

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	UVOD V PREDELAVO POLIMERNIH MATERIALOV IN ORODJA
Course title:	INTRODUCTION OF PLASTIC PROCESSING TECHNOLOGIES AND MOULDS

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Tehnologija polimerov, 1. stopnja		1	1.,2.
Polymer Technology, 1 st level		1 st	1 st , 2 nd

Vrsta predmeta / Course type

Temeljni /Compulsory

Univerzitetna koda predmeta / University course code:

UPPMO

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individ. work	ECTS
60		30 SV, 60 LV			150	10

Nosilec predmeta / Lecturer:

viš. pred. Andrej Glojek / Sen. Lect. Andrej Glojek

Jeziki /

Predavanja/Lectures:

Slovenski / Slovenian

Languages:

Vaje/Tutorial:

Slovenski / Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Znanje matematike, fizike in kemije na srednješolskem tehničnem nivoju.

Prerequisites:

Knowledge of Mathematics, Physics and Chemistry on the college level.

Vsebina:

V okviru predmeta študenti spoznajo ključne in posebne tehnologije predelave polimernih materialov ter pomembnost usklajenega delovanja sklopa material, tehnologije, stroj, orodje, pomožne naprave in procesni parametri. Dobijo pregled nad delovanjem vsakega posameznega elementa (sklopa) v procesu, kakor tudi pregled nad delovanjem sistema kot celote:

- Ključne tehnologije predelave polimernih materialov, ter njihova sistematizacija, ki je pomemben dejavnik pri razumevanju pojmov predelave polimerov.

Content (Syllabus outline):

Students get the knowledge about key plastic processing technologies and special processing technologies and get the possibility to link material – machine – mould – technology issues in the PPP.

- Knowledge about the plastic processing process and their systematization.
- Production process of the mould, with the focus on the injection moulding technologies, they get the knowledge about mould materials, heat treatment, etc.)

- Delovanje orodij, kot centralnih elementov procesa predelave plastičnih materialov, s poudarkom na orodjih za brizganje plastike: sestavni deli orodij, njihove specifikacije in vloga v konstrukciji. Orodni materiali ter pomen toplotnih obdelav posameznih delov orodja: poznati orodne materiale, njihovo strukturo in »obnašanje« glede na njihovo strukturo in toplotno obdelavo, površinske zaščite, pomen strukture površin.
- Prototipna orodja in prototipne tehnologije.
- Vloga senzorsko aktuatorskih sistemov v orodjih.
- Delovanje strojev za predelavo plastike: delovanje stroja, njegova kinematika in funkcionalnost. Sistemi za krmiljenje stroja.
- Vzdrževanje strojev: najpomembnejši vzdrževalni ukrepi na strojih in sistemi za planiranje dela na strojih Sistemi vpenjanja orodij na stroje ter njihovo priključitev.
- Periferne naprave na strojih, kot so sušilci, temperirne naprave, mešalniki, dozatorji, centralni dozirni sistemi.
- Manipulatorji in roboti: delovanje in programiranje, potrebno okolje za delovanje teh naprav.
- Postopek tehnološke priprave na proizvodnjo (npr. brizganje): priprava materiala (skladiščenje, sušenje, mletje, transport, barvanje ...), priprava orodja (temperiranje ...), priprava stroja (določitev optimalnega stroja, nastavitve procesnih parametrov, določitev cikla, zapiralne sile ...)
- Vpliv parametrov na lastnost izdelka (materiale lastnosti, vnos napetosti, orientacijo ...)

- Prototype technologies and prototype moulds.
- Sensor-actuator systems in molds and their roles.
- Injection molding machine operation: the operation of the machine, its kinematics and functionality. Systems for control the machine.
- Maintenance of machines: major maintenance actions on machines and systems for process planning. Mould clamping systems and procedure.
- Machine production, assembly, and technology. They get the knowledge with the control unit of the machine, and basics about the maintenance. They get knowledge about the utilisation of the machine.
- Peripheral units in the PPP, like dryers, tempering devices, mixers, injection units, feeding units.
- Robots and manipulators.
- Procedure of technology preparation for production (eg. Injection moulding): preparation of materials (storage, drying, transportation, painting ...), mould preparation (tempering ...), machine preparation (determining the optimum process setting, determining the cycle time and clamp force ...)
- The impact of process parameters on a characteristic of the product (material properties, internal stresses, orientation ...)

Temeljni literatura in viri / Readings:

1. Osswald D. A., Understanding Polymer Processing, Hanser, 2010.
2. Michaeli W., Mohren P., Menges G., How to make injection moulds, Muenchen: Hanser Publications, 2001.
3. Navodnik J., Kopčič M., Plastik orodjar, 3. dopolnjena izdaja, 1998.
4. Drstvenšek I., Slojevite tehnologije, Maribor, Fakulteta za strojništvo, 2004.
5. Gastrow H., Der Spritzgiess - Werkzeugbau in 100 Beispielen, Muenchen: Hanser Publications, 1990.

