Polish course name	**TECHNOLOGIE SZYBKIEGO PROTOTYPOWANIA**
English course name	**RAPID PROTOTYPING TECHNOLOGIES**
Course code	**WIP-MDL-D1-RPT-06**
Field of study	**Materials design and logistics**
Level of qualification	**First degree**
Form of study	**Full-time**
Semester	**6**
Number of ECTS points	**5**
Ways of assessment	**Test**

Number of hours per semester

Lecture	Seminar	Classes	Laboratory	Project
30			15	15

TEACHERS:

Dr hab. inż. Piotr Szota, prof. PCz.,
Dr inż. Andrzej Stefanik,
Dr hab. inż. Andrzej Zyska, prof. PCz.,
Dr hab. inż. Konrad Laber, prof. PCz.

COURSE OBJECTIVES:

- **C1** Providing students with knowledge in the field of rapid prototyping technology.
- **C2** Gaining by students the ability to prepare models for rapid prototyping.
- **C3** Acquiring by the students the skills to make an element with the use of rapid prototyping technology.

PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES:

1. Knowledge of algebra, geometry, trigonometry and programming at the high school level.
2. The student has a basic knowledge of materials science.
3. Knowledge of technical drawing and creating technical documentation.

4. Basic ability to use a CAD program and spreadsheets.

COURSE CONTENT

LECTURE

- **L1, L2** Introduction to rapid prototyping technology.
- **L3 - L6** Fundamentals of additive manufacturing.
- **L7 - L10** Basics of manufacturing technique with the use of subtractive processing.
- **L11 - L14** Incremental shaping technology.
- **L15 - L18** Coding of CNC devices and 3D printers.
- **L19, L20** Materials and techniques used in 3D printing technology.
- **L21, L22** The use of CNC machine tools for rapid prototyping.
- **L23, L24** Rapid prototyping with the use of ceramic materials.
- **L25, L26** Application of rapid prototyping techniques in foundry.
- **L27 - L30** Model and mold technology, preparation of piece and series production.

LABOLATORY

- **Lab1, Lab2** Preparation of object models in the CAD program.
- **Lab3, Lab4** Designing assemblies of elements and their cooperation.
- **Lab5** Possibilities, use and limitations of 3D scanning techniques.
- **Lab6** Coding of CNC devices and 3D printers.
- **Lab7** Printing parameters in the context of the materials used for 3D printing.
- **Lab8, Lab9** Fabrication of component models with the use of 3D printers.
- **Lab10** Getting to know the CAM environment - virtualization of machine tool operation.
- **Lab11, Lab12** Manufacturing of component models with the use of CNC machine tools.
- **Lab13, Lab14** Preparation of models and molds for rapid prototyping of ceramic materials.
- **Lab15** Research on the mechanical and technological properties of model and molding core sands used in foundry rapid prototyping methods.

PROJECT

- **P1 - P4** Development of the project for the assembly of cooperating elements and verification of the project with the use of 3D printing technology.

› **P5 - P8** Development of a CAD model of a selected element and preparation of a CAM project for a numerical machine tool.
› **P9 - P12** Development of prototyping technology for the production of prototype elements from ceramic materials.
› **P13 - P15** Application of rapid prototyping techniques in the design of foundry models, molds and tooling. Preparation of object models in the CAD program.

BASIC REFERENCES

1. France A.K., Świat druku 3D, Helion, 2014 r.
2. Kwapisz M., Charakterystyka Metod druku 3D, Inżynieria Zarządzania Cyfryzacja Produkcji, Aktualności badawcze 1, Warszawa 2019 r.
3. User Manuals XYZprinting da Vinci 1.0 Pro 3in1 [2019] www.xyzprinting.com/.
4. Gebhardt A., Rapid Prototyping, Carl Hanser Verlag, Munich – 2007 r.
5. Augustyn K., EdgeCAM - Komputerowe wspomaganie wytwarzania, Helion, Gliwice 2007 r.
6. K. E. Oczoś, Intensywna ekspansja rapid-technologii, Mechanik, 7/2007, 539 - 545.
7. K. E. Oczoś, Rosnące znaczenie Rapid Manufacturing w przyrostowym kształtowaniu wyrobów, Mechanik 4/2008, 241 - 257.
8. Bubicz M., Szybkie prototypowanie. Maszyny, materiały zastosowania, Projektowanie i konstrukcje inżynierskie nr 4/2008.
9. Miecielica M., Techniki szybkiego prototypowania – rapid prototyping, Przegląd Mechaniczny nr 2/2010.
10. Chlebus Edward red., i inni, Innowacyjne technologie rapid prototyping-rapid tooling w rozwoju produktu, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2003 r.

SUPPLEMENTARY REFERENCE MATERIALS

1. Chlebus Edward red., i inni, Innowacyjne technologie rapid prototyping-rapid tooling w rozwoju produktu, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2003 r.
2. Bubicz M., Szybkie prototypowanie, Maszyny, materiały zastosowania, Projektowanie i konstrukcje inżynierskie nr 4/2008.

LEARNING OUTCOMES

› **EU1** The student has knowledge of the use of incremental methods in high-speed manufacturing technology and is able to use programming environments.
› **EU2** The student has the knowledge of innovative/advanced techniques for the production of models, semi-finished products and finished products from polymer, metal and ceramic materials.
› **EU3** The student is able to design and implement the process of rapid prototyping of the model, semi-finished product, and ready element using the selected technique, and to assess the material and geometric quality of the detail obtained.

