are many different CAD software present today on the market, where some of them have also the capability to discretise the structure with the aim to determine unknown displacements, stresses or strains. The goal of this course is to introduce the student with the basic concepts of FEM through the derivation of the stiffness matrix for the most applied elements. The PhD student has to be trained to recognise the problem, choose the suitable type of the element, set properly the boundary conditions and loading and finally interpret the results on the common solved examples.

Teaching methods:
The lessons will be given combining the lectures and exercises, where the practical problems of structural mechanics will be solved. During the lectures two assignments will be given as the home work and solving of them proves the lessons understanding. The first home work includes the construct of the global stiffness matrix by hand and calculation of some physical values for some simple problem. The aim of this work is to introduce the student with the mathematics and logics, which uses the computer programme by solving of the matrix system. Within the second home work, it is needed to solve the problem of strength of some complex structure, qualifying with it to be able to use some software for finite element analysis. The observation of the work on the assignments is continuously, as well as the control of the knowledge acquirement.

Recommended reading:

- Sorić, J.: Metoda konačnih elemenata, Golden marketing, Zagreb, 2004.
- Zienkiewicz, O. C. and Taylor, R.L.: The Finite Element Method: Volume 1 The Basis, 5th Edition, Butterworth-Heinemann, Oxford, 2000.
- Bathe, K.-J.: Finite Element Procedures, Second Edition, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1995.
- Huebner, H. K.; Thornton, A. E.; Byrom, G. T.: The finite element method for engineers, Third edition, John Wiley&Sons Inc., New York, 1995.

Supplementary reading:

- Müller, G.; Rehfeld, I.; Katheder, W.: FEM für Praktiker, Die Methode der Finiten Elemente mit dem FE-Programm ANSYS, 2. verbesserte Anlage, Expert Verlag 1995.
- Moaveni, S.: Finite Elemente Analysis, Theory and Application with ANSYS, Prentice Hall, New Jersey, 1999.

ECTS (Number of credits allocated):

7,5 ECTS
The course will be performed during the semester with the schedule of the 24 hours of lectures and 6 hours of experimental work.
Number of credits will be allocated as follows:
24 hours of lectures = 1 ECTS
6 hours of experimental work = 0,5 ECTS
60 hours of autonomous work supported with consultations = 3 ECTS
45 hours study of literature = 1,5 ECTS
45 hours for the assignments = 1,5 ECTS

Assessment methods:

During the semester the student's knowledge has to be checked continuously (two assignments), as the control of course matter understanding. This serves also as verification of the student’s competence to apply acquired knowledge. Positive grade from the assignments replaces the written part of the exam and presents the precondition for the admission to the oral part of exam. Continual examination is carrying the 60 percent, and the oral part of exam is carrying the 40 percent of the final grade.

Quality assurance methods:

The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams; and if is necessary also the international supervision is possible.

PD 902 Modeling of Design and Design Processes

Module: **Design and Numerical Modelling of Products**

Course contents:
Methodic design and modeling of design processes. Product development. Design process and product data management. Matrix transformation of design features analysis, collaborative design, and evaluation of design alternatives. Archive organization, documentation, classification (code) systems. Conception and projecting steps. Modeling and dimensioning of mechanical design parts. Work and critical status of mechanical design parts and assembly analysis. Computer application in design. Hardware arrangement, information support, data models. Computer software of general or special purpose. Informatics model feature and mathematical data processing methods. Computer body model, body design geometry. Machine parts and assembly modeling supported via computer - interactive modeling, parametric modeling, object modeling, modeling under expert systems. CAD systems standards and interfaces. Handling software tools for design support.

Learning outcomes and competences:
The goal of this class is acquiring special knowledge in methodic design and modeling of design process, respectively about product design and data flow process. Essential knowledge of various procedures in machine parts and assembly modeling with computer support.

Teaching methods:
Classes are conducted via combined lectures and projects in which student works through material previously done in class, implementing on existing or new technical system given in project. The follow-up during the project is constant, as is examining of acquired knowledge, with a public presentation of the project final testing is conducted.

Recommended reading:
- Hubka, V.; Eder, W.E.: Theory of Technical Systems, Springer, New York 1988.
- Roller, D.; Brunet P.: CAD Systems Development Tools and Methods, Springer, 1997.
- Manttyla, M.: An Introduction to Solid Modelling, Helsinki University of Technology, 1984.
- Suh, N. P.: The Principles of Design, Oxford Univ. Press, New York 1990.