Cilji in kompetence:

Predmetno specifični cilji in kompetence (znanje in razumevanje):

- Študenta seznaniti s ključnimi tehnologijami predelave polimerov, delovanjem orodij, strojev in perifernih naprav.
- Študent zna povezati znanja s področja orodjarstva in strojegradnje.
- Študenta usposobiti za branje potrebne dokumentacije.
- Študenta usposobiti za oskrbovanje sistemov.

Objectives and competences:

Subject-specific objectives and competences (knowledge and understanding):

- Student gets the knowledge about different production process of plastic materials
- Student is able to link different knowledge from tool and machine making
- Student is able to read the technical documentation
- Student is able to maintain systems

Predvideni študijski rezultati:

Znanje in razumevanje:

- Poznavanje ključnih tehnologij predelave plastike.
- Razumevanje delitve orodij za predelavo plastike, delovanja orodnih sklopov in sistemov,
- Poznavanje sestavnih delov orodij, orodnih materialov, sistemov montaž orodij, pogonov v orodju).
- Stroji (vrste strojev za predelavo plastike (hidravlični, mehanski, električni, hibridni), krmiljenje strojev, pogoni strojev),
- Določevanje in izbira optimalnega orodnega materiala
- Poznavanje perifernih enot strojev z namenom zagotavljanja nemotene proizvodnje, manipulatorjev, robotov, tekočih trakov, separatorjev, mlinov, zalagovnikov).

Intended learning outcomes:

Knowledge and understanding:

- Key plastic processing processes (PPP)
- Moulds (mould types, mould assemblies, standard parts, mould materials, runners in the mould).
- Moulds components, mould materials, clamping process, molds slides
- Machines (type of the machines, control units, machine power).
- Mould materials determination
- Pheripheral units (manipulators, robots, conveyors, separators, mixers, etc.).

Metode poučevanja in učenja:

- predavanja
- demonstracija
- računalniške in video predstavitve
- praktikum
- seminarska naloga z obravnavo izbranega primera in MS Power Point predstavitev

Learning and teaching methods:

- lectures
- demonstration
- computer and video presentations
- practicum
- seminar work on the selected practical case and MS PowerPoint presentation

Pogoji za pristop k izpitu:

- 80% prisotnost na predavanjih
- 100% prisotnost na praktikumu
- poročilo o vajah
- seminarska naloga

Conditions for accession to the exam:

- 80% attendance at lectures
- 100% attendance at practicum
- report on laboratory work
- seminar

Načini ocenjevanja:

Delež (v %) /
Weight (in %)

Assessment:

Skupno oceno predmeta sestavljajo:		Final grade consists of:
- Seminarska naloga - Pisni izpit - Ustni izpit		- Seminar paper - written exam - Oral examination
- Seminarska naloga - Izpit	20 80	- Seminar - Exam

Reference nosilca / Lecturer's references:

- (1) Pedagoško delo
 - izvajanje predavanj in vaj na Visoki šoli za tehnologijo polimerov pri naslednjih predmetih: Načrtovanje tehnologij in orodij, Preizkušanje materialov in zagotavljanje kakovosti, Oblikovanje in konstruiranje izdelkov.
 - izvajanje predavanj in vaje na Fakulteti za strojništvo, Univerze v Ljubljani, izpostava Celje, leta 2007 - 2008
 - izvajanje predavanj in vaje na Višji gospodarski šoli, Mariborska cesta 2, Celje (Snovanje in konstruiranje orodij), od 2011
 - izvajanje predavanj na Višji strokovni šoli, Šolskega centra Velenje (Tehnološki procesi), od 2012
- (2) Strokovno delo:
 - izvajanje simulacij brizganja plastike (Moldflow)
 - izvajanje mehanskih preračunov s pomočjo metode končnih elementov (Abaqus, Ansys, I-deas)
 - razvoj in konstruiranje izdelkov za brizganje plastike in ekstrudiranje
 - razvoj in konstruiranje orodij za plastiko
 - sodelovanje na številnih nacionalnih in internacionalnih razvojno-raziskovalnih projektih na različnih področjih
 - pisanje RR-projektov
 - razvoj in konstruiranje izdelkov za masivno preoblikovanje, razvoju orodij za kovanje,
 - CNC-programiranjem
 - razvoj različnih naprav, strojev in izdelkov
 - upravljanje in optimiranje strojev za brizganje plastike
 - izvajanje seminarjev, vaj in predavanja o konstruiranju orodij za brizganje plastike
 - simulacijah brizganja plastike, tehnološki pripravi na brizganje, plastičnih materialih ...

(3) Raziskovalno delo

– sodelovanje pri številnih domačih (SMART MOULD, IPDS, MI NANOTECH, OPTIMIZED COMPOUNDS, Advanced PartSim , ...), bilateralnih (Slovenia – China cooperation in Science and Technology – FEM based optimization of process parameters and product design for sheet metal products by using the advanced forming technologies in small volume product enterprise, Slovenia – Macedonia cooperation in Science and Technology – Support of reverse engineering in the development of moulds for injection moulding and tools for sheet metal forming, Scientific and research cooperation between the Republic of Slovenia and Bosnia and Herzegovina – Using Finite Element Method to process 3D digitised data about thin-walled products) in mednarodnih projektih (AppliCMA, ProTuBend, DePSME-VE.Net, PolyRegion, DIBBIOPACK, ProTuBend, I-WEG, iMOULD, ...), vključno s 6. operativnim programom (Tool-East, Pro4Plast, Flexform, MagForge, EMOLD), 7. operativnim programom ... (ENER-Plast, AppliCMA, TIPSS) in Eureko (INTELLCON, SURFACE +, IPDS).

