

TEHNIČNO RISANJE IN RAČUNALNIŠKO MODELIRANJE GEOMETRIJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Tehnično risanje in računalniško modeliranje geometrije
Course title:	Technical drawing and computer aided modelling of geometry
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - razvojno raziskovalni program, prva stopnja, univerzitetni	Ni členitve (študijski program)	1. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:

0577579

Koda učne enote na članici/UL Member course code:

2005-U

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45		30			50	5

Nosilec

predmeta/Lecturer:

Jovan Trajkovski, Nikola Vukašinović, Robert Kunc

Izvajalci predavanj:

Izvajalci seminarjev:

Izvajalci vaj:

Izvajalci kliničnih vaj:

Izvajalci drugih oblik:

Izvajalci praktičnega usposabljanja:

Vrsta predmeta/Course type:

Obvezni splošni predmet /Compulsory general course

Jeziki/Languages:

Predavanja/Lectures:

Slovenščina

Vaje/Tutorial:

Slovenščina

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

1. Predznanje srednješolske in osnovnošolske matematike
2. Ravninska opisna geometrija
3. Osnovno poznavanje postopkov obdelave materialov
4. Poznavanje dela z računalnikom
5. Osnove izdelovalnih tehnologij

1. Prior knowledge of secondary and primary mathematics.
2. Plane (2D) descriptive geometry.
3. Basic knowledge of material treatment processes.
4. Basic computer skills.
5. Basic knowledge about manufacturing technologies.

Vsebina:**Content (Syllabus outline):**

1. Predavanje: Osnove ročne in računalniške izdelave tehnične dokumentacije
 - Temeljna načela ISO
 - Načini prikazovanja, modeli, vrste risb
 - Standardi ISO za TD in GPS
2. Predavanje: Prikazovanje predmetov na tehničnih risbah
 - Vrste projekcij na TR po ISO standardih
 - Tehnično skiciranje in računalniško risanje
 - Večpogledne projekcije po ISO in ASME in aksonometrične projekcije
3. Predavanje: Prikazovanje predmetov na delavniških in sestavnih/glavnih risbah in kotiranje
 - Pogledi, prerezi ter posebnosti
 - Elementi in oprema delavniških risb
 - Elementi in oprema sestavnih/glavnih risb
 - Kotiranje - 1
4. Predavanje: Kotiranje in osnove toleriranja in ujemov

1. Lecture: Basics of manual and computer-aided design of technical documentation
 - Basic principles of ISO.
 - Methods of presentation, models, types of drawings.
 - ISO standards for TD and GPS.
2. Lecture: Presenting objects in technical drawings
 - Types of projections in technical drawings according to ISO standards.
 - Technical sketching and computer-aided drawing.
 - Multiview projections in accordance with ISO and ASME and axonometric projections.
3. Lecture: Presenting objects in workshop and assembly/main drawings and dimensioning
 - Projections, sections and specificities.
 - Elements and symbolic description of workshop drawings.
 - Elements and symbolic description of assembly/main drawings.
 - Dimensioning - 1