Supplementary reading:
- http://www.bfi.org/designsc.htm/
- http://www.cad-portal.com/

ECTS (Number of credits allocated):
7,5 ECTS
This course is performed through semester in addition with 26 hours of lectures and 4 hours of experimental work (of conventional 45-minute lectures in class).
26 hours of lectures = 1,0 ECTS
4 hours of experimental work = 0,5 ECTS
60 hours autonomous works supported with consultations = 3 ECTS
45 hours study of references = 1,5 ECTS
45 hours project work = 1,5 ECTS

Assessment methods:
The course is passed through public presentation that is made independently by the student with guidance from professor and associates included in project. Public presentation is also attended

by module leader. During the semester knowledge is tested (quiz, preliminary exam, test), understanding, application of acquired knowledge, analyticity and systematic via established system for knowledge evaluation. Continuous evaluation brings 60 %, and final presentation 40 % of final grade.

Quality assurance methods:
Student evaluation, evaluation by professor and experts in that area, success in partial tests, and if necessary international supervision (see the preposition of Samardžić-Maglić-Majdandžić).

PD 903 Fatigue Strength and Fracture Mechanics

Module: **Design and Numerical Modelling of Products**

Course contents:
Typical stress-time cycles of dynamic loads constructions. Fatigue of materials. Fatigue under cyclic load. Influence of prestresses on fatigue strength. S-N curves, Wöhler's stress-time cycles curve for alternating stresses, fatigue (endurance) limit of the material. Influence of mean stress, determinations of the Haigh's and Smith's diagrams of allowable stresses of material. Analysis parameters subjected to dynamic load of machinery elements. Spectrum of stresses subjected to variable cyclic loads, parameters of spectrums, standard spectrums. Hypothesis of linear cumulative damage by fatigue of element. Palmgren-Miner's test. Life-time and fatigue strength of structures and machines. Influential factors affecting the fatigue strength of component in a machine: stress concentration, size effect, environmental effects, surface finish and treatments. Influence of high temperature on fatigue strength of material. Residual stresses in mechanical components of constructions and their influence on fatigue limit of the material. Determination of the fatigue lines, Collin's and Juvinall-Shigley's methods. Examples of correctly design of mechanical elements.

Introduction to fracture mechanics. Linear-elastic fracture mechanics. Modes of crack tip deformation. Calculation of the stress intensity factor. Irwin's force of crack extension. Mathematical basic of elastic-plastic fracture mechanics. Dugdal's model of crack. Determination of critical dimension of crack. Stresses in the neighborhood of a crack. Relationship between the stress intensity factor, COD-displacement and J-contour integral. Influences on the velocity of the fatigue crack propagation: plastic zone, dimensions of element and environmental effects. COD criteria for fracture toughness of the material. Crack growth rate during cyclic loading. The velocity of the fatigue crack propagation. Paris's equation. Correction of Paris's equation, life-time of material. Influence of the crack on the failure strength. Prevention procedures of crack propagation. Repair of cracks in constructions. Introduction to the up-to-date numerical design methods of mechanical constructions: SINTAP-procedure. Regulations, guidelines and standards for fatigue strength and fracture mechanics of steel constructions (safety, etc.).

Learning outcomes and competences:
The aims of this course are acquisition of specifically knowledge relating to design of mechanical structures subjected to variable cyclic loads; anticipation of life-time and application of fracture mechanics; possibilities of scientific approach in design process of mechanical structures. Too, the students will be given experience for application of advanced methods of fatigue strength in calculation process of failure and life-time of mechanical structures which make possible application and understanding of numerical model in design process of mechanical structures; and repairing of cracks in constructions.

Teaching methods:
Teaching method is composed from lectures, solving illustrative problems and assignment of project in which the student provides parts of course that are given on lectures, and applying those on existing or new technical system which is setting in project. Observation of project work is continually; too verification of accomplishments; and publicly oral presentation of project is final test of knowledge.

Recommended reading:

- Alfirević, I.: Nauka o čvrstoći II., Biblioteka: Tehnička mehanika, Knjiga – 6, Golden marketing, Zagreb, 1999.
- Radaj, D.: Ermüdungsfestigkeit der Konstruktionen, Springer-Verlag, Berlin 1995.

- Husnjak, M.: Mehanika loma, Inženjerski priručnik IP1, Zagreb 1996.
- Anderson, T. L.: Fracture Mechanics, Fundamentals and Applications, CRC Press, Boca Raton, Florida 1995.

Supplementary reading:
- Boresi, A. P.; Schmidt, R. J.; Sidebottom, O. M.: Advanced mechanics of materials, J. Wiley, New York 1993.
- Dowling, N. E.: Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue, Prentice Hall**,** 1998.

