Fakulteta za industrijski inženiring
Faculty of Industrial Engineering

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Trajnostni razvoj izdelkov, procesov in inovacije
Course title:	Sustainable development of products, processes and innovatins

Študijski program Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Inženiring in avtomobilska industrija		drugi	5
Engineering and automotive industry		second	5

Vrsta predmeta / Course type	Izbirni / optional
Univerzitetna koda predmeta / University course code:	**MAG_21009**

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
45	-	15	30	-	150	8

Nosilec predmeta / Lecturer:	doc. dr. Tomaž Jurejevčič

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits that the student has to fulfil in order to attend studies are:**
• Vpis v 2. letnik magistrskega študija	• approved entry of 2nd year

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Vsebina:	Content (Syllabus outline):
• **Kategorije avtomobilskih razvojnih projektov** ○ Projektni razvoj vozil in razlike projektov po vsebini, finančnih okvirih in času izvedbe ○ Glavni vidiki, ki vplivajo na razlikovanje projektov, kot npr. nivo razvojnih aktivnosti, obseg razvojnih aktivnosti, stopnja inovativnosti, število verzij • **Trajnostni razvoj izdelkov in procesov s področja razvoja v avtomobilski industriji** ○ Snovanje in razvoj izdelka: kupčeve zahteve in posebne karakteristike, ponudbe in koncipiranje izdelka, projektno vodenje, razvojne inženirske aktivnosti, sočasni inženiring, re-inženiring, ko-inženiring s kupci, validacija izdelka in procesov, zagon proizvodnih procesov (IATF 16949) ○ Izbrana poglavja iz metod razvoja proizvodov in procesov: ▪ Metode sočasnega inženiringa: timsko delo s sočasnimi aktivnostmi *razvoja izdelka*, *razvoja procesa*, *aktivnostmi nabave* in *kalkuliranju* trenutne cene izdelka. ▪ FMEA[1] metoda: Analiza možnih napak in njihovih posledic pri razvoju izdelka (D-FMEA) in procesa (P-FMEA). Metodologija za izvedbo timskega pristopa, kjer strokovnjaki iz različnih področij analizirajo možne napake in njihove posledice in iščejo proizvodne ukrepe in prilagoditve lastnosti izdelka z namenom preprečevanja in/ali saniranja pričakovanih napak ▪ PLM[2]; sistem za obvladovanje podatkov/znanja in tehnične dokumentacije skozi celoten življenjski cikel proizvoda, obvladovanje veljavnosti in verzij dokumentov, strukturni plan dokumentacije, pomen CAD sistemov v razvoju izdelka ▪ Metode vrednotenja funkcionalnosti izdelka v razvojnih fazah: simulacije tolerančnih verig, FEM[3]-statične, dinamične in tranzientne simulacije, CFD[4] simulacije, kinematične simulacije, DOE[5] ▪ metode obvladovanja kakovosti v razvojni in v	• **Categories of automotive development projects** ○ Project development of vehicles and project differences from the aspect of contents, financial framework and time framework ○ Main aspect that influence to differentiation of projects like complexity level of development activities, scope of development activities, innovation rate, number of versions • **Sustainable development of product and development processes** in automotive industry: ○ Concept & development of the product: customer requirements and special characteristics, offers and concept solustions, project management, engineering development activities, concurrent engineering, re-engineering, co-engineering with the customer, product validation and process validation, production process ramp-up (IATF 16949[11]) ○ Selected topics for product- and process development methods: ▪ Concurrent engineering methods: teamwork using concurrent engineering of *product development*, *process development*, *purchasing activities* and *calculations* of actual product costs. ▪ FMEA method: Analysis of potential failure modes and effects for product (D-FMEA) and process (P-FMEA). Methodology for execution of teamwork where experts from various fields analyze potential failures and their effects and search for product related- and production measures for prevention of respective failures / effects ▪ PLM; data management system for maintenance of data/knowledge and technical documentation throughout product life-cycle, documentation versioning, structural documentation plan, role of CAD systems in product development process ▪ Functional evaluation methods in various development phases: simulations of tolerance chains, FEM-static-, dynamic- and transient simulations, CFD simulations,