TEACHING TOOLS

› Lecture with the use of audiovisual aids.
› Design exercises with the use of computer stations with the required CAD / CAM software, 3D printer, CNC machine tool, stations for manufacturing elements using casting techniques.
› E-learning platform of the Czestochowa University of Technology or other distance learning.

WAYS OF ASSESSMENT (F - FORMATIVE, P - SUMMATIVE)

› **F1** Assessment of the implementation of tasks included in the curriculum.
› **F2** Assessment of the mastery of the teaching material being the subject of laboratory tasks - final test.
› **P1** Assessment of the mastery of the teaching material within the lectures - final test.

STUDENT WORKLOAD

Form of activity	Number of hours	ECTS
Contact hours with the teacher		
Lectures	30	1,2
Seminar		
Classes		
Laboratory	15	0,6
Project	15	0,6

Test	2	0,08
Exam		
Total contact hours	62	2,48
Student's own work		
Getting acquainted with the indicated literature	20	0,8
Preparation for seminar		
Preparation for classes		
Preparation for lab	15	0,6
Project preparation	15	0,6
Consultation	3	0,12
Preparation for the test	10	0,4
Total student's own work	63	2,52
Total number of hours/ ECTS points for the course	**125**	**5,0**

ADDITIONAL INFORMATION

Timetable of classes	https://wip.pcz.pl/dla-studentow/plan-zajec/studia-stacjonarne
Information about the consultation (time + place)	https://wip.pcz.pl/dla-studentow/konsultacje-dla-studentow

MATRIX OF LEARNING OUTCOMES REALISATION

Learning outcome	**Reference of given outcome to outcomes defined for whole program**	**Course objectives**	**Course content**	**Ways of assessment**
EU 1	K_W02, K_W05, K_W06, K_U01, K_U02, K_U05, K_K01, K_K02,	C1	L1 - L30	P1
EU 2	K_W02, K_W05, K_W06, K_U01,	C2	Lab1 - Lab15	F1, F2

	K_U02, K_U05, K_K01, K_K02,			
EU 3	K_W02, K_W05, K_W06, K_U01, K_U02, K_U05, K_K01, K_K02,	C3	P1 - P15	F1, F2

FORM OF ASSESSMENT - DETAILS

EU1 The student has knowledge of the use of incremental methods in rapid production technology and is able to use programming environments.

- 2,0 The student has no knowledge of the use of incremental methods in the rapid production technology and is able to use programming environments.
- 3,0 The student has a basic knowledge of the use of incremental methods in the rapid production technology and has difficulties with independent use of the programming environment.
- 3,5 The student has knowledge of the use of incremental methods in the rapid production technology and has difficulties with the use of the programming environment.
- 4,0 The student has knowledge of the use of incremental methods in high-speed manufacturing technology and is able to use programming environments.
- 4,5 The student has extensive knowledge of the use of incremental methods in fast production technology and is able to use advanced programming environments.
- 5,0 The student has extensive knowledge of the use of incremental methods in rapid production technology and is able to use programming environments at an advanced level and shows his own solutions.

EU2 The student has the knowledge of innovative/advanced techniques for the production of models, semi-finished products and finished products from polymer, metal and ceramic materials.

- 2,0 The student has no knowledge of innovative/advanced techniques for the production of models, semi-finished products and finished products from polymer, metal and ceramic materials.

- 3,0 The student has basic knowledge in the field of innovative/advanced techniques for the production of models, semi-finished products and finished products from polymer, metal and ceramic materials.
- 3,5 The student has quite good knowledge in the field of innovative/advanced techniques for the production of models, semi-finished products and finished products from polymer, metal and ceramic materials.
- 4,0 The student has good knowledge in the field of innovative/advanced techniques for the production of models, semi-finished products and finished products.
- 4,5 The student has a good plus knowledge in the field of innovative/advanced techniques of producing models, semi-finished products and finished products, is able, with the help of the teacher, to choose a polymer, metal or ceramic material depending on the intended use.
- 5,0 The student has very good knowledge in the field of innovative/advanced techniques of producing models, semi-finished products and finished products

EU3 The student is able to design and implement the process of rapid prototyping of a model, semi-finished product, and ready-made element using the selected technique, and to assess the material and geometric quality of the obtained detail.

- 2,0 The student is not able to design and implement the process of rapid prototyping of the model, semi-finished product, and ready element using the selected technique, and to assess the material and geometric quality of the detail obtained.
- 3,0 The student is able to sufficiently design and implement the process of rapid prototyping of the model, semi-finished product, and finished element using the selected technique, and can evaluate the material and geometric quality of the detail obtained.
- 3,5 The student is able to quite well design and implement the process of rapid prototyping of a model, semi-finished product, and a finished element using the selected technique, and can evaluate the material and geometrical quality of the obtained detail.
- 4,0 The student is able to design and implement the process of rapid prototyping of a model, semi-finished product, and a finished element using the selected technique, and can evaluate the material and geometric quality of the detail obtained.

› 4,5 The student is able to design and implement the process of rapid prototyping of a model, semi-finished product, and finished element with the use of a selected technique, and to assess the material and geometric quality of the obtained detail.

› 5,0 The student is able to very well design and implement the process of rapid prototyping of a model, semi-finished product, and a finished element using the selected technique, and to assess the material and geometric quality of the detail obtained.