ECTS (Number of credits allocated):
7,5 ECTS
This course is performed through 3rd semester in addition with 26 hours of conventional 45-minute lectures in class and 4 hours of practice in labs.
Number of credits will be allocated as follows:
26 hours of lectures and 4 hours of practice = 1,5 ECTS
60 hours autonomous works supported with consultations = 3 ECTS
45 hours study of references = 1,5 ECTS
45 hours project work = 1,5 ECTS

Assessment methods:
The final exam is laying down by publicly presentation of project which the student has made under leading of the lecturer and the associates which are participating in performance of course. The leader of module is present at publicly defending of project. Through the course semester proficiency in the topics of course listed above will be assessed by performance on quiz show, preliminary exam, test; the apprehension, the uses accomplishment; the analyticity and systematic with fortified system for the evaluation of the knowledge. Continual examination is carrying the 60 percent, and the final defending of project is carrying the 40 percent of the final grade.

Quality assurance methods:
The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams; and if is necessary also the international supervision is possible.

PD 904 Selected Topics in the Area of Mechanical Engineering Elements

Module: **Design and Numerical Modelling of Products**

Course contents:
Application of numerical methods in studying static and dynamic load capacity, shape optimization; casings, axles, shafts, flexible and rigid joints, pre-stressed screw joints, flanges, shaft joints with hubs, clamped joints, geared joints, joints with pins and star shaped shafts. Brakes (automobile, rail, operating machinery), drum brakes, disk brakes, with assisted brake system. Primary and secondary brake. Mechanical, pneumatic, and hydraulic brakes. Clutches for synchronization. Safety clutches for machinery. One-way (shut-off) couplings and brakes. Elements for the transfer of power and motion. Special transfer using elastic elements. Principles of formatting and analysis of structural elements made out of artificial and composite materials. Special elements with high deformability (snap-couplings).

Learning outcomes and competences:
The aim of subjects study is to acquire special knowledge's in analysis of selected latitude structural elements from the aspect statically and dynamical load. Using various optimization models students can acquire knowledges for optimization special structural elements in development and modeling structures of mechanic.

Teaching methods:
Teaching is leading by lectures combinating and project inflicting in which student lonely and/or in work group is applying acquiremented knowledges, by deepending through the analysis established and/or solving new constructional tasks. Folowing project make is continuous, as and check new knowledge. Whith the project presentation students get final mark.

Recommended reading:
- Križan, B.: Osnove proračuna i oblikovanja konstrukcijskih elemenata, Rijeka,1998.
- Opalić, M.: Prijenosnici snage i gibanja, Zagreb, 1998.
- Mott, R. L.: Machine Elements in Mechanical Design, Prentice – Hall, 1999.
- Decker, K.H.: Maschinenelemente, Hanser, 1998.

Supplementary reading:
- Haberhauer, H.; Bodenstein, F.: Maschinenelemente, Springer, 1996.
- Spotts, M.; Shoup, T.; Hornberger, L.: Design of Machine Elements, N.York, 2004.

ECTS (Number of credits allocated):
7,5 ECTS
Subject is representing during semester with collectively 30 lecture lessons.
30 lecture lessons = 1,5 ECTS
60 lessons substantive work beside consultations = 3 ECTS
45 lessons literature study = 1,5 ECTS
45 lessons work on project= 1,5 ECTS

Assessment methods:
Test is slopping with project presentation which student has lonely made beside teacher and assistant support. On project presentation is present modul leader. During the semester knowledge is checking (quiz, preliminary exam, test), understanding, use a new knowledge, analyticity and systematic with the system for knowledge evaluation. Continuing test wear 60 %, and end indication of project 40 % final mark.

Quality assurance methods:
Students evaluation, teacher evaluation, and latitude professionals, efficiency on partial tests, and if is necessary international supervision (see suggestion Samardžić-Maglić-Majdandžić).

PD 951 Methodology for the Evaluation of Design Alternatives

Module: **Design and Numerical Modelling of Products**

Course contents:
Design theory. Product models. Identification design features of product as technical system. Requirement list structure, modeling and PDM. Model functions. Functional structure design solution. Variables and constraints. Variant defining of structure. The multicriterion analysis and synthesis structural features principal variants of solutions. Modeling system by copying from original. Consistent of transforming process structural features. Evaluation models structural features. Evaluation model based on π - similarity theorem. Methodology for the Evaluation of Design Alternatives (MEDA). Conceptual Design Evaluation Method (CDEM). AHP (Analytical Hierarchy Process) evaluation model on the base applying characteristic vector method. Evolutionary applying potential method. With the presentation of practical examples analytical and numerical evaluation models, undeceive on mathematical formalization degree and possibilities of applying evaluation structural product features.

