UČNI NAČRT PREDMETA/COURSE SYLLABUS	
Predmet	Inovativne obdelovalne tehnologije
Course title	Innovative Machining Technologies

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Tehnologije in sistemi v strojništvu/ 2. stopnja	Ni smeri študija	2. letnik	3.
Technologies and systems in mechanical engineering/ 2nd Cycle	No study field	2nd year	3rd

Vrsta predmeta/Course type	Modularni/module

Univerzitetna koda predmeta/University course code	**TSS M1 UN 2**

Predavanja **Lectures**	**Seminar** **Seminar**	**Sem. vaje** **Tutorial**	**Lab. vaje** **Laboratory work**	**Teren. vaje** **Field work**	**Samost. delo** **Individ. work**	**ECTS**
30			30		120	6

Nosilec predmeta/Lecturer:	prof. dr. Mirko Soković

Jeziki/ **Languages:**	**Predavanja/Lectures:** **Vaje/Tutorial:**	slovenski/Slovenian slovenski/Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
• Vpis v drugi letnik študijskega programa. • Študent mora pred izpitom pripraviti in predstaviti ter zagovarjati projektno seminarsko nalogo.	• A prerequisite for inclusion is enrolment in the second year of study. • Student has to prepare, present and defend a project seminar before the exam.

Vsebina:	**Content (Syllabus outline):**
• *Uvod* Razvrstitev postopkov odrezovanja kovin. Kinematika postopkov odrezovanja in rezalni parametri. Geometrija rezalnih orodij. Trendi v teoriji in praksi odrezovanja kovin. Prihodnost proizvodnje.	• *Introduction* Classification of metal cutting processes. Kinematics of cutting process and cutting parameters. Geometry of cutting tools. Trends in metal cutting theory and practice. The future of manufacturing.

• *Mehanika rezanja* Rezalne sile pri ortogonalnem rezanju. Rezalne sile pri poševnem rezanju. Energija pri rezanju. Napetost v rezalni coni. • *Mehanizem rezanja* Model nastajanja odrezka. Vplivi na proces nastajanja odrezka. Osnovne vrste odrezkov. Pojav nalepka (sprimka). • *Toplotne razmere pri rezanju* Toplotna energija pri rezanju. Izvori in distribucija toplote v rezalni coni. Karakteristične temperature pri rezanju. Sredstva za hlajenje in mazanje (SHM). Načini dovajanja SHM. Vpliv hladilnih tekočin na proizvodno okolje. Kriogeno hlajenje. • *Obraba orodja* Mehanizmi obrabe. Oblike obrabe. Določanje obrabe in obstojnosti orodja. • *Kakovost obdelane površine* Topografija površine. Kinematična hrapavost. Dosegljive hrapavosti obdelane površine v praksi. Meritve hrapavosti površine. Lastnosti podpovršinske plasti. • *Obdelovalnost materiala* Koncept obdelovalnosti. Ocena obdelovalnosti. Raziskave obdelovalnosti inženirskih materialov. • *Ekonomski vidiki procesov rezanja* Ekonomika obdelave. Optimizacija parametrov rezanja. Postopek na osnovi enačbe obstojnosti orodja. Postopek na osnovi kriterija energetske učinkovitosti. • *Rezalni materiali in orodja* Razdelitev rezalnih materialov. Trde zaščitne prevleke na orodjih. Orodja za konvencionalne postopke obdelave.	• *Cutting mechanics* Cutting forces in orthogonal cutting. Cutting forces in oblique cutting. Cutting energy. Stresses in the shear zone. • *Cutting mechanism* Chip formation model. Influences on the chip formation process. Basic chip types. Appearance of a BUE. • *Heat in metal cutting* Heat in metal cutting. Heat generation and distribution in the cutting zone. Characteristic cutting temperatures. Coolants and lubricants (CFs). Different methods of cooling. Impact of coolants on manufacturing environment. Cryogenic cooling. • *Tool wear* Tool wear mechanisms. Types of tool wear. Determination of tool wear and tool life. • *Quality of the machined surface* Surface topography. Kinematic roughness. Achievable surface roughness in practice. Surface roughness measurement. Properties of subsurface layer. • *Machinability of materials* The machinability concept. Machinability rating. Survey of machinability of engineering materials. • *Economic aspects of cutting processes* Machining economics. Optimization of cutting parameters. Procedure based on tool-life equation Procedure based on energy efficiency criterion. • *Cutting tool materials and tools* Classification of cutting tool materials. Hard protective catting tool coatings. Utting tools for conventional machining processes.

• *Napredni obdelovalni postopki* Obdelava z velikimi hitrostmi. Obdelava brez hlajenja ali z minimalnim hlajenjem. Obdelava trdih obdelovancev. Visoko zmogljiva in visoko učinkovita obdelava. Večopravilna obdelava in obdelava z enim prehodom. Ultrazvočno in termično podprti hibridni obdelovalni postopki.	• *Advanced machining processes* High-speed machining (HSM). Dry and semi-dry machining (MQL). Hard part machining (HM). High-performance and high-efficiency machining. Multitasking and one-pass machining. Ultrasonically and thermally assisted hybrid machining processes.

Temeljna literatura in viri/Readings:

- KOPAČ, Janez. *Odrezavanje – Teoretične osnove in tehnološki napotki*. Ljubljana: Fakulteta za strojništvo, 2008. ISBN 978-961-245-583-5
- de VOS, Patrick in Jan-Eric STAHL. *Uporabna fizika odrezavanja kovin: dobre prakse.* PROFIDTP, 2017.
- de VOS, Patrick in Jan-Eric STAHL. *Odrezavanje kovin: teorija v praksi.* PROFIDTP, 2019.

