

# VARNOST STROJEV IN NAPRAV

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

<b>Predmet:</b>	Varnost strojev in naprav
<b>Course title:</b>	Safety of Machinery and Equipment
<b>Članica nosilka/UL Member:</b>	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - projektno aplikativni program, prva stopnja, visokošolski strokovni	Konstruiranje industrijskih sistemov (smer)	3. letnik	1. semester	obvezno

<b>Univerzitetna koda predmeta/University course code:</b>	0563472
<b>Koda učne enote na članici/UL Member course code:</b>	3055-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

<b>Nosilec predmeta/Lecturer:</b>	Boris Jerman
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<b>Vrsta predmeta/Course type:</b>	Izbirni strokovni predmet /Elective specialised course
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<b>Jeziki/Languages:</b>	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

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

Izpolnjevanje pogojev za vpis v Visokošolski strokovni študijski program I. stopnje Strojništvo - Projektno aplikativni program	Meeting the enrollment conditions for the MECHANICAL ENGINEERING - Project Oriented Applied Programme.
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## Vsebina:

1. Predavanje: Zgodovina varstva pri delu in osnovni pojmi s tega področja. Definicija varnosti v preteklosti in sedanjosti. Definicija tveganja. Razlika med tveganjem in nevarnostjo. Vgrajena in dodana varnost. Slovenska zakonodaja, uredbe ES in harmonizirani standardi, ki se navezujejo na vgrajeno in dodano varnost.
2. Predavanje: Terminologija in definicije s področja varnosti strojev, naprav in priprav. Izgled, namen in uporaba znaka CE. Način pridobivanja oznake CE, zahteve za pridobitev in označevanje, izjava o skladnosti.
3. Predavanje: Zagotavljanje varnosti proizvodov, s poudarkom na delovni opremi. Posebnosti zagotavljanja varnosti v posameznih obdobjih dobe trajanja delovne opreme. Pregled varnostne opreme. Pregled osebne varovalne opreme. Dokumentacija, ki mora spremljati varen proizvod, s poudarkom na navodilih za varno delo. Primer ustreznih navodil za izbrani stroj.
4. Predavanje: Predstavitev zakonskih zahtev ter določil standardov, na osnovi katerih se vrednoti tveganje ter določi ustrezna raven varnosti in ustrezna varnostna oprema pri določenem delovnem procesu. Ogljični odtis delovne opreme. Varnostna analiza in varnostno poročilo. Izjava o varnosti z oceno tveganja (delovno mesto). Principi doseganja ustrezne varnosti.
5. Predavanje: Iterativni postopek zagotavljanja varnosti med snovanjem proizvoda. Ocena tveganja kot del iterativnega postopka razvoja strojev in naprav. Zanesljivost. Pomen zanesljivosti posameznih elementov za varno delovanje stroja. Redundanca in diverziteta.
6. Predavanje: Teorija zaščite (načela

## Content (Syllabus outline):

Lecture: History of occupational safety and basic concepts in this field. Definition of safety at work in the past and present. Definition of risk. The difference between risk and hazard. Built-in and added safety. Slovenian legislation, EU regulations and harmonized standards related to built-in and added safety.

Lecture: Terminology and definitions in the field of safety of machinery and equipment. The appearance, purpose and use of the CE marking. Method of obtaining the CE marking, acquisition and marking requirements, declaration of conformity.

Lecture: Ensuring safety of products, with a focus on work equipment. Specifics of ensuring safety in individual periods of work equipment service life. Inspection of safety equipment. Inspection of personal protective equipment. Documentation that must accompany a safe product, with emphasis on safe working instructions. Example of appropriate instructions for the selected machine.

Lecture: Presentation of statutory requirements and standards, based on which the risk is assessed and the appropriate level of safety and appropriate safety equipment are selected for a particular work process. Carbon footprint of work equipment. Safety Analysis and Safety Report. Statement of Safety with Risk Assessment (Workplace). Principles of achieving adequate safety.

Lecture: An iterative procedure of ensuring safety during product design. Risk assessment as part of an iterative process of the development of machinery. Reliability. The importance of the reliability of the individual

ter načrtovanje varovanja strojev, naprav in delovnih priprav, dejavniki, ki vplivajo na izbor in učinkovitost varnostne opreme, tipične nevarnosti pri strojih). Residualno tveganje in njegovo obvladovanje.

7. Predavanje: Določanje potrebnega nivoja zaščite in razreda integritete varnostnega sistema -predstavitev metode in primeri.

Tehnike varovanja - opis, delovanje in uporaba - (varovala, varnostna stikala, varnostni dvoročni vklop, varnostne krmilne naprave, naprave, občutljive na približanje, laserji, ...).

8. Predavanje: Ergonomski vidiki pri snovanju strojev, naprav in priprav ter pri snovanju in izbiranju varnostnih sistemov. Načelo izogibanja nepotrebnim ponavljajočim se gibom ter nepotrebnemu dvigovanju in prenašanju težjih bremen.

9. Predavanje: Primeri izvedb sistemov varovanja za nizki nivo tveganja (mehanski, električni, hidravlični, pnevmatski) in njihovo delovanje.

10. Predavanje: Primeri izvedb sistemov varovanja za srednji in visoki nivo tveganja (električni, hidravlični, pnevmatski) in njihovo delovanje.

11. Predavanje: Ocena tveganja s pomočjo priznanih metod - predstavitev metod