Learning outcomes and competences:
The aim of subjects study is to acquire special knowledges about various evaluation methods structural features with greater or less degree of mathematical formalism in different phasis product growth. On this way students can develop capability of objective decision and create approach of evaluation in development of structural product.

Teaching methods:
Teaching is leading by lectures combinating and project inflicting in which student lonely and/or in work group is applying acquiremented knowledges, by deepending through the analysis established and/or solving new constructional tasks. Folowing project make is continuous, as and check new knowledge. Whith the project presentation students get final mark.

Recommended reading:

- Duhovnik, J.; Tavčar, J.: Elektronsko poslovanje in tehnični informacijski sistemi, LECAD, Univerza v Ljubljani; 2000.
- Rozenburg, E.: Product Design Fundamentals and Methods, Willey 1995.
- Sen, P.; Yang, J. B.: Multiple Criterion Decision Support in Engineerng Design, Springer-Verlag, London, 1998.
- French, M.: Conceptual Design for Engineers, Springer 1998.

Supplementary reading:

- Saaty, T. L.: The Analitic Hierarchy Process, RWS Publications, Pittsburgh, 1996
- Bjarnemo, R.: Towards a Computer Implementable Evaluation Procedure for the Mechanical Engineering Design process, Lunds University, Division of Machine Design of Department od Design Science, Sverige, 1994

ECTS (Number of credits allocated):
7,5 ECTS
Subject is representing during semester with collectively 30 lecture lessons.
30 lecture lessons = 1,5 ECTS
60 lessons substantive work beside consultations = 3 ECTS
45 lessons literature study = 1,5 ECTS
45 lessons work on project= 1,5 ECTS

Assessment methods:
Test is slopping with project presentation which student has lonely made beside teacher and assistant support. On project presentation is present module leader. During the semester knowledge is checking (quiz, preliminary exam, test), understanding, use a new knowledge, analyticity and systematic with the system for knowledge evaluation. Continuing test wear 60 %, and end indication of project 40 % final mark.

Quality assurance methods:
Evaluation of students, teacher evaluation, and latitude professionals, efficiency on partial tests, and if is necessary international supervision (see suggestion Samardžić-Maglić-Majdandžić).

PD 952 Calculation, Design and Optimization of Mechanical Constructions

Module: **Design and Numerical Modelling of Products**

Course contents:
General principles to design of mechanical constructions. Types and methods of calculations. Analytical calculation methods – possibilities and limitations. Design with approaches of guidelines from technical standards for mechanical constructions. Numerical design methods - possibilities and limitations. Modeling of plane and three-dimensional problems, discretization of models, setting of appropriate boundary conditions, testing of models, convergence of solutions, presentation and analysis of results.

Analytical, numerical and experimental methods for optimizations of mechanical constructions. Evaluation of the construction characteristics for realization of the aims from given value of the goal function. Application of the inverse goal function for enlargement of accuracy to realization the variables of the goal function. Optimization with the influences of dimensions and shape of construction elements, arrangement of particular elements in construction, materials of particular components, stability of construction, reduction of mass and total costs of production. Risk analysis of constructions with the aspect of human safety, fortune and environment.

Introduction to the world-wide CAD packages which have included module for numerical analysis (I-deas, SolidWorks, Algor, etc.); and with integration possibility to a different programme package which has the module for optimization of the goal function (MatLab, Mathematica etc.).

Solving of project assignments: definition of construction characteristics, modeling, design and optimization for examples of contract joints, connections joints, elements of power and motion transmissions, pressurized vessels, etc.

Learning outcomes and competences:
The goals of this course are acquisition of specifically knowledge relating to design of mechanical constructions; applications of the analytical, numerical and experimental methods for optimization of mechanical constructions; and possibilities of scientific approach to the evaluation of construction characteristics in design process of mechanical constructions. Too, the students will be given experience for application of the advanced calculation methods in design process and optimization of mechanical constructions, which make possible of use and understanding of numerical models in design process of mechanical constructions.

Teaching methods:
Teaching method is composed from lectures and assignment of project in which the student provides parts of course that are given on lectures, and applying those on existing or new technical system which is setting in project. Observation of project work is continually; too verification of accomplishments, and publicly presentation of project is final test of knowledge.

