**Course code:** ……. **Plan position:** ……

## A. INFORMATION ABOUT THE COURSE

### B. Basic information

| | |
|---|---|
| Name of course | Polymer Science and Processing |
| Field of studies | Mechanical Engineering |
| Level of studies | First degree |
| Profile of studies | Academic |
| Form of studies | Full-time |
| Specialty | Research and Development<br>Production Maintenance |
| Unit responsible for the field of studies | Faculty of Mechanical Engineering |
| Name and academic degree of teacher(s) | Piotr Szewczykowski, PhD<br>Karol Pepliński, PhD |
| Introductory courses | Materials Science and Engineering, Basics of machine construction, Manufacturing techniques |
| Introductory requirements | Basic knowledge in chemistry, physics, and mathematics, knowledge of MS Office package, ability to use databases of scientific publications, Engineering graphics. Engineering materials |

### C. Semester/week schedule of classes

| Semester | Lectures (W) | Auditorium classes (Ć) | Laboratory classes (L) | Project classes (P) | Seminar (S) | Field classes (T) | Number of ECTS points |
|---|---|---|---|---|---|---|---|
| Winter/Summer | 45 | | 30 | | | | 5 |

## 2. LEARNING OUTCOME

| No. | Learning outcomes description | The reference to the learning outcomes of specific field of study | The reference to the learning outcomes for the area |
|---|---|---|---|
| KNOWLEDGE | | | |
| K1 | has knowledge in the field of manufacturing engineering and polymer processing technology, including techniques, processes and machines | K_W10 | P6S_WG |
| SKILLS | | | |
| S1 | is able to plan the production process with the use of simple machines and technological devices for plastics processing, control the technological parameters of production and initially estimate its costs | K_U06 | P6S_UW |
| S2 | has the ability to self-educate, e.g. in order to improve professional competences in the field of machines and technological devices for plastics processing, including | K_U12 | P6S_UW |

| | | | |
|---|---|---|---|
| | the control of technological parameters of production | | |
| SOCIAL COMPETENCES | | | |
| SC1 | understands the need and knows the possibilities of continuous training (second and third degree studies, postgraduate studies, courses) - improving professional, personal and social competences in the field of polymer processing technology | K_K01 | P6S_KK |
| SC2 | is aware of the importance and understands the non-technical aspects and effects of the activity of a mechanical engineer, including its impact on the environment, and the related responsibility for decisions made in the area of polymer plastics processing technology | K_K04 | P6S_KK |

## 3. TEACHING METHODS

### A. Traditional methods used ***

multimedia lecture, laboratory, and other methods, e.g., CES Edupack software, videos, books, catalogs, diagrams, blackboard, online techniques, exercise workbook classes

### B. Distance learning methods used ***

**Synchronous method** (classes conducted in a way that ensures direct interaction between the student and the teacher in real time, enabling immediate flow of information, the method can be used only if it is provided for in the study plan for a given cycle of education):
e.g. remote lecture in the form of videoconference, remote discussion, etc.

**Asynchronous method** used as an auxiliary (a method that does not ensure direct interaction between the student and the teacher in real time, used only as an auxiliary / complementary method):

e.g. online educational videos, online multimedia presentations, etc.

## 4. METHODS OF EXAMINATION

Written test/colloquium, reports from laboratory work

## 5. SCOPE

| | |
|---|---|
| Lectures | Introduction to the 'World of Polymers' and historical development of plastics materials. Chemical nature of chosen plastics and states of aggregation in polymers (linear amorphous polymers, crystalline polymers and cross-linked structures). Relation of structure to chemical properties (ex. factor affecting the: glass transition temperature, ability crystalline, crystalline melting point). Chosen individual properties of plastics (melt viscosity, density, impact strength etc.). Interpretation thermal properties of solid and molten polymers. Thermal basic: heating and cooling in plastics processing and their efficiency. Basic of polymer plasticization: extruder-barrel, basic of plasticization theory, screw and non-screw plasticization. Basic behaviour of polymers: rheology of polymers, mechanical properties of plastics etc. Basic additives in plastics and their influence on part properties. Brief description the properties of generic polymeric materials and plastics behaviour in basics polymer processing. Plastics technology basic: role and meaning of working plasticization unit, defect processing, shrinkage, stresses, etc. Basic processing determinants. Theoretical knowledge about the basic materials processing like injection molding, extrusion, extrusion blow molding, |

