

ZAGOTAVLJANJE KAKOVOSTI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Zagotavljanje kakovosti
Course title:	Quality Assurance
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni (od študijskega leta 2026/2027 dalje)	Proizvodne tehnologije (smer)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0563511
Koda učne enote na članici/UL Member course code:	3060-V

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30		30			40	4

Nosilec predmeta/Lecturer: izr. prof. dr. Davorin Kramar

Izvajalci predavanj:	
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type: Izbirni strokovni predmet /Elective specialised course

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

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

Izpolnjevanje pogojev za vpis v Visokošolski strokovni študijski program I. stopnje Strojništvo - Projektno aplikativni program.

Prerequisites:

Meeting the enrollment conditions for the MECHANICAL ENGINEERING - Project Oriented Applied Programme.

Vsebina:

1. Predavanje: Uvod v kakovost

- kultura kakovosti
- definicije kakovosti
- 8 determinant kakovosti izdelka

Content (Syllabus outline):

1. Lecture: Introduction to quality

- a culture of quality
- definitions of quality
- 8 determinants of product quality

<ul style="list-style-type: none"> • 5 determinant kakovosti storitve • zgodovina kontrole kakovosti 2. Predavanje: Pet stebrov kakovosti • fokus na kupca/stranko • vključenost vseh zaposlenih • meritve • sistemska podpora • stalne izboljšave 3. Predavanje: Merjenje in kalibriranje za zagotavljanje kakovosti • pomen merjenja za kakovost izdelka • meritve v proizvodnji • sodobne merilne naprave/metode za kontrolo kakovosti • 3-koordinatni merilni stroj (CMM) • 3D skeniranje • multi-fokusni 3D mikroskop 4. Predavanje: Orodja kakovosti I • namen uporabe orodij, problemi pri uvedbi • delitev orodij v skladu z metodologijo DMAIC (Define, Measure, Analyze, Improve, Control) • orodja za zbiranje/definiranje podatkov (diagram poteka, IPO diagram,...) • orodja za merjenje (kontrolni list, histogram, Pareto diagram, ...) 5. Predavanje: Orodja kakovosti II • orodja za analizo (SWOT analiza, 5x zakaj, korelacijski diagram, analiza JE/NI, ...) • orodja za izboljšanje (SMED, 5S, viharjenje možganov, večkratno glasovanje,...) • orodja za kontrolo (Gantt diagram, PDCA krog, Radar diagram, kontrolne karte, ...) 6. Predavanje: Metode reševanja problemov v skupini • izbira tima in timsko delo • reševanje problema • orodja timskega dela / tehnike kreativnega razmišljanja • za identifikacijo in razumevanje problema • za analizo problema • Proces reševanja problema (metoda 8D) 7. Predavanje: Stroški kakovosti (CoQ) • definicija stroškov kakovosti • vrste stroškov kakovosti • razlike med kakovostjo izdelka in kakovostjo storitev • izgube v proizvodnji 8. Predavanje: Standardizacija v kakovosti • uvod v standardizacijo • ISO 9001:2015; Sistem vodenja kakovosti • ISO 14001:2015; Sistem ravnanja z okoljem • ISO 45001:2018; Sistem vodenja varnosti in zdravja pri delu (ex. OHSAS 18001) • integrirani sistemi kakovosti 9. Predavanje: Sistemi vodenja kakovosti v avtomobilski industriji 	<ul style="list-style-type: none"> • 5 determinants of service quality • quality control history 2. Lecture: Five pillars of quality • focus on customer / customer • involvement of all employees • measurements • system support • continuous improvements 3. Lecture: Measurement and calibration for quality assurance • the importance of measurement for product quality • measurements in production • modern measuring instruments / methods for quality control • 3-coordinate measuring machine (CMM) • 3D scanning • multi-focus 3D microscope 4. Lecture: Quality Tools I • purpose of use of tools, problems with implementation • splitting of tools according to the DMAIC methodology (Define, Measure, Analyzes, Improve, Control) • Data collection / definition tools (flowchart, IPO diagram, ...) • measuring tools (checklist, histogram, Pareto diagram, ...) 