Recommended reading:

- Ulrich, K.; Eppinger, S.: Product Design and Development, McGraw-Hill/Irwin, 2003.
- Otto, K.; Wood, K.: Product Design, Prentice Hall, 2000.
- Young W. K.; Hyochoong, B.: The Finite Element Method Using MATLAB, Second Edition, CRC Press, 2000.
- Ramamurti, V.: Computer-Aided Mechanical Design and Analysis, Mc Graw Hill, 1998.

Supplementary reading:

- http://ocw.mit.edu/OcwWeb/Sloan-School-of-Management/15-783JProduct-Design-and-DevelopmentSpring2002/CourseHome/index.htm
- http://www.eng.uci.edu/dept/mae

ECTS (Number of credits allocated):

7,5 ECTS

This course is performed through 4th semester in addition with 30 hours of conventional 45-minute lectures in class.

Number of credits will be allocated as follows:

30 hours of lectures = 1,5 ECTS

60 hours autonomous works supported with consultations = 3 ECTS

45 hours study of references = 1,5 ECTS

45 hours project work = 1,5 ECTS

Assessment methods:

The final exam is laying down by publicly presentation of project which the student has made under leading of the lecturer and the associates which are participating in performance of course. The leader of module is present at publicly defending of project. Through the course semester proficiency in the topics of course listed above will be assessed by performance on quiz show, preliminary exam, test; the apprehension, the uses accomplishment; the analyticity and systematic with fortified system for the evaluation of the knowledge. Continual examination is carrying the 60 percent, and the final defending of project is carrying the 40 percent of the final grade.

Quality assurance methods:

The student evaluation is necessary, the evaluation from other professors and the experts in this scientific area, the efficiency on partial exams; and if is necessary also the international supervision is possible.

PD 953 Product Development and Ergonomics

Module: **Design and Numerical Modelling of Products**

Course contents:
Basic areas of construction activities (product development, solving customer orders, offer analysis, and construction of tools and devices). Theory, validity, and development of products and its status in a technical system. Validity of development, evaluation, useful life, and aging of products (economical, technical-technological, ecological, and ergonomic). Marketing and market needs during product development. List of requirements during the structural development of products (functions, quality, safety, esthetics, expenses, and other). Product development process (design, technology, and manufacturing).

Multidisciplinary aspects of product development and innovations, creativity principles. Methods and approaches in product development and innovations. System theory. Product theory. PDM system (Product Data Management). Product transformation matrix during the design process. Modeling products for a complete and consistent presentation of all information, integration of Cad methodologies, simulations and virtual development for overall cost reduction, and using relevant methodologies for improving the development process.

Introduction to design principles and material selection according to the useful life of products. Introduction to organization, procedures, and effects of material recycling and product restoration. Introduction to methods, installations, and equipment for recycling and ecological management at the end of the useful life of products.

Applying ergonomic principles during product development from the aspects of biomechanical and anthropometrical analysis.

Learning outcomes and competences:
The aim of subjects study is to acquire special knowledges about methodical approach development of product with the special accent on PDM system on application CAx methodology in simulation. Application biomechanical analysis through wholelife cycle gives new aspects in product development. With this approach students can developt capability whole product development.

Teaching methods:
Teaching is leading by lectures combinating and project inflicting in which student lonely and/or in work group is applying acquiremented knowledges, by deepending through the analysis established and/or solving new constructional tasks. Folowing project make is continuous, as and check new knowledge. Whith the project presentation students get final mark.

Recommended reading:

- Duhovnik, J.; Tavčar, J.: Elektronsko poslovanje in tehnični informacijski sistemi, LECAD, Univerza v Ljubljani; 2000.
- Rozenburg, E.: Product Design Fundamentals and Methods, Willey 1995.
- Mikšić, D.: Ergonomija, FSB, Zagreb, 2000.
- Andreasen, M.; ... Wood, O.: Product Design, Prentice Hall 2001.

Supplementary reading:

- Quarante, D.: Osnove industrijskog dizajna, Sveučilišna naklada Zagreb, 1991.
- Muftić, O.; Veljović, F.; Jurčević-Lulić, T.; Milčić, D.: Osnovi ergonomije, Univerzitet u Sarajevu, 2001.

ECTS (Number of credits allocated):
7,5 ECTS
Subject is representing during semester with collectively 30 lecture lessons.
30 lecture lessons = 1,5 ECTS
60 lessons substantive work beside consultations = 3 ECTS
45 lessons literature study = 1,5 ECTS
45 lessons work on project= 1,5 ECTS

Assessment methods:
Test is slopping with project presentation which student has lonely made beside teacher and assistant support. On project presentation is present modul leader. During the semester knowledge is checking (quiz, preliminary exam, test), understanding, use a new knowledge, analyticity and systematic with the system for knowledge evaluation. Continuing test wear 60 %, and end indication of project 40 % final mark.