| | |
|---|---|
| | thermoforming, rotational molding, welding, type of plastics recycling, rapid prototyping, etc. Basic of polymer coating. The fundamentals of technological designing with plastics during project new product. Basic information about the plastics processing tools like: screw, die and injection mold. Basics of energy consumption in plastics processing<br><br>Introduction to the issues of polymer processing engineering. The place of processing technology and processing of polymeric materials in technology. Basic knowledge of the most important plastics and polymer plastics processing technologies used in the area of the considered technologies. Polymer processing technologies in the field of physico-chemical processing of the first type: bonding, welding and welding, free pore and shaping, thermal separation, drying, thermal improvement. Basics of plasticizing technology in plastics processing; meaning and methods of plasticization. Screw, multi-screw plasticizing. Disc, piston and mixed plasticizing. Type II physico-chemical processing technologies: single and multi-screw extrusion, autothermal extrusion, blowing and coating extrusion, cast extrusion, high-speed extrusion, rotational casting, extrusion with free and non-free blowing, extrusion with 3D blowing, extrusion with granulation. Technologies of physical and chemical processing of the second type: conventional injection molding and accompanying phenomena, precision injection molding, tool system of the injection process, multi-component and curable elastomers injection molding, low and high pressure pressing, calendering. Chemical and physical processing: foaming, application, gluing, metallization, lamination and casting. Processing technology and organization: processing conditions, the basis for selection of optimal processing conditions for selected technologies - injection, extrusion, extrusion blow molding, extrusion with granulation. Special methods of polymer plastics injection, including: multi-component injection, ICM compression injection, IML labelling, RHCM, blow molding, micro-injection, etc. Mechanical recycling technology and other types of polymer recycling: basics, varieties, importance of recycling for the environment conditions for the use of recyclates and regranulates in plastics processing technologies. Fundamentals of energy resources management in plastics processing technologies: conditions, types of energy loads. Impact of polymer plastics processing technology on the natural environment. Summary. |
| Laboratories | Determination individual properties of selected amorphous, semi crystalline and crystalline plastics: melt flow index, density, impact strength, processing shrinkage. Efficient heating and cooling in blowing and injection moulds. Selection of basic conditions in injection moulding and they influence on final product. Calculate the thickness of plastic coatings in the process of fluidization and thermoforming. Calculate basic unit operations in Polymer Processing: plasticizing, extrusion, injection molding. Basic parison thickness geometry in extrusion blow moulding process. Disintegration of post consumer plastics in recycling process. Determination of polymer apparent viscosity with using a laboratory extruder with rheological head and pressure sensors. |

| | |
|---|---|
| | Introduction to the course of laboratory classes and expected results. Theoretical exercises and a practical course in various areas of plastics processing technology: Welding technology of thermoplastics. The technology of shaping the geometry of polymeric products by thermoforming. Getting acquainted with the technology of manufacturing continuous profiles from polymeric materials by extrusion. Bottle blow molding extrusion technology. Injection of polymer materials, including pore injection. Technological parameters of injection of thermoplastics. Summary of the series of classes. |

## 6. METHODS OF VERIFICATION OF LEARNING OUTCOMES

| LEARNING OUTCOME | Form of assessment | | | | | |
|---|---|---|---|---|---|---|
| | Oral examination | Written exam | Colloquium | Project | Reports | Class attendance |
| K1 | | | x | | x | x |
| S1-S2 | | | x | | x | x |
| SC1-SC2 | | | x | | x | x |

## 7. LITERATURE

| | |
|---|---|
| Basic literature | - Callister WD, Rethwisch DG, 2015, Materials Science and Engineering, John Wiley & Sons (Asia) Pte Ltd<br>- Ashby M, Shercliff H, Cebon D, 2014, Materials: Engineering, Science, Processing and Design, Elsevier Ltd, The Boulevard, Langford, Lane, Kidlington, Oxford<br>- Arie R., 1997. Fundamentals of polymer engineering. Technion-Israel Institute of Technology, Plenum Press, New York.<br>- Brydson J.A., 1999. Plastics Material. Seventh edition. A division of Reed Educational and Professional Publishing Ltd, Oxford.<br>- Herman F.M., 2004. Encyclopedia of Polymer Science & Technology, John Wiley & Sons<br>- Manas Ch., Roy S.K., 2007. Plastics Technology Handbook, 4th. Manas Chanda and Salil K. Roy. CRC Press.<br>- Rosato D.R., 2000. Injection molding handbook. Kluwer Academic - Publishers. USA.<br>- Rosato D., 1997. Plastics Processing Data Handbook. 2nd ed. USA |
| Supplementary literature | - Gebhardt A., 2003. Rapid Prototyping. Carl Hanser Verlag, Munich.<br>- Gunter E., 2006. Designing With Plastics. Carl Hanser Verlag, Munich.<br>- Rao N., O'Brien K., 1998. Design Data for Plastics Engineers. Carl Hanser Verlag, Munich.<br>- Gunter E., 2006. Designing With Plastics. Carl Hanser Verlag, Munich.<br>- Herman F. M.,2004, Encyclopedia of Polymer Science & Technology, John Wiley & Sons. |

## 8. TOTAL STUDENT WORKLOAD REQUIRED TO ACHIEVE EXPECTED LEARNING OUTCOMES EXPRESSED IN TIME AND ECTS CREDITS

| Student's activity | | Student workload– number of hours |
|---|---|---|
| Classes conducted under a direct supervision of an academic teacher or other | Participation in classes indicated in point 1B | 75 |
| | Supervision hours | 10 |

| | | |
|---|---|---|
| persons responsible for classes | | |
| Student's own work | Preparation for classes | 10 |
| | Reading assignments | 30 |
| | Other (preparation for exams, tests, carrying out a project etc) | 20 |
| Total student workload | | 145 |
| | Number of ECTS points | 5 |