

UČNI NAČRT PREDMETA/COURSE SYLLABUS

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| Predmet: | Avtomatizacija proizvodnje |
| Course title: | MANUFACTURING AUTOMATION |
| Članica nosilka/UL Member: | UL FS |

| Študijski programi in stopnja | Študijska smer | Letnik | Semestri |
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| Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski | Mehatronika in laserska tehnika (smer) | 2. letnik | 1. semester |

Univerzitetna koda predmeta/University course code: 0566823

Koda učne enote na članici/UL Member course code: 6063-M

| Predavanja | Seminar | Vaje | Klinične vaje | Druge oblike študija | Samostojno delo | ECTS |
|------------|---------|------|---------------|----------------------|-----------------|------|
| 30 | | 30 | | | 65 | 5 |

Nosilec predmeta/Lecturer: Drago Bračun

Vrsta predmeta/Course type: Obvezni strokovni predmet na smeri Mehatronika in laserska tehnika, ki je izbirni strokovni predmet na ostalih smereh./Compulsory specialised course in the study of Mechatronics and laser technology, which is an elective specialised course in other fields of study.

Jeziki/Languages:

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| Predavanja/Lectures: | Slovenščina |
| Vaje/Tutorial: | Slovenščina |

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

Prerequisites:

Izpolnjevanje pogojev za vpis v Magistrski študijski program II. stopnje Strojništvo - Razvojno raziskovalni program.

Meeting the enrollment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.

Vsebina:

Content (Syllabus outline):

- Predavanje: Uvod
 - motivacija: učinkovitost, variabilnost
 - vrste avtomatizacije (toga, programabilna, fleksibilna),
 - uvajanje avtomatizacije.
- Predavanje: Pregled osnovnih gradnikov

- Lecture: Introduction
 - motivation: efficiency, variability
 - types of automation (fixed, flexible, programmable),
 - automation migration strategy.
- Lecture: Basic building blocks
 - sensors,

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| <ul style="list-style-type: none"> - senzorji, - aktuatorji, - krmilniki, - industrijske komunikacije, - uporabniški vmesniki. <p>3. Predavanje: Robotski sistemi</p> <ul style="list-style-type: none"> - specifikacije robota, - integracija, - končni aktuatorji, - zunanji senzorji, - tipične aplikacije. <p>4. Predavanje: Numerično krmiljeni sistemi</p> <ul style="list-style-type: none"> - izvedbe, - karakteristike, - preračun NC pogona. <p>5. Predavanje: Avtomatizacija materialnih tokov</p> <ul style="list-style-type: none"> - izhodišča, - tračnice, trakovi, - AGV sistemi. <p>6. Predavanje: Lokalizacija</p> <ul style="list-style-type: none"> - pregled dotičnih in brezdotičnih metod, - lokalizacija za CNC sisteme, - lokalizacija izdelkov v razsutem stanju. <p>7. Predavanje: Kontrola procesov in izdelkov</p> <ul style="list-style-type: none"> - problem variabilnosti, - 100% vs. vzorčna kontrola, - obvladovanje procesov. <p>8. Predavanje: Sistemi za krmiljenje in nadzor delovnih sistemov</p> <ul style="list-style-type: none"> - SCADA, - MES, - nadzorni sistemi, - industrijski internet stvari. <p>9. Predavanje: Avtomatska identifikacija in zajem podatkov</p> <ul style="list-style-type: none"> - pregled metod, - črtne in QR kode, - RFID. <p>10. Predavanje: Uporaba slikovnih sistemov v avtomatizaciji</p> <ul style="list-style-type: none"> - osvetlitev in svetlobni efekti, - izbira kamere in izračun objektiva, - problematika nalaganja pri vzorčenju slike. <p>11. Predavanje: Posebnosti obdelave slik pri</p> <ul style="list-style-type: none"> - dimenzijski kontroli izdelkov, - iskanju površinskih napak, - lokalizaciji izdelkov, - sledenju šiva. <p>12. Predavanje: Umeritev slikovnih sistemov</p> <ul style="list-style-type: none"> - model kamere, - umeritev in razpačitev slike, - računanje koordinat v 3D prostoru. <p>13. Predavanje: Primeri uporabe slikovnih sistemov v avtomatizaciji</p> | <ul style="list-style-type: none"> - actuators, - controllers, - industrial data communications, - user interfaces. <p>3. Lecture: Robotic systems</p> <ul style="list-style-type: none"> - robot specification, - integration, - end effectors, - external sensors, - typical applications. <p>4. Lecture: Numerically controlled systems</p> <ul style="list-style-type: none"> - structure, - characteristics, - calculation of NC drive. <p>5. Lecture: Avtomatization of material flow</p> <ul style="list-style-type: none"> - basics, - rails, belts, - AGV systems. <p>6. Lecture: Localization</p> <ul style="list-style-type: none"> - review of contact and contactless methods, - localization for CNC systems, - localization of objects with random poses. <p>7. Lecture: Process and product control</p> <ul style="list-style-type: none"> - variability, - 100% vs. sampling control, - process management and control. <p>8. Lecture: Systems for monitoring and control of production systems</p> <ul style="list-style-type: none"> - SCADA, - MES, - monitoring systems, - industrial internet of things. <p>9. Lecture: Automatic identification and data capture</p> <ul style="list-style-type: none"> - overview, - bar and QR code, - RFID. <p>10. Lecture: Imaging systems in automation</p> <ul style="list-style-type: none"> - illumination and light effects, - camera and lens selection, - image sampling and aliasing. <p>11. Lecture: Specifics of image processing at</p> <ul style="list-style-type: none"> - dimensional part inspection, - detection of surface defects, - part localization, - seam tracking. <p>12. Lecture: Imaging systems calibration</p> <ul style="list-style-type: none"> - camera model, - calibration and image correction, - calculation of 3D space coordinates. <p>13. Lecture: Example applications of imaging systems in automation</p> <ul style="list-style-type: none"> - dimension inspection, - surface defect detection, - seam tracking. |
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| <ul style="list-style-type: none"> - kontrole dimenzij, - prepoznavne površinskih napak, - sledenja šiva. <p>14. Predavanje: Avtomatizirane kontrolne priprave</p> <ul style="list-style-type: none"> - dotične kontrolne tehnike, - brezdotične kontrolne tehnike, <p>15. Predavanje: Zmogljivost sistemov avtomatizacije</p> <ul style="list-style-type: none"> - realno-časovno delovanje, - zanesljivost, - razpoložljivost, - varnost in povezani standardi. | <p>14. Lecture: Avtomated inspection devices</p> <ul style="list-style-type: none"> - contact inspection methods, - contactless inspection methods, <p>15. Lecture: Performance of automation systems</p> <ul style="list-style-type: none"> - real-time operation, - reliability, - availability, - security and connected standards. |
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Temeljna literatura in viri/Readings:

1. Springer Handbook of Automation; Shimon Y. Nof, Springer, Berlin, Heidelberg 2009
2. Robotics, Vision and Control; Peter Corke, Springer, Berlin, Heidelberg 2011
3. Automation, Production systems, and Computer-Integrated manufacturing, Mikell P. Groover, Pearson Prentice Hall, 2008
4. Digital Image Processing using Matlab, Rafael C. Gonzalez, Pearson Prentice Hall, 2008

Cilji in kompetence:

Cilji:

1. Spoznati uporabo avtomatizacije za izboljšanje produktivnosti in zmanjšanje variabilnosti v proizvodnji.
2. Spoznati integracijo osnovnih mehatronskih gradnikov v avtomatizirane sisteme.
3. Spoznati osnovne metode lokalizacije in identifikacije izdelkov.
4. Spoznati sintezo merilnih in mehatronskih sistemov pri avtomatiziranih kontrolnih pripravah.
5. Spoznati uporabo strojnega vida v avtomatizaciji in kontroli izdelkov.
6. Spoznati opredelitev zmogljivosti in varnosti avtomatiziranih sistemov.

Kompetence:

1. S2-MAG + P6-MAG: Uporaba avtomatizacije v proizvodnji za izboljšanje produktivnosti in obvladovanje variabilnosti
2. S2-MAG + P1-MAG: Sinteza mehatronskih gradnikov v avtomatizirane mehatronske sisteme.
3. S6-MAG + P6-MAG: Poznavanje metod lokalizacije in identifikacije objektov.
4. S2-MAG + P1-MAG: Sposobnost razvoja kontrolnih priprav.
5. S8-MAG + P1-MAG: Sposobnost uporabe strojnega vida.
6. S3-MAG + P1-MAG: Sposobnost analize zmogljivosti in varnosti avtomatiziranih sistemov.

Objectives and competences:

Goals:

1. Understand the use of avtomation to improve productivity and reduce variability in production.
2. Understand the integration of basic mechatronic components in automated systems.
3. Understand the basic methods of localization and product identification.
4. Understand the synthesis of measuring and mechatronic systems in automated control devices.
5. Understand the use of machine vision in product automation and inspection.
6. Understand the definition of performance and security of automated systems.

Competences:

1. S2-MAG + P6-MAG: The use of avtomation to improve productivity and reduce variability in production.
2. S2-MAG + P1-MAG: Integration of mechatronic components in automated systems.
3. S6-MAG + P6-MAG: Understanding the basic methods of localization and product identification.
4. S2-MAG + P1-MAG: Development of inspection devices.
5. S8-MAG + P1-MAG: Use of machine vision.
6. S3-MAG + P1-MAG: Ability to analyse performance and security in automated systems.