Quality assurance methods:
Students evaluation, teacher evaluation and latitude professionals, efficiency on partial tests and if is necessary international supervision (see suggestion Samardžić-Maglić-Majdandžić).

PD 954 Damages of Constructions

Module: **Design and Numerical Modelling of Products**

Course contents:
Introduction. Causes of damages: overloading, fatigue of material, corrosion, wrong material and technology selection. Failure determination: visual control, non destructive and destructive quality control methods, confidence level of quality control methods. Preparation and sampling for: mechanical, metallographic and fractographic examinations. Mechanical aspects: service conditions, application of fracture mechanics postulates, effect of three axes stress and limitation of material yielding, temperature influence and the influence of deformation velocity. Crack propagation: brittle and ductile fracture, fatigue, creep, the influence of high temperature, aggressive environment. Numerical models: calculation of fracture stress, determination of residual life. Fault tree. Deductive decision. Examples (case studies) of damages on constructions in service. Repairing of damages. Assessment of designer, manufacturer and user responsibilities.

Teaching methods:
Lectures and experimental investigation. Education process is combined with seminar project. Monitoring of seminar project progress is continuous as a part of knowledge evaluation. Finally, the public presentation and discussion relating to seminar project is predicted.

Recommended reading:
- Domazet, Ž.: Life Extension of Fatigue Damaged Components, Advances in Fracture Research, Pergamon Press, 1997.
- Wulpi, D. J.: Understanding How Components Fail, American Society for Metals, 1985.
- Hertzberg, R. W.: Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, 1996.
- Brooks, C. R.; Choudhury, A.: Metallurgical Failure Analysis, McGraw-Hill, 1993.

Supplementary reading:
- http://www.mate.calpoly.edu/mate450/index.html, 18.2.2004.
- http://www.engr.sjsu.edu/WofMatE/FailureAnaly.htm, 18.2.2004.

ECTS (Number of credits allocated):
7,5 ECTS
Lecture 24 hours and Experimental investigation 6 hours.
24 hours Lecture + 6 hours Experimental investigation = 1,5 ECTS
60 hours of individual work with consultation = 3 ECTS
45 hours for literature study = 1,5 ECTS
45 hours of individual work on seminar project = 1,5 ECTS

Assessment methods:
Seminar project.

Quality assurance methods:
Students evaluations, professors evaluations, evaluations of professors who participate in successful performance of study program.

3.5. Rhythm of studying and responsibilities of students. Study requirements, admission to the following semester/year and preconditions for taking a particular subject or group of subjects

3.5.1. Rhythm of studying and responsibilities of students

Duration of the postgraduate doctoral study of Mechanical Engineering at the Faculty of Mechanical Engineering in Slavonski Brod is six semesters or three years for **full time** students. Students are required to attend all lectures regularly and fulfil all their obligations (for compulsory as well as for eligible subjects) which is confirmed by the second signature in student's matriculation book, or by registering a semester as completed.

Responsibilities include: regular attendance at lectures, continued laboratory and experimental work, taking and passing exams or other forms of assessment and all other activities described in items **3.1**. – **3.3.**

3.5.2. Study requirements, admission to the following semester/year and preconditions for taking a particular subject or group of subjects

To control the level of success and provide conditions for successful mastery of the next semester courses, the following admission requirements are set:

- To be admitted to semester 3 students should earn at least 30 ECTS points by passing exams, producing and defending seminar papers or /and publishing the results of scientific-research work (semester 1 load cleared),
- To be admitted to semester 5 at least 90 credit points should be earned (first, second and third semester load cleared) or a master's degree in technical sciences held.
- To register for a dissertation theme at least 60 credit points should be earned.
- Before the dissertation assessment procedure begins the candidate should earn at least 150 ECTS points, 120 of which at the end of semester 4 and after registering for a dissertation, and additional 30 points earned according to the criteria given in item **3.3.**

For other requirements see the Statute of the Faculty of Mechanical Engineering in Slavonski Brod (item VII.7: Other questions referring to the study, Article 65).