(4) Pomembnejša dela:

– GANTAR, Gašper, GLOJEK, Andrej, MORI, Mitja, NARDIN, Blaž, SEKAVČNIK, Mihael. Resource efficient injection moulding with low environmental impacts. Strojniški vestnik, 2013, vol. 59, no. 3, str. 193-200.

– HANČIČ, Aleš, KUZMAN, Karl, KOSEL, Franc, GLOJEK, Andrej, CUNHA, A.M., GANTAR, Gašper. Mechanical and processing characterisation of effective behaviour of wood-plastic composites by analytical and numerical simulation. Materials science forum, 2008, letn. 575/578, str. 959-971.

– NARDIN, Blaž, ŽAGAR, Boštjan, GLOJEK, Andrej, KRIŽAJ, Dejan. Adaptive system for electrically driven thermoregulation of moulds for injection moulding. Journal of materials processing technology, 2007, vol. 187-188, str. 690-693.

– ŽAGAR, Boštjan, NARDIN, Blaž, GLOJEK, Andrej, KRIŽAJ, Dejan. Prilagodljivi sistem za hlajenje orodij za brizganje plastike s pomočjo termoelektričnih modulov = An adaptive system for cooling injection-moulding moulds via thermoelectric modules. Strojniški vestnik, 2006, letn. 52, št. 10, str. 630-644.

Lecturer's references:

(1) Teaching:

– lecturer of subjects at Polymer Technology College (Introduction of plastic processing technologies and moulds, Testing and characterization of polymer materials and quality assurance, Basics of numerical simulations)

– lecturer of subjects at Faculty of Mechanical Engineering, University of Ljubljana, dislocation Celje, 2007-2008

– lecturer of subjects at College of Industrial Engineering, Celje (Tools design and construction)

– lecturer of subjects at Higher Vocational College of Celje (Technological processes) since 2012

(2) Professional:

– Simulations of injection molding (Moldflow)

– Calculations using the finite element method (Abaqus, Ansys, I-DEAS)

- construction of products for injection molding and extrusion
- Development and design of tools for plastics
- Participation in numerous national and international research and development projects in various fields
- Writing R & D projects
- CNC programming
- Optimization of injection molding machines
- Implementation of seminars, tutorials and lectures on design of injection molding tools
- Simulation of injection molding

(3) Research work:

- National projects (SMART MOULD, IPDS, MI NANOTECH, OPTIMIZED COMPOUNDS, Advanced PartSim , ...)
- Bilateral projects (Slovenia – China cooperation in Science and Technology – FEM based optimization of process parameters and product design for sheet metal products by using the advanced forming technologies in small volume product enterprise, Slovenia – Macedonia cooperation in Science and Technology – Support of reverse engineering in the development of moulds for injection moulding and tools for sheet metal forming, Scientific and research cooperation between the Republic of Slovenia and Bosnia and Herzegovina – Using Finite Element Method to process 3D digitised data about thin-walled products)
- International projects (AppliCMA, ProTuBend, DePSME-VE.Net, PolyRegion, DIBBIOPACK, ProTuBend, I-WEG, iMOULD, ...),
- 6th Framework programme (Tool-East, Pro4Plast, Flexform, MagForge, EMOLD),
- 7th Framework programme (ENER-Plast, AppliCMA, TIPSS)
- Eureka (INTELLCON, SURFACE +, IPDS)

(4) Selected publications:

- GANTAR, Gašper, GLOJEK, Andrej, MORI, Mitja, NARDIN, Blaž, SEKAVČNIK, Mihael. Resource efficient injection moulding with low environmental impacts. Strojniški vestnik, 2013, vol. 59, no. 3, str. 193-200.
- HANČIČ, Aleš, KUZMAN, Karl, KOSEL, Franc, GLOJEK, Andrej, CUNHA, A.M., GANTAR, Gašper. Mechanical and processing characterisation of effective behaviour of wood-plastic composites by analytical and numerical simulation. Materials science forum, 2008, letn. 575/578, str. 959-971.
- NARDIN, Blaž, ŽAGAR, Boštjan, GLOJEK, Andrej, KRIŽAJ, Dejan. Adaptive system for electrically driven thermoregulation of moulds for injection moulding. Journal of materials processing technology, 2007, vol. 187-188, str. 690-693.
- ŽAGAR, Boštjan, NARDIN, Blaž, GLOJEK, Andrej, KRIŽAJ, Dejan. Prilagodljivi sistem za hlajenje orodij za brizganje plastike s pomočjo termoelektričnih modulov = An adaptive system for cooling injection-moulding moulds via thermoelectric modules. Strojniški vestnik, 2006, letn. 52, št. 10, str. 630-644.