5. Lecture: Quality Tools II • analysis tools (SWOT analysis, 5x why, correlation diagram, YES/NO analysis, ...) • enhancement tools (SMED, 5S, brainstorming, multiple voting, ...) • control tools (Gantt diagram, PDCA circuit, Radar diagram, control charts, ...) 6. Lecture: Team problem solving methods • team selection and teamwork • solving the problem • teamwork tools / creative thinking techniques • to identify and understand the problem • to analyze the problem • Problem solving process (8D method) 7. Lecture: Cost of quality (CoQ) • definition of quality costs • types of quality costs • differences between product and service quality • production losses 8. Lecture: Standardization in quality • introduction to standardization • ISO 9001: 2015; Quality management system • ISO 14001: 2015; Environmental management system • ISO 45001: 2018; Occupational Health and Safety Management Systems (ex. OHSAS 18001) • integrated quality systems 9. Lecture: Quality management systems in the automotive industry
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<ul style="list-style-type: none"> • pregled standardov (IATF 16949:2016 (ex. ISO/TS 16949:2009), VDA 6.3/6.5, Toyota way,...) • implementacija IATF 16949:2016 • dobavitelj (tier 1, tier 2) in proizvajalec originalne opreme (OEM) <p>10. Predavanje: Kontrola variacij v procesu (QVC)</p> <ul style="list-style-type: none"> • kakovost in variacije • robustnost in variabilnost ter zanesljivost • analiza izdelka in procesa • stabilnost, sposobnost procesa • osnove DOE <p>11. Predavanje: Statistični nadzor procesa (SPC)</p> <ul style="list-style-type: none"> • uvod v statistični nadzor kakovosti (SQC) in procesa (SPC) • opisna statistika • kontrolne karte za attribute in variable • prevzemno vzorčenje <p>12. Predavanje: Analiza merilnih sistemov (MSA)</p> <ul style="list-style-type: none"> • uporaba, opis, omejitve, postopek • lokacijska, širinska in sistemska odstopanja • statistične lastnosti merilnih sistemov • študija merilnega sistema <p>13. Predavanje: Analiza možnih napak in njihovih posledic (FMEA)</p> <ul style="list-style-type: none"> • ocena tveganja • stopnja pomembnosti napake (Risk Priority Number - RPN) • FMEA proizvoda / konstrukcije (DFMEA) • FMEA procesa (PFMEA) • FMEA ekologije (EFMEA) <p>14. Predavanje: Odgovornost za izdelke z napako</p> <ul style="list-style-type: none"> • razvoj področja odgovornosti • garancija • direktiva 2006/42/ES • CE znak <p>15. Predavanje: Uporaba in nadgradnja akademskega znanja v praksi (predavanje iz prakse)</p>	<ul style="list-style-type: none"> • review of standards (IATF 16949: 2016 (ex. ISO / TS 16949: 2009), VDA 6.3/6.5, Toyota way, ...) • implementation of IATF 16949: 2016 • Supplier (tier 1, tier 2) and OEM (OEM) <p>10. Lecture: Process Variation Control (QVC)</p> <ul style="list-style-type: none"> • quality and variation • robustness and variability and reliability • product and process analysis • stability, process capability • DOE basics <p>11. Lecture: Statistical Process Control (SPC)</p> <ul style="list-style-type: none"> • introduction to statistical quality (SQC) and process (SPC) control • descriptive statistics • control charts for attributes in variables • acceptance sampling <p>12. Lecture: Measurement System Analysis (MSA)</p> <ul style="list-style-type: none"> • use, description, restrictions, process • location, latitude and systematic deviations • the statistical characteristics of the measurement systems • study of the measurement system <p>13. Lecture: Analysis of possible errors and their consequences (FMEA)</p> <ul style="list-style-type: none"> • risk assessment • Risk Priority Number (RPN) • FMEA Product / Construction (DFMEA) • FMEA Process (PFMEA) • FMEA Ecology (EFMEA) <p>14. Lecture: Liability for defective products</p> <ul style="list-style-type: none"> • developing the area of responsibility • guarantee • Directive 2006/42 / EC • CE mark <p>15. Lecture: Use and upgrade of academic knowledge in practice (lecture from practice)</p>
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Temeljna literatura in viri/Readings:

1. R. Basu: Implementing Quality – A Practical Guide to Tools and Techniques, Thomson Learning, London, 2004 [COBISS.SI-ID [7672603](#)]
2. R. Dan Reid, Nada R. Sanders-Operations Management; 2020 Wiley; [COBISS.SI-ID [146810371](#)]
3. Montgomery, D. C. ; Jennings, Cheryl L. ; Pfund, Michele E: Managing, controlling, and improving quality Wiley, cop. 2011, [COBISS.SI-ID [14560790](#)]
4. Bračun, D., Kramar, D.. Dodatno učno gradivo pri predmetu Načrtovanje in obvladovanje kakovosti : MAG 1. letnik : magistrski študijski program druge stopnje Strojništvo - Razvojno raziskovalni program. Ljubljana: Univerza v Ljubljani, Fakulteta za strojništvo, 2021. [COBISS.SI-ID [64542467](#)]

Cilji in kompetence:

Cilji:
 spoznati osnovna orodja kakovosti in tehnike statističnega nadzora procesa (SPC)
 spoznati področje merjenja in kalibriranja ter metodo za analizo merilnih sistemov (MSA)
 spoznati stroške kakovosti

Objectives and competences:

Goals:
 1. Learn the basic quality tools and techniques of statistical process control (SPC)
 2. Know the field of measurement and calibration and the method of analysis of measurement systems (MSA)

<p>spoznati standardizacijo na področju kakovosti s poudarkom na avtomobilski industriji spoznati metode reševanja problemov v skupini Kompetence: S1-PAP, S6-PAP, S9-PAP, P3-PAP, P7-PAP: uporaba osnovnih orodij in tehnik zagotavljanja kakovosti v vseh fazah nastanka proizvoda/storitve. S2-PAP, S6-PAP, S9-PAP, P3-PAP: prepoznavna kakovosti na različnih področjih strojništva – načrtovanje proizvodov, energetskih naprav in sistemov, izdelovalnih tehnologij, nadzora procesov, meritev. S2-PAP, S6-PAP, S9-PAP, P3-PAP, P6-PAP: sposobnost analize stroškov kakovosti. S2-PAP, S6-PAP, S9-PAP, P3-PAP, P5-PAP: sposobnost uporabe standardov in standardizacije v povezavi s kakovostjo, okoljem ter varnostjo in zdravjem in implementacija v avtomobilski industriji. S2-PAP, S6-PAP, S9-PAP, P3-PAP: sposobnost reševanja problemov v skupini in uporaba orodij in tehnik kreativnega razmišljanja.</p>	<p>3. Know the cost of quality 4. Learn about quality standardization with a focus on the automotive industry 5. Learn the methods of group problem solving Competences: 1. S1-PAP, S6-PAP, S9-PAP, P3-PAP, P7-PAP: use of basic tools and quality assurance techniques at all stages of product/service creation. 2. S2-PAP, S6-PAP, S9-PAP, P3-PAP: recognition of quality in various fields of mechanical engineering - design of products, energy devices and systems, manufacturing technologies, process control, measurements. 3. S2-PAP, S6-PAP, S9-PAP, P3-PAP, P6-PAP: the ability to analyze cost of quality. 4. S2-PAP, S6-PAP, S9-PAP, P3-PAP, P5-PAP: ability to apply standards and standardization in relation to quality, environment, safety and health, and its implementation in the automotive industry. 5. S2-PAP, S6-PAP, S9-PAP, P3-PAP: ability to solve group problems and use tools and techniques of creative thinking.</p>
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<p>Predvideni študijski rezultati: Znanja: Z1: Poglobljeno strokovno teoretično in praktično znanje s področja zagotavljanja kakovosti, ki vključuje različne vidike kakovosti, sisteme vodenja kakovosti kot tudi primerna orodja in tehnike za doseg zahtevanih ciljev. Spretnosti: S1.1 Izvajanje analize izvora in reševanja problemov, ki vključujejo uporabo metodoloških orodij. S1.3 Diagnosticiranje in reševanje problemov v različnih specifičnih delovnih okoljih, povezanih z zagotavljanjem kakovosti.</p>	<p>Intended learning outcomes: Knowledge: Z1: In-depth professional theoretical and practical knowledge in the field of quality assurance, incorporating various aspects of quality, quality management systems as well as appropriate tools and techniques to achieve the required objectives. Skills: S1.1 Perform problem source analysis and solving involving the use of methodological tools. S1.3 Diagnosis and problem solving in various specific work environments related to quality assurance.</p>
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<p>Metode poučevanja in učenja: P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov. P4 Laboratorijske vaje z namenski didaktičnimi pripomočki (merilni instrumenti in računalniško podprta orodja za analizo) P5 Uporaba študijskega gradiva v obliki knjig in skripta in e-verzije predstavitve predavanj. P7 Študij literature in razprava P9 Skupinsko delo – viharjenje možganov P10 Uporaba anket v realnem času</p>	<p>Learning and teaching methods: P1 Lectures by solving selected – typical for study area - theoretical and practical examples. P4 Laboratory exercises with dedicated teaching aids (measuring instruments and computer-aided analysis tools) P5 Use of study materials in the form of books and scripts and e-versions of lecture presentation. P7 Literature studies and discussion P9 Teamwork - Brainstorming P10 Use real-time surveys</p>
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Načini ocenjevanja:	Delež/Weight	Assessment:
Teoretične vsebine (predavanja).	50,00 %	Theoretical content (lectures).
Praktične vsebine (vaje).	50,00 %	Practical content (tutorials).