Priporočljiva literatura/Recommended literature

- GRZESIK, Wit. *Advanced Machining Processes of Metalic Materials –Theory, Modelling, and Applications*, Second Edition, Amsterdam: Elsevier, 2017. ISBN: 978-0-444-63711-6.
- KLOCKE, Fritz. *Manufacturing Processes 1 – Cutting.* Berlin: Springer-Verlag, 2011. ISBN 978-3- 642-11978-1
- de VOS, Patrick in Jan-Eric STAHL. *Applied Metal Cutting Physics – Best Practice.* Fagersta, Sweden: Seco Tools AB, 2016.
- de VOS, Patrick in Jan-Eric STAHL. *Metal Cutting – Theories in Practice.* Fagersta, Sweden: Seco Tools AB, 2014.

Cilji in kompetence:	**Objectives and competences:**
Učna enota prispeva predvsem k razvoju naslednjih splošnih in specifičnih kompetenc: • sposobnost samostojnega in ustvarjalnega raziskovalno-razvojnega dela na področju strojništva, • sposobnost razumevanja, samostojne analize, sinteze in uporabe teoretičnih in aplikativnih znanj o inovativnih obdelovalnih tehnologijah, • sposobnost aktivnega reševanja problemov na področju inovativnih obdelovalnih tehnologij v konkretnem delovnem okolju,	*The learning unit mainly contributes to the development of the following general and specific competences:* • ability of independent and creative R&D work in the field of mechanical engineering, • ability to understand, independently analyse, synthesize and apply theoretical and applied knowledge about innovative machining technologies, • ability to actively solve problems in the field of innovative processing technologies in a specific work environment,

• seznanitev s sodobnimi razvojno-raziskovalnimi metodami in procesi za učinkovito uveljavljanje inovativnih tehnologij v strojništvu, • sposobnost ovrednotenja obdelovalnih tehnologij s stališča ekonomskih vidikov posameznih procesov obdelave, • sposobnost prenosa teoretičnega znanja iz področja inovativnih obdelovalnih tehnologij v proizvodne organizacije, • sposobnost timskega dela s strokovnjaki z različnih področij v proizvodni organizaciji, • sposobnost učinkovite uporabe informacijsko-komunikacijske tehnologije, • sposobnost organiziranja, vodenja in nadzora tehnoloških procesov v smislu poklicne in okoljske odgovornosti.	• acquaintance with modern R&D methods and processes for the effective implementation of innovative technologies in mechanical engineering, • ability to evaluate machining technologies from the point of view of economic aspects of individual machining processes, • ability to transfer theoretical knowledge from the field of innovative processing technologies to production organizations, • ability to work in teams with experts from various fields in the production organization, • ability to effectively use information and communication technology, • ability to organize, manage and control technological processes in terms of professional and environmental responsibility.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent/študentka:	***Students:***
• pozna osnovne pojme povezane s proizvodnjo in nastajanjem izdelka, • spozna sodobne trende na področju inovativnih obdelovalnih tehnologij v strojništvu, • razume napredne postopke obdelave, ki so vse bolj prisotni v sodobni industrijski proizvodnji, • zna predstaviti teoretične osnove in strokovni pristop za posamezne primere novih naprednih obdelovalnih tehnologij in sistemov, • obvlada ustrezne metode in tehnike za učinkovito uvajanje in uporabo različnih inovativnih obdelovalnih tehnologij v industrijsko okolje. • zna ekonomsko ovrednotiti posamezne obdelovalne tehnologije in jih primerjati med seboj, • se usposobi za kritično presojo in analizo stanja na področju obdelovalnih in	• knows the basic concepts related to the production and creation of the product, • learns about modern trends in the field of innovative machining technologies in mechanical engineering, • understands the advanced machining processes that are increasingly present in modern industrial production, • is able to present the theoretical foundations and professional approach for individual cases of new advanced processing technologies and systems, • masters appropriate methods and techniques for efficient introduction and use of various innovative processing technologies in the industrial environment, • is able to economically evaluate individual processing technologies and compare them with each other, • is trained to critically assess and analyze the situation in the field of processing

izdelovalnih tehnologij in sistemov v konkretnem proizvodnem okolju.	and manufacturing technologies and systems in a specific production environment.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov), • *avditorne vaje:* reševanje problemov, študije primerov, kritično presojanje, diskusija, refleksija izkušenj, vrednotenje, projektno delo, timsko delo, • *laboratorijske vaje:* laboratorijske vaje ter ogledi proizvodnih tehnologij v uspešnih podjetij v JV regiji, • *seminar:* priprava, predstavitev in uspešen zagovor projektne/raziskovalne naloge, (reševanje problemov, študije primera, kritično presojanje, diskusija, refleksija izkušenj, vrednotenje, projektno delo, timsko delo).	• *lectures* with active student participation (explanation, discussion, questions, examples, problem solving), • *tutorial:* problem solving, case studies, methods of critical thinking, discussion, reflection of experience, evaluation, project work, team work, • *laboratory work:* laboratory exercises and visits to production technologies in successful companies in the SE region, • *seminar tutorial:* presentation and defence of project/research work (problem solving, studies, critical thinking, discussion, reflection of experience, evaluation, project work, team work).

	Delež (v %) Weight (in %)	**Assessment:**
Načini: • pisni izpit • ustni izpit • projektno seminarsko delo Ocenjevalna lestvica: ECTS.	 40 % 40 % 20 %	Types: • written exam • oral examination • project seminar Grading scheme: ECTS.