[1] FMEA – Failure Mode and Effect Analysis
[2] PLM – Product Lifecycle Management
[3] FEM – Finite Element Method
[4] CFD – Computational Fluid Dynamics
[5] DOE – Design of Experiment
[11] IATF ISO/TS 16949 (now IATF 16949) - http://www.iatfglobaloversight.org/content.aspx?page=IATF%20ISO/TS%2016949%20Revision%20Workgroup%20News

proizvodni fazi izdelka, APQP[6], DFSS[7] in SPC[8] ▪ validacija konceptov: hitra izdelava prototipov (rapid prototyping), razvojne meritve v laboratorijskem okolju in v eksploataciji • **Procesi upravljanja invencij, inovacij in patentov, standardizacija** ○ Pomen know-howa v avtomobilski industriji, potreba po upravljanju znanj v avtomobilski industriji, upravljanje izkustvenega znanja v avtomobilski industriji, obvladovanje in priskrba potrebnih znanj (izobraževanje), pridobivanje in upravljanje izkustvenih informacij, ○ management invencij, inovacij in patentov, inovacijski proces, metodologija inovacijskega procesa, organiziranje inovacijske dejavnosti v podjetju, proces prijave za pridobitev patenta ○ Standardizacija, internacionalna in nacionalna (IATF 16949[9], ISO/IEC 17025[10]), standardi, smernice in modularne rešitve na nivoju izdelkov, komponent in pripadajočih proizvodnih procesov	kinematic simulations, DOE ▪ Quality management methods in development- and ramp-up phases, APQP, DFSS in SPC ▪ Concept validations: rapid prototyping, development measurements in laboratory and in the field • **Development, research and innovations**, **standardisation** in automotive industry ○ The meaning of the know-how in automotive industry, needs and management of know-how, management of lessons-learned knowledge in automotive industry, maintenance and assurance of needed know-how (education), acquisitionn and management of lessons learned, ○ management of inventions, innovations and patents, innovation process / methodology, organizational aspects of innovation activity in the company, patent application process ○ Standardisation, international and national (IATF 16949, ISO/IEC 17025), standards, guidelines and modular solutions for products, components and respective production processes

[6] APQP – Advanced Product Quality Planning
[7] DFSS – Design For Six Sigma
[8] SPC – Statistical Process Controll
[9] IATF16949 – International Automotive Task Force - Quality management system for organizations in the automotive industry
[10] ISO/IEC 17025 - General requirements for the competence of testing and calibration laboratories

Temeljni literatura in viri / Readings:

Temeljna literatura:

1. Baars Wouter: Project Management Handbook, DANS – Data Archiving and Networked Services, The Hague – 2006, ISBN 90 6984 496 6
2. Hauc A.: Projektni management, GV Založba, 2007, ISBN 86-7061-285-2
3. Hoyle David: Automotive Quality Systems Handbook, Butterworth Heinemann, 2000, ISBN 0 7506 7243 9
4. ISO TS 16949:2009 Quality Management Systems – Particular requirements for the ISO 9001:2008 for automotive production and relevant service part organizations, International Organization for Standardization (www.iso.org)
5. Weber Julian: Automotive Development Processes, Springer-Verlag Berlin Heidelberg 2009, e-ISBN 978-3-642-01253-2
6. MacDermott, Robin E., The basics of FMEA, Portland, OR : Productivity, cop. 1996.
7. Kamrani, Ali K.; Nasr, Emad S. Abouel (Eds.), Collaborative Engineering: Theory and Practice, Springer, 2008.
8. Grote, Karl-Heinrich; Antonsson, Erik K. (Eds.), Springer Handbook of Mechanical Engineering, Springer, 2009.
9. Jože Gričar, Sistemski inženiring: celostna sistemska metodologija za ustvarjalno reševanje problemov, Zavod za organizacijo poslovanja, Ljubljana, 1988.
10. Mitja Požar, Inovativnost v slovenski avtomobilski industriji, Magistrsko delo, Ekonomska fakulteta, Ljubljana, 2003.
11. ISO/IEC 17025 - General requirements for the competence of testing and calibration laboratories
12. E-gradiva predmeta | E-Course material