Ocenjevalna lestvica:

Grading system:

5 - 10, pri čemer velja, da je pozitivna ocena od 6 - 10

5 - 10, a student passes the exam if he is graded from 6 to 10

Reference nosilca/Lecturer's references:

Davorin Kramar:

1. ZIVKOVIC, Srdjan, ČERČE, Luka, KOSTIC, Julija, MAJSTROVIC, Vidosav, **KRAMAR, Davorin**. Reverse engineering of turbine blades Kaplan's type for small hydroelectric power station. V: MORONI, Giovanni (ur.), PETRÒ, Stefano (ur.). The 15th CIRP Conference on Computer Aided Tolerancing, CIRP CAT 2018, 11-13 June 2018, Milan, Italy, 15th CIRP Conference on Computer Aided Tolerancing, CIRP CAT 2018, 11-13 June 2018, Milan, Italy, (Procedia CIRP, ISSN 2212-8271, Vol. 75). [Amsterdam etc.]: Elsevier. 2018, vol. 75, f. 379-384, ilustr. doi: 10.1016/j.procir.2018.04.037. [COBISS.SI-ID [16209435](#)]
2. VUJOVIĆ, Aleksandar, JOVANOVIĆ, Jelena, KRIVOKAPIĆ, Zdravko, PEKOVIĆ, Sanja, SOKOVIĆ, Mirko, **KRAMAR, Davorin**. The relationship between innovations and quality management system. Tehnički vjesnik, ISSN 1330-3651, 2017, vol. 24, no. 2, str. 551-556, ilustr. doi: 10.17559/TV-20150528100824. [COBISS.SI-ID [15481371](#)]
3. HAFNER, Rok, GRGURAŠ, Damir, **KRAMAR, Davorin**. Milling process optimization for the best surface coat adhesion of the rigid polyurethane foam. Journal of polymer engineering. 2018, vol. 38, iss. 10, f. 995-1005, ilustr. ISSN 0334-6447. <https://www.degruyter.com/view/j/polyeng.ahead-of-print/polyeng-2018-0035/polyeng-2018-0035.xml>, DOI: 10.1515/polyeng-2018-0035. [COBISS.SI-ID [16114203](#)]
4. KRIVOKAPIĆ, Zdravko, VUČUREVIĆ, Radoslav, **KRAMAR, Davorin**, JOVANOVIĆ, Jelena. Modelling surface roughness in the function of torque when drilling. Metals. 2020, iss. 3, vol. 10, str. 1-15, ilustr. ISSN 2075-4701. <https://www.mdpi.com/2075-4701/10/3/337>, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.3390/met10030337. [COBISS.SI-ID [17169435](#)]
5. MUŽENIČ, David, **KRAMAR, Davorin**, PUŠAVEC, Franci. Advances in understanding of damage formation during laser-assisted milling of ZnO-based varistor ceramics. Journal of manufacturing processes. [Print ed.]. Dec. 2022, vol. 84, str. 1478-1491, ilustr. ISSN 1526-6125. <https://www.sciencedirect.com/science/article/pii/S1526612522007812>, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.jmapro.2022.11.008. [COBISS.SI-ID [130224387](#)]