3.6. Study consultation and supervision system, entry standards, tasks of study counsellors and supervisors, candidate and dissertation mentors

In addition to the vice dean for science and the Committee for postgraduate study and doctor's degree, the study consultation and supervision system includes:

- Study counsellors (one for each study year). Study counsellors are appointed by the Academic Senate on the Dean of academic affairs' or the Dean of the Faculty's suggestion. The study counsellors assist in the selection of students and their orientation and help the candidates to better and easier master the doctoral programme. They cooperate closely with the module leaders and candidate mentors trying to solve problems in case they arise. They also supervise study programme performance and the quality of lecturing.
- Module leaders are appointed by the Academic Senate on the Dean of academic affairs' or the Dean of the Faculty's suggestion. They coordinate the module teaching sessions and supervise the study module performance and the quality of lecturing. If a problem arises they try to solve it together with the study counsellors, doctoral candidate mentors and dissertation mentors.

- Doctoral candidate mentors (one mentor can have up to three candidates) are appointed by the Academic Senate on the Dean of academic affairs' or the Dean of the Faculty's suggestion. They help the candidates in solving questions relating to successful performance of the study programme. They also follow the progress of the candidates taking care that all the preconditions necessary for the progress are met (required scientific literature, choice of elective subjects, cooperation with the lecturers and scientists whose scientific fields are of interest to candidates, especially if they come from abroad or another faculty etc.).
- Dissertation mentors are assigned to doctoral candidates when all preconditions for working on the doctoral thesis are met. Mentors are appointed by the Academic Senate on suggestion of the Dissertation Theme Assessment Committee. A dissertation mentor may but need not at the same time be the doctoral candidate's mentor (see Statute of the Faculty of Mechanical Engineering in Slavonski Brod – VIII.: Mentor, Article 81.).

The list of 42 potential mentors should be available to all postgraduate students and is given in the following table:

Assistant professor	Associate professor	Full professor
Galeta Tomislav Maglić Leon	Avsec Jurij Benšić Mirta Ergić Todor Gliha Vladimir Ivandić Željko Sabo Kristian Šimunović Katica Stojkov Marinko	Aračić Stjepan Balič Jože Brnić Josip Budić Ivan Čaklović Lavoslav Domazet Željko Duhovnik Jože Grizelj Branko Gubeljak Nenad Kladarić Ivica Kljajin Milan Kopač Janez Kozak Dražan Križan Božidar Krumes Dragomir Lamza Maronić Maja Lujić Roberto Marušić Vlatko Matejiček Franjo Mišina Nedjeljko Raos Pero Samardžić Ivan Scitovski Rudolf Sedmak Aleksandar Sopta Luka Stoić Antun Šarić Tomislav Šimunović Goran Veža Ivica Živić Marija

It should be pointed out that all potential mentors must fulfil certain criteria in order to become the mentors to the candidates during the whole process of writing the dissertation. Every potential mentor should have some previous experience as a mentor for 6 graduation theses or 3 graduation theses and 1 M.S. thesis and should have at least 3 papers published in magazines (one of them should be indexed in primary bases, and two in secondary bases). If the mentor does not have the adequate number of graduation theses, he should have more (research) papers, i.e. 1 paper in the primary base is equivalent to 2 graduation theses, and 1 paper in the secondary base is equivalent to 1 graduation thesis. Previous experience as a mentor of doctoral dissertations is more than welcome.
All functions and activities described above are to be coordinated with the Postgraduate Doctoral Study Regulations which is an integral part of the Statute of the Faculty of Mechanical Engineering in Slavonski Brod.

3.7. List of subjects and/or modules which can be selected from other postgraduate doctoral and specialist study programmes

Students enrolled in one of the postgraduate study modules at the Faculty of Mechanical Engineering in Slavonski Brod can with no restrictions choose other module subjects.
Possibility to choose subjects from other postgraduate and specialist study programmes shall be regulated by separate agreements between the University members submitting the proposal and other universities.