<ul style="list-style-type: none"> • Kotiranje - 2 • Posebni pogledi • Posnetja in stanja robov • Tolerance dolžinskih mer in kotov (splošne in posebne) <p>5. Predavanje: Risanje standardiziranih oblik in elementov</p> <ul style="list-style-type: none"> • Navoji in vijačne zveze • Osi in gredi • Gredne zveze • Ležaji in tesnila <p>6. Predavanje: ISO tolerance in ujemi ter Geometrijske tolerance (GT)</p> <ul style="list-style-type: none"> • ISO tolerance in ujemi • Načela in elementi geometrijskega toleriranja • Vrste geometrijskih toleranc (GT) • Podajanje geometrijskih toleranc na risbah <p>7. Predavanje: Označevanje kakovosti površin ter risanje varjencev</p> <ul style="list-style-type: none"> • Označevanje kakovosti površin • Usklajevanje hrapavosti površin s tolerancami • Obdelovalni postopki in stopnje hrapavosti • Značilnosti risb varjencev, prikaz varjencev, risanje in označevanje zvarov <p>8. Predavanje: Risanje ulitkov in odkovkov ter osnove pravil tehnične dokumentacije na 3D geometrijskih modelih (MBD načela)</p> <ul style="list-style-type: none"> • Značilnosti delavniških risb ulitkov in odkovkov • Simbolika zahtev TR na 3D in 2D geometrijskih modelih ter risbah • Posebnosti • Prednosti in slabosti <p>9. Predavanje: Opredelitev 3D modeliranja in skiciranje v modelirnikih</p> <ul style="list-style-type: none"> • Osnove računalniške grafike, • Opredelitev 3D prostora v CAD, • Koordinatni sistemi, • Osnove 3D geometrije, • Pozicioniranje skic v prostor • Uporaba topoloških elementov za 	<p>4. Lecture: Dimensioning and basics of tolerancing and fits</p> <ul style="list-style-type: none"> • Dimensioning - 2 • Special projections. • Chamfers and states of edges. • Tolerances for linear and angular dimensions (general and special). <p>5. Lecture: Drawing standardised forms and elements</p> <ul style="list-style-type: none"> • Threads and bolt connections. • Axes and shafts. • Shaft connections. • Bearings and seals. <p>6. Lecture: ISO tolerances and fits and geometrical tolerances (GT)</p> <ul style="list-style-type: none"> • ISO tolerances and fits. • Principles and elements of geometrical tolerancing. • Types of geometrical tolerances (GT). • Adding geometrical tolerances to drawings. <p>7. Lecture: Marking surface quality and drawing welded workpieces</p> <ul style="list-style-type: none"> • Marking surface quality. • Coordination of surface roughness and tolerances. • Machining processes and levels of roughness. • Characteristics of welded workpiece drawings, presenting welded workpieces, drawing and marking welds. <p>8. Lecture: Drawing of casted and forged workpieces and basic rules of technical documentation on 3D geometrical models (MBD principles)</p> <ul style="list-style-type: none"> • Characteristics of workshop drawings of castings and forgings. • Symbols of technical drawing requirements on 3D and 2D geometrical models and in drawings. • Specificities. • Advantages and deficiencies. <p>9. Lecture: Definition of 3D modelling and sketching in CAD modellers</p> <ul style="list-style-type: none"> • Basics of computer graphics,
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<p>izdelavo osnovnih parametrov geometrije</p> <ul style="list-style-type: none"> • Relacije med različnimi elementi skic – topološkimi gradniki. <p>10. Predavanje: Osnove modeliranja s trdnimi modeli in z značilkami</p> <ul style="list-style-type: none"> • Različni pristopi k modeliranju in uvod v trdne modele, • Razvoj modeliranja in modelirnikov, • Lastnosti trdnih modelov • Delo s trdnimi modeli • Kaj so to značilke, primer uporabe, • Osnovne značilke <p>11. Predavanje: Modeliranje z izpeljanimi značilkami</p> <ul style="list-style-type: none"> • Različne stopnje kompleksnosti pri modeliranju z značilkami, • Zaokrožitve • Posnetja • Zrcaljenje • Vzorčenje • Izvotlitev • Rebra <p>12. Predavanje: Delo s krivuljami in površinami</p> <ul style="list-style-type: none"> • Osnovni geometrijski gradniki (točka, daljica, površina,...), • Zahtevane lastnosti krivulj in fizikalna ozadja zapisov krivulj • Prehod iz krivulj v površine • Izdelava površinskih modelov • Sestavljanje površin • Zveznosti med površinami • Tvorjenje trdnih modelov iz površin • Kombiniranje trdnih in površinskih modelov. <p>13. Predavanje: Modeliranje sestavov</p> <ul style="list-style-type: none"> • Medsebojni vpliv značilk in izdelka, • Struktura izdelka in nivoji konstruiranja, • Tehnika modeliranja sestavov od spodaj navzgor, • Tehnika modeliranja sestavov od zgoraj navzdol. <p>14. Predavanje: Tvorjenje tehnične dokumentacije iz 3D modelov</p> <ul style="list-style-type: none"> • Kako tvorimo dokumentacijo 	<ul style="list-style-type: none"> • Definition of 3D space in CAD, • Coordinate systems, • Basics of 3D geometry, • Positioning sketches in space, • Use of topological elements for definition of basic geometry parameters, • Relations between different elements of a sketch – topological building blocks. <p>10. Lecture: Basics of solid and feature modelling</p> <ul style="list-style-type: none"> • Different approaches to modelling and introduction into solid models, • Evolution of modelling and modellers, • Characteristics of solid models, • Dealing with solid models, • What are features, examples of use, • Basic (sketched) features. <p>11. Lecture: Modelling with applied features</p> <ul style="list-style-type: none"> • Different levels of complexity in feature modelling, • Fillets, • Chamfers, • Mirroring, • Patterns, • Shelling, • Ribs. <p>12. Lecture: Dealing with curves and surfaces</p> <ul style="list-style-type: none"> • Basic geometrical building blocks (point, line segment, surface, etc.). • Required characteristics of curves and physical background of curve annotations, • Transition from curves to surfaces, • Designing surface models, • Combining of surfaces, • Continuities between surfaces, • Designing solid models from surfaces, • Combining solid and surface models, <p>13. Lecture: Modelling of assemblies</p> <ul style="list-style-type: none"> • Interaction between features and a product, • Structure of a product and levels of
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<ul style="list-style-type: none"> • Določanje geometrijskih in dimenzijskih toleranc na modelu in načrtu • Določanje dodatnih konstrukcijskih pravil na 3D modelu in v dokumentaciji <p>15. Predavanje: Definiranje na osnovi 3D modela – Model Based Definition</p> <ul style="list-style-type: none"> • Izdelava dokumentacije neposredno na 3D modelu, • Načini prikazov in izvozov pri MBD, • Prehod iz MBD na papir, <p>Priprava in uporaba MBD za proizvodnjo.</p>	<p>design,</p> <ul style="list-style-type: none"> • Assembly modelling: bottom-up approach, • Assembly modelling: Top-down approach. <p>14. Lecture: Creation of technical drawings and documentation from 3D models</p> <ul style="list-style-type: none"> • How to create documentation, • Determination of geometrical and dimensional tolerances on a model and on a drawing. • Annotation of additional design specifications on a 3D model and in documentation. <p>15. Lecture: Model Based Definition (MBD)</p> <ul style="list-style-type: none"> • Design of documentation on a 3D model, • Different visualisation and exportation methods of information from MBD. • Transition from MBD to a sheet of paper. • Preparation and use of MBD for production purposes.
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Temeljna literatura in viri/Readings:

Osnovna:

1. PREBIL, Ivan, KUNC, Robert. Opisna geometrija : potrebna znanja za pravilno risanje - osnove tehničnega risanja. 4. izd. Piran: STRI svetovanje, 2011, [COBISS.SI-ID [258074368](#)]
2. PREBIL, Ivan, ZUPAN, Samo. Tehnična dokumentacija. izd. Ljubljana: Stri svetovanje, 2011, [COBISS.SI-ID [259015680](#)]
3. KRAUT, Bojan, Krautov strojniški priročnik, 17. slovenska popravljena izd., predelana, 1. Natis; Ljubljana: Univerza v Ljubljani, Fakulteta za strojništvo, 2019, [COBISS.SI-ID [302515200](#)]
4. DUHOVNIK, Jože, DEMŠAR, Ivan, DREŠAR, Primož. Space modeling with SolidWorks and NX. Cham [etc.]: Springer, cop. 2015. XIV, 490 str., ilustr. ISBN 978-3-319-03861-2. ISBN 978-3-319-03862-9, doi: 10.1007/978-3-319-03862-9. [COBISS.SI-ID [13418011](#)]
5. DUHOVNIK, Jože, DEMŠAR, Ivan, DREŠAR, Primož. Modeliranje z značilkami na osnovi SolidWorks. Prenovljena izd. Ljubljana: Fakulteta za strojništvo, 2017. VI, 274 str., ilustr. ISBN 978-961-6980-28-9. [COBISS.SI-ID [288756992](#)]

Dodatna:

1. GLODEŽ, Srečko. Tehnično risanje. Ljubljana: Tehniška založba Slovenije, 2010, [COBISS.SI-ID [250885632](#)]

Cilji in kompetence:

Cilji:

1. Pridobiti teoretično in praktično znanje s področja računalniškega tehničnega risanja in 3D modeliranja
2. Spoznati uporabo specializiranih programskih orodij za tehnično risanje in 3D modeliranje
3. Spoznati ključne veljavne standarde s področja tehnične dokumentacije
4. Razumeti modeliranje in tehnično risanje kot delovni proces za zagotavljanje želenih funkcij izdelka pri konstruiranju izdelkov.
5. Spoznati povezavo med procesom konstruiranja, procesom 3D modeliranja, tehničnega risanja in tehnološkimi procesi izdelave izdelka.
6. Spoznati in znati samostojno uporabljati razpoložljive tehnologije, algoritme in naprave, ki omogočajo predstavitev izdelkov v prostoru.
7. Pridobiti popolno poznavanje vsaj enega modelirnika z njegovimi karakteristikami.

Kompetence:

1. S1-RRP + P1-RRP: Sposobnost opredelitve in razumevanja izzivov z uporabo temeljnih teoretičnih znanj s področja strojništva.
2. S4-RRP: Sposobnost strokovnega sporazumevanja in pisnega izražanja.
3. S5-RRP: Sposobnost uporabe informacijsko-komunikacijske tehnologije.
4. S5-RRP + P2-RRP: Obvladovanja virtualnega 3D prostora, kot delovnega okolja sodobnih inženirskih znanosti.
5. S6-RRP + P6-RRP: Razumevanje in kompetence za sistemsko obravnavo izdelkov, opredeljevanje posameznih funkcij in njihovo integrirano

Objectives and competences:

Objectives:

1. Gaining theoretical and practical knowledge of computer-aided technical drawing and 3D modelling.
2. Learning to use specialised software tools for technical drawing and 3D modelling.
3. Understanding key applicable standards in the field of technical documentation.
4. Understanding modelling and technical drawing as the work process in product design procedure used to ensure desired functions of a product.
5. Learning the relations between design process, 3D modelling, technical drawing and technological processes of product creation.
6. Learning and being able to independently use available technologies, algorithms and devices, which enable representation of products in space.
7. Gaining full competences for using at least one 3D CAD modeler.

Competences:

1. S1-RRP + P1-RRP: The ability to identify and understand the challenges of using fundamental theoretical knowledge in the field of mechanical engineering.
2. S4-RRP: Good professional communication and writing skills.
3. S5-RRP: The ability to use the information and communications technology.
4. S5-RRP + P2-RRP: The ability to work in virtual 3D space as a working environment of modern engineering sciences.
5. S6-RRP + P6-RRP: Understanding

<p>obdelavo v sistemih, kar je pogoj za pristop h konstruiranju.</p> <p>6. S1-RRP + P4-RRP: Uporaba obstoječih algoritmov za predstavitev geometrijskih gradnikov in združevanje v gradnike višjega reda. Uporaba algoritmov za geometrijske transformacije v 3D prostoru.</p> <p>7. S5-RRP + P2-RRP: Uporaba najmanj enega modelirnika ter razumevanje delovanja večine sodobnih modelirnikov z minimalno potrebno priučitvijo za njihovo rutinsko uporabo.</p>	<p>and competences for systematic handling of products, characterisation of individual functions and their integration into systems as a condition for successful modelling and design process.</p> <p>6. S1-RRP + P4-RRP: Application of existings algoritms for representation of geometrical building blocks and their merging into the blocks of higher complexity level. Application of geometric transformations in 3D space.</p> <p>7. S5-RRP + P2-RRP: Use of at least one 3D modeller and principle understanding of most of modern modeller with minimal required training for their routine use.</p>
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Predvideni študijski rezultati:

<p>Znanja:</p> <p>Z1: Poglobljeno strokovno teoretično in praktično znanje na področju tehničnega risanja in računalniškega modeliranja geometrije, podprto s širšo teoretično in metodološko osnovo:</p> <p>Spretnosti:</p> <p>S1.1 Izvajanje kompleksnih operativno-strokovnih opravil, ki vključujejo tudi uporabo metodoloških orodij:</p> <ul style="list-style-type: none"> • Branje tehničnih risb in razumevanje prostorskih oblik na osnovi 2D risb. • Izdelava tehničnih rib na osnovi prostorskih modelov. • Uporaba veljavnih standardov pri opremljanju tehničnih risb <p>S1.2 Obvladovanje zahtevnih, kompleksnih delovnih procesov ob samostojni uporabi znanja v novih delovnih situacijah:</p> <ul style="list-style-type: none"> • Izdelava geometrijskih 3D modelov • razumevanje in uporabo 3D modeliranja za potrebe reševanja osnovnih inženirskih konstrukcijskih problemov. • Razvoj veščin, potrebnih za sistemski pristop k razvoju izdelkov in/ali

Intended learning outcomes:

<p>Knowledge:</p> <p>Z1: In-depth professional theoretical and practical knowledge in the field of technical drawing and computer-aided geometric modelling, supported by a wide theoretical and methodological basis.</p> <p>Skills:</p> <p>S1.1 Performance of complex operational and specialist tasks, including the use of methodological tools:</p> <ul style="list-style-type: none"> • Reading technical drawings and understanding spatials forms based on 2D drawings. • Designing technical drawings based on 3D models. • Use of applicable standards in creating symbolic descriptions for technical drawings. <p>S1.2 Handling difficult, complex working priciples by independent application of knowledge in new working situations:</p> <ul style="list-style-type: none"> • Creation of geometric 3D modells • Understanding and use of 3D modelling for solving basic design engineering problems.
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projektiranju.	<ul style="list-style-type: none"> Development of skills which are necessary for systematic approach to development of products and planning.
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Metode poučevanja in učenja:

Learning and teaching methods:

<p>P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.</p> <p>P2 Obravnava snovi po urejeni in vnaprej razloženi sistematiki.</p> <p>P4 Laboratorijske vaje tehničnega risanja in 3D modeliranja z namenski didaktičnimi pripomočki:</p> <ul style="list-style-type: none"> Računalniške delovne postaje s programskimi paketi za modeliranje in izdelavo tehničnih risb. <p>P8 Izdelava in predstavitev aplikativnih seminarskih nalog.</p> <p>P12 Individualizirane domače naloge v spletni učilnici.</p> <p>P14 Virtualne predstavitve.</p> <p>P15 Uporaba video vsebin kot priprava na predavanja in vaje.</p>	<p>P1 Auditory lectures with solving selected and typical theoretical and practical examples.</p> <p>P2 Presentation of a subject matter based on the arranged and previously explained scheme.</p> <p>P4 Laboratory exercises of technical drawing and 3D modelling with dedicated didactic aids:</p> <ul style="list-style-type: none"> Computer workstations with software packages for modeling and drawing technical drawings. <p>P8 Creation and presentation of applicative seminar assignments.</p> <p>P12 Individual homework assignments in a virtual classroom.</p> <p>P14 Virtual presentations.</p> <p>P15 Use of video contents as preparation for lectures and tutorials.</p>
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Načini ocenjevanja:

Delež/ Weight

Assessment:

Teoretični izpit (pisno/ustno)	50,00 %	Theory examination (written/oral).
Delo na laboratorijskih vajah (vključno z izdelki)	35,00 %	Practical examination in laboratory (written/oral).
Projektna naloga (pisno)	15,00 %	Project work (written).