Dodatna literatura:

13. Juran M. Joseph, Blanton A. Godfrey: Juran's Quality Handbook - 5th Ed - McGraw Hill 1999, ISBN 0-07-034003-X
14. Baas Issa: Six Sigma Statistics with Excel and Minitab - McGraw-Hill, 2007 , ISBN 0-07-154268-X
15. Monka M., Schöneck N.M., Voß W.: Statistik am PC - Lösungen mit Excel, Carl Hanser Verlag, München, 5.Aufl., ISBN 978-3-446-41555-3
16. Smith David J.: Reliability, Maintainability and Risk - Practical methods for engineers – 8th Ed - Elsevier 2011
17. Newbold P.: Statistics for Business and Economics, 7/E, Prentice Hall, 2010, ISBN-10: 0136085369
18. Grote K.H., Feldhusen J.: Dubbel Taschenbuch für Maschinenbau, 21. Auflage, 2005, ISBN 3-540-22142-5
19. Devore Jay L.: Probability & Statistics for Engineering and the Sciences - 8th Ed, Brooks Cole Cengage 2012, ISBN-13: 978-0-538-73352-6

Cilji in kompetence:	**Objectives and competences:**
Cilji: • načrtovanje, upravljanje in kontroliranje razvoja proizvoda, procesov in inovacij, • izvajanje sočasnega inženiringa – postopek razvoja proizvoda, procesa, nadzora procesa in vzpostavitve proizvodnje, • načrtovanje tehnologije, skladno z njihovo tehnično in ekonomsko upravičenostjo ter metodami razvoja procesa (FMEA, DOE), • spodbujanje inovativnega dela in inovacij v procesu razvoja, • navajanje uporabe literature, katalogov in programov, • razvijanje sposobnosti za uporabo znanstvenih metod in sredstev za reševanje strokovnih problemov, • razvijanje sposobnosti analize lastnega arhiva, rešitev konkurence in izsledkov raziskav, • razvijanje sposobnosti analize zakonodaje, regulative in smernice (ECE, EuroNCAP, IATF16949, ISO 14001 itd.), • samostojnost pri odločanju in reševanju problemov v avtomobilski industriji, • delo v timih in projektno delo. **Kompetence** - po koncu predmeta bodo študenti imeli: • razvite strokovne in organizacijske sposobnosti za izvajanje razvojnih aktivnosti in projektov v okviru razvojnega procesa v avtomobilski industriji • pregled nad pristopi, postopki in metodologijami, ki so potrebne za sodelovanje v mednarodni delitvi dela v okviru avtomobilske industrije • širok vpogled v izzive in priložnosti, ki jih podjetjem prinaša trg avtomobilske industrije • razumevanje osnovnih teorij o sistematičnem in inovativnem načrtovanju izdelkov in reševanju problemov v okviru razvoja v avtomobilski industriji • praktične izkušnje za razvoj pristopov in rešitev v okviru razvoja izdelkov in procesov v avtomobilski industriji s pomočjo konkretnih primerov	Objectives: • planning, management and control of product & process development and innovations • execution of concurrent engineering – proceedings of product & process development, process control and production ramp-up • technology planning according to technical- and economic parameters and development process methods (FMEA, DOE) • promotion of innovation way of working and innovations during development process • referencing of literature, catalogs and software • developing of ability for scientific methods and means for solving of expert tasks • developing of ability for analysis of own archives, competitor's solutions and research results • developing of ability for legislation analysis, regulations and guidelines (ECE, EuroNCAP, IATF16949, ISO 14001 etc.), • integrity for decisions and solving of problems in automotive industry • teamwork and project approach **Competences** – after the course students will have: • developed expert- and organisational abilities for execution of development activities and projects within automotive development process • overview of proceedings, procedures and methods needed for international co-operation in automotive industry • broad overview of challenges and opportunities for companies acting in automotive industry • uderstanding of basic theories about systematic and innovative product planning and problem solving in automotive industry • experiences for development of procedures and solutions within product & process development with the help of case studies and examples

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študenta/študentka: • spozna in razume kompleksnost procesa razvoja proizvoda in razvoja procesa ter njuno prepletenost v industriji; • spozna in razume pomen inovativne dejavnosti v sodobnih visokotehnoloških podjetjih; • spozna in razume pomen stalnih tehnoloških izboljšav, razvoja in inovacij v razvojnem in proizvodnem procesu; • razume pomen konstruiranja in tehnoloških procesov v industriji, tako v vsakodnevnem življenju posameznika, kot v neposredni poklicni dejavnosti na vseh možnih področjih; • seznani se z nekaterimi bistvenimi metodami v razvoju proizvodov v industriji; • spozna razmerja med bistvenimi elementi v proizvodnji: cena, trajnost, razvoj izdelka, razvoj procesa, prilagodljivost, infrastruktura in oprema, tehnologija in procesi, delovna sila in organizacija, logistika in dobaviteljska veriga ter raziskave in inženiring; • ustvarja si in tudi spreminja svojo inženirsko filozofijo, kjer visoko ceni spoštuje dosežke in spoznanja s področij tehnike in inženirstva; • spoznava in doumeva odnose med osnovnimi in aplikativnimi raziskavami njih medsebojno prepletenost in povezanost znanosti s sodobno tehniko in visokimi tehnologijami v avtomobilski industriji; • doseže širše znanje s področja metod razvoja in procesov ter inovacij daje študentom nove izzive in možnosti in za osebno zadovoljstvo na novih službenih dolžnostih, velike možnosti napredovanja v svoji karieri.	Student: • recognises and understands complexity of product and process development and their interrelations in the industry • recognises and understands the meaning of innovative activity in modern high-tec companies • recognises and understands the meaning of continuous technology improvements, development and innovations in the development & production process • understands the meaning of design and technology in industry, both for ordinary people aswel as for various expert jobs • gets acquainted with important methods in the industrial product development • recognises relations between important elements in the production: price, sustainability, product development, process development, flexibility, infrastructure and equipment, technology and processes, labour force and organsation, logistics and supply chain, research and engineering • creates and changes of his/her engineering phylosophy, while highly apprecciates and respects achievements from the field of technology and engineering • recognises and understands relationships between basic and applicative research, their interrelations and connection between science and modern engineering technologies in automotive industry • with wide knowledge about methods of product & process development and innovations gets new challenges and possibilities for personal satisfaction at new job positions, and gets high chances for job promotions as steps in their careers