3.8. List of subjects that can be lectured on in a foreign language (Stating the language)

Code	Subject	Language
PD 101	Logistics of Scientific Research Work	English
PD 103	Modern Manufacturing Processes	English
PD 104	Applying of the Artificial Intelligence	English
PD 201	High Efficiency Joining Processes	English
PD 203	Deformation Manufacturing	German
PD 204	Rapid Prototyping and Manufacturing	English
PD 301	Thermal Activated Processes	German
PD 302	High Speed Machining Processes and Systems	English
PD 303	Technology of the Product	English
PD 304	Modifying Surface of Materials and Surface Engineering	German
PD 401	Welding – Selected Chapters	English
PD 403	Selected Chapters from Materials	German
PD 501	Operational Management	English
PD 502	Production, Project and Resource Management	English
PD 503	Computer Aaided Design, Process Planning and Manufacturing (CAD/CAPP/CAM)	English
PD 601	ERP Systems	English
PD 602	Intelligent Production Systems	English
PD 603	Information Systems: Strategy & Management	English
PD 604	Human Resource Management	English
PD 702	Flexible Manufacturing Systems	English
PD 703	Quality Management	English
PD 704	Strategic Management	English
PD 801	Design Theory	English
PD 802	Elastomechanics and Plastomechanics	English
PD 803	Thin-Walled Structures	English
PD 804	Theory of Mechanical Engineering Systems	English
PD 901	Finite Element Method in Structural Analysis	English
PD 902	Modeling of Design and Design Processes	English
PD 903	Fatigue Strength and Fracture Mechanics	English
PD 904	Selected Topics in the Area of Mechanical Engineering Elements	English
PD 951	Methodology for the Evaluation of Design Alternatives	English
PD 952	Calculation, Design and Optimization of Mechanical Construction	English
PD 953	Product Development and Ergonomics	English
PD 954	Damages of Constructions	English

3.9. Criteria and ECTS points transfer requirements, credit allocation to the subjects selected from other study programmes of the University that submitted the proposal or another university

See the Statute of the Faculty of Mechanical Engineering in Slavonski Brod (item VII.2.: Transfer of ECTS points, Article 60.).

ECTS points can be earned at different university postgraduate doctoral study programmes.

Criteria and ECTS points transfer requirements stated here are regulated by a general act of universities and faculties i.e. agreement between university institutions (university submitting the proposal or other universities)

3.10. Study completion procedure and registration for a dissertation theme. Procedure and requirements for acceptance of dissertation theme. Dissertation assessment procedure. Dissertation defence.

See the Statute of the Faculty of Mechanical Engineering in Slavonski Brod (VII.1.1.: University study, Article 42.; VII.1.1.3.: Postgraduate study, Article 45.; VII.1.1.4.: Dissertation registration, assessment and defence, Article 46.-49.; VII.1.1.5.: Dissertation assessment and defence, Article 50.-58.).

All details in connection with the study completion procedure and registration for a dissertation theme, procedure and requirements for acceptance of dissertation theme, dissertation assessment procedure and dissertation defence will be covered by the Act on Postgraduate Doctoral Study, which is an integral part of the Statute of the Faculty of Mechanical Engineering in Slavonski Brod.

3.11. Admission requirements for candidates who broke off their studies or lost the right to continue a study programme

Admission requirements for candidates who broke off their studies or lost the right to continue a study programme will be defined by the Act on Postgraduate Doctoral Study, which is an integral part of the Statute of the Faculty of Mechanical Engineering in Slavonski Brod. Higher semester bridging requirements (if any) will be decided upon by the Committee for Postgraduate Study and Dissertations or a specially appointed committee for a particular case.

3.12. Requirements for ABDs to obtain a certificate to prove that they have completed required courses and examinations but not a dissertation, as part of life-long education

The postgraduate doctoral students at the Faculty of Mechanical Engineering in Slavonski Brod are entitled to the certificate which proves that they have completed required courses and examinations but not a dissertation, as part of life-long education, if:

- they have completed required courses, confirmed by the course professor’s signature.

- they have successfully passed all examinations and fulfilled other scheduled obligations (experimental work, projects etc.).
- they have settled their financial obligations towards the Faculty.

Form, contents and price of the certificate will be defined by the Act on Postgraduate Doctoral Study, which is an integral part of the Statute of the Faculty of Mechanical Engineering in Slavonski Brod.

3.13. Requirements and criteria for winning a doctor's degree by enrolling in the doctoral study and working on dissertation without attending lectures and sitting for exams

This possibility does not for the moment exist within the framework of the Mechanical Engineering postgraduate doctoral study programme at the Faculty of Mechanical Engineering in Slavonski Brod, but if another faculty doctoral candidate with a required number of ECTS points earned would like to take his degree from the Faculty, a Committee for the candidate and the dissertation theme assessment will be appointed to give its opinion about the number of ECTS points and any bridging requirements.

3.14. Maximum duration of the study

Maximum duration of the mechanical engineering postgraduate doctoral study at the Faculty of Mechanical Engineering in Slavonski Brod, from beginning to end, including the work on and defence of dissertation, is 6 (six) years.

If, for any reasons, legitimate or not, doctoral candidate is not able to finish the study within 6 years, he can apply for the change of dissertation theme. If the application is accepted a new time limit for dissertation and its defence will be set.

All details relating to terms and procedures will be covered by the Act on Postgraduate Doctoral Study, which is an integral part of the Statute of the Faculty of Mechanical Engineering in Slavonski Brod.