Ocenjevalna lestvica:

Grading system:

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Reference nosilca/Lecturer's references:

Robert Kunc:

- TRAJKOVSKI, Jovan, PERENDA, Jasenko, **KUNC, Robert**. Blast response of light armoured vehicles (LAVs) with flat and V-hull floor. Thin-walled structures. Oct. 2018, vol. 131, str. 238-244, ilustr. ISSN 0263-823

<https://www.sciencedirect.com/science/article/pii/S0263823117315793?via%3Dihub>, <https://repozitorij.uni-lj.si/IzpisGradiva.php?id=105227>, DOI: 10.1016/j.tws.2018.06.040. [COBISS.SI-ID [16149275](#)]

2. ŽEROVNIK, Andrej, PEPEL, Vili, PREBIL, Ivan, **KUNC, Robert**. The yield-point phenomenon and cyclic plasticity of the uniaxially loaded specimens. *Materials & design*. Feb. 2016, vol. 92, str. 971-977, ilustr. ISSN 0264-1275. DOI: 10.1016/j.matdes.2015.1111. [COBISS.SI-ID [14442011](#)]
3. TRAJKOVSKI, Jovan, AMBROŽ, Miha, **KUNC, Robert**. The importance of friction coefficient between vehicle tyres and concrete safety barrier to vehicle rollover - FE analysis study. *Strojniški vestnik*. Dec. 2018, vol. 64, no. 12, str. 753-762, si 106, ilustr. ISSN 0039-2480. https://www.sv-jme.eu/?ns_articles_pdf=/ns_articles/files/ojs/5290/public/5290-30742-1-PB.pdf&id=6225, <http://www.dlib.si/details/URN:NBN:SI:doc-LKUR52C5>, <https://repozitorij.uni-lj.si/IzpisGradiva.php?id=105228>, DOI: 10.5545/sv-jme.2018.5290. [COBISS.SI-ID [16220699](#)]
4. TRAJKOVSKI, Jovan, **KUNC, Robert**. Soft target protection by using blast resistant trash receptacles. V: HOFREITER, Ladislav (ur.). *Soft target protection : theoretical basis and practical measures*. Dordrecht: Springer, 2020. Str. 351-359, ilustr. NATO science for peace and security, Series C, Environmental security. ISBN 978-94-024-1757-9, ISBN 978-94-024-1754-8, ISBN 978-94-024-1755-5. ISSN 1874-6543. https://link.springer.com/chapter/10.1007/978-94-024-1755-5_29, DOI: 10.1007/978-94-024-1755-5_29. [COBISS.SI-ID [17064987](#)]
5. TRAJKOVSKI, Jovan, **KUNC, Robert**. Primerjalne računalniške simulacije testov enostranske JVO L-LIGHT H4b-objekt v skladu s standardom SIST EN 1317-2. Ljubljana: Fakulteta za strojništvo, Katedra za modeliranje v tehniki in medicini, Laboratorij za modeliranje elementov in konstrukcij, 2020. 19. f, ilustr. [COBISS.SI-ID [17060379](#)]

Nikola Vukašinović:

1. URBAS, Uroš, **VUKAŠINOVIĆ, Nikola**, DEMŠAR, Ivan. Prehod v celovito opredelitev CAD-modela (MBD). *Ventil : revija za fluidno tehniko in avtomatizacijo*. [Tiskana izd.]. feb. 2020, letn. 26, št. 1, str. 38-43, ilustr. ISSN 1318-7279. [COBISS.SI-ID [17062939](#)]
2. URBAS, Uroš, VRABIČ, Rok, **VUKAŠINOVIĆ, Nikola**. Displaying product manufacturing information in augmented reality for inspection. V: BUTALA, Peter (ur.), GOVEKAR, Edvard (ur.), VRABIČ, Rok (ur.). *52nd CIRP Conference on Manufacturing Systems (CMS)*, Ljubljana, Slovenia, June 12-14, 2019, (Procedia CIRP, ISSN 2212-8271, vol. 81). Amsterdam: Elsevier. 2019, vol. 81, f. 832-837, ilustr. <https://www.sciencedirect.com/science/article/pii/S221282711930513X>, doi: 10.1016/j.procir.2019.03.208. [COBISS.SI-ID [16675611](#)]
3. **VUKAŠINOVIC, Nikola**, DUHOVNIK, Jože. Polnilni ventil iz plasticnih mas : SI 24236 (A), 2014-05-30. Ljubljana: Urad Republike Slovenije za intelektualno lastnino, 2014. 5 f., 2 f. pril., ilustr. [COBISS.SI-ID 13520923] patentna družina: Številka prijave: P-201400066, 2014-02-21 [COBISS.SI-ID [13520923](#)]
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