Metode poučevanja in učenja:	**Learning and teaching methods:**
• Predmet bo temeljil na predavanjih, vajah in razpravah. Uporabljali bomo kombinacijo teksta in primerov za študij o teh temah • Vaje: vaje se bodo izvajale na konkretnih primerih uporabe posamezne metodologije oz. na konkretnih primerih metodologij tipičnih za razvoja proizvoda in procesa, npr. (le nekaj od naštetega zaradi omejenih časovnih okvirov vaj) ○ FMEA delavnica na konkretnem primeru izdelka / procesa s prepoznavanjem funkcionalnosti, primerov uporabe/ eksploatacije, tveganji in modusi napak, korektivnimi ukrepi ○ Reševanje tehničnih problemov z uporabo DMAIC metodologij npr. • Ishikawa, Fault-tree analysis • SWOT • X-R chart • TOP-x histograma dogodkov, itd. ○ uporabo statističnih porazdelitev verjetnosti in njihovih parametrov, določanje parametrov iz eksperimentalno pridobljenih podatkov, ○ statistične analize proizvodnih procesov z namenom ugotavljanja • kratkoročne- in dolgoročne stabilnosti procesov, ○ tolerančna analiza, itd. Na vajah potrebna oprema: računalnik, Excel, Power Point, Visio, video predvajalnik • Seminarsko delo: študent bo v okviru seminarja obdelal razvojne tematike (metodologije, razvojna orodja, itd.). Vsak študent bo izbral enostaven izdelek ali proces za analizo, izvedel nalogo s predlogi rešitev problematike (analiza, optimizacija) in napisal o tem seminarski elaborat. Predmet je oblikovan na kombinirani način študija, ki vključuje aktivnosti preko elektronskega (on-line) okolja: te aktivnosti so sestavljene iz samostojnih in skupinskih aktivnosti z uporabo učnega okolja Moodle in drugih elektronskih vsebin. Praviloma vključujejo diskusije v forumih, spletne strani, ogled posnetih predavanj in vaj, preverjanje znanja, odgovori na vprašanja, iskanje po spletu (bazah) itd.	• The subject will be based on lectures, exercises based on particular cases, and discussion. Combination of text and examples will be used to study mentioned themes • Practicum: exercises will be conducted with the focus to particular cases of product development and processes in automotive. Typical cases would be as follows: ○ FMEA workshop of real case study of product / process – functional recognition, use cases, reisks, failure modes, corrective measures ○ Execution and leading of brainstormings while using DMAIC tools e.g. ▪ Ishikawa, Fault-tree ▪ SWOT ▪ X-R chart ▪ TOP-x event-hystogramm, etc. ○ Definition of statistical probability distributions and respective parameters from experimental data ○ Statistical analyses of production processes in order to define ▪ short term- and long term stability, ○ tolerance analysis, etc. Necessary equipment: PC, Excel, Power Point, Visio (or similar), video player • A course work: student will work out some design & development themes (methodologies, project tools, development tools, etc.). Every student will select simple product or process that will be subsequently analysed and optimised in terms of better solution (analysis, optimisation) and he will write the course expert-report. The course is designed as blended learning that includes online activities: Online activities consist of independent and group activities using the LMS Moodle and other electronic or online content. Activities usually include discussions in forums, websites, viewing of recorded lectures and tutorials, assessments, answering questions, searching the web (databases), etc.

Načini ocenjevanja:	Delež / Weight (%)	Assessment:
Pogoj za pristop k izpitu je udeležba na vajah. • pisni izpit • ocena sodelovanja na vajah • elaborat seminarja Ocenjevalna lestvica je skladna z ECTS in Pravilnikom o preverjanju in ocenjevanju znanja FINI NM.	 60% 20% 20%	A prerequisite for the written exam is attendance on practical work. • written examination / oral examination • practicum assessment • coursework written report Evaluation scale in accordance with ECTS and the Rules on the Evaluation and Assessment of Knowledge FINI NM.

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KERNC, Janko, JUREJEVČIČ, Tomaž. Preskuševališče za testiranje pedalnega sklopa = Test stand for brake pedal tests. Stroj. vestn., 1999, letn. 45, št. 12, str. 513-521. [COBISS.SI-ID 3528475]

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JUREJEVČIČ, Tomaž, ZALAZNIK, Aleš, WAGNER, Andrej, FAJDIGA, Matija. Žaromet A3400 : simulacija trka žarometa A3400 v model lutke pešca. Ljubljana: Fakulteta za strojništvo, LAVEK, 2008. 46 str., ilustr. [COBISS.SI-ID 10534683]

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