Predvideni študijski rezultati:

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| Znanja: |
| Z1: Predmet je obravnava uporabo avtomatizacije za izboljšanje učinkovitosti in variabilnosti v proizvodnji, sintezo osnovnih gradnikov avtomatizacije, lokalizacijo, identifikacijo, avtomatizirane kontrolne priprave, uporabo strojnega vida, zmogljivost ter varnost v avtomatiziranih sistemih. S pridobljenimi kompetencami so študenti sposobni razvijati avtomatizirane sisteme. |
| Spretnosti: |
| 1. S2.1 Razvoj specifikacij, sinteza osnovnih gradnikov avtomatizacije, programiranje in preizkušanje delovanja avtomatiziranih sistemov. |
| 2. S2.2 Načrtovanje, izvedba in umerjanje avtomatiziranih kontrolnih priprav ter njihova integracija v industrijske informacijske sisteme. |
| 3. S2.3 Uporaba strojnega vida za potrebe avtomatizacije in kontrole izdelkov. |

Intended learning outcomes:

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| Knowledge: |
| Z1: The course deals with the use of automation to improve efficiency and reduce variability in production, synthesis of basic building blocks of automation, localization, identification, automated inspection devices, use of machine vision, performance and safety in automated systems. With the acquired competences, students are able to develop automated systems. |
| Skills: |
| 1. S2.1 Development of specifications, synthesis of basic building blocks of automation, programming and testing of automated systems. |
| 2. S2.2 Design, implementation and calibration of automated inspection devices and their integration into industrial information systems. |
| 3. S2.3 Use of machine vision for automation and product inspection purposes. |

Metode poučevanja in učenja:

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| P1 Avditorna predavanja s študijem primerov iz prakse ter z reševanjem izbranih teoretičnih in praktično uporabnih primerov. |
| P2 Obravnava snovi po urejeni in vnaprej razloženi sistemati. |
| P4 Laboratorijske vaje z namenski didaktičnimi pripomočki: senzorji in aktuatorji, CNC sistemi, industrijski roboti, kontrolnimi pripravami in slikovnimi sistemi. |
| P8 Izdelava in predstavitev aplikativnih seminarskih nalog. |
| P14 Virtualni eksperimenti |

Learning and teaching methods:

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| P1 Classroom lectures by case study of selected theoretical and practical examples. |
| P2 Structured and systematic lectures. |
| P4 Laboratory exercises with dedicated teaching aids: sensors and actuators, CNC systems, industrial robots, control devices and imaging systems. |
| P8 Design and presentation of practical seminars. |
| P14 Virtual Experiments |

Načini ocenjevanja:**Delež/Weight****Assessment:**

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| Teoretična snov (predavanja). | 50,00 % | Theoretical matter (lectures). |
| Laboratorijsko delo na vajah (vključno s poročili). | 20,00 % | Laboratory work in exercises (including reports). |
| Projektni seminar. | 30,00 % | Project seminar. |

Reference nosilca/Lecturer's references:

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| Drago Bračun: |
| 1. ŠKULJ Gašper, SLUGA Alojzij, BRAČUN Drago , BUTALA Peter, VRABIČ Rok. Energy efficient communication based on self-organisation of IoT devices for material flow tracking. CIRP annals, ISSN 0007-8506, 2019, vol. 68, iss. 1, str. 495-498. |
| 2. BRAČUN Drago , LEKŠE Igor. A visual inspection system for KTL coatings. 52nd CIRP Conference on |

Manufacturing Systems (CMS), 2019, (Procedia CIRP, ISSN 2212-8271, vol. 81). Amsterdam: Elsevier. 2019, vol. 81, f. 771-774.

3. **BRAČUN Drago**, SLUGA Alojzij. Stereo vision based measuring system for online welding path inspection. Journal of materials processing technology, ISSN 0924-0136. 2015, vol. 223, str. 328-336.
4. VUKAŠINOVIĆ Nikola, **BRAČUN Drago**, MOŽINA Janez, DUHOVNIK Jože. A new method for defining the measurement-uncertainty model of CNC laser-triangulation scanner. The international journal of advanced manufacturing technology, ISSN 0268-3768, 2012, no. 9/12, str. 1097-1104.
5. PERDAN Boštjan, **BRAČUN Drago**, DIACI Janez, MOŽINA Janez. Online assessment of power transmission belt geometry by using laser triangulation and profile parameterisation. The international journal of advanced manufacturing technology, ISSN 0268-3768, 2010, vol. 49, no. 1/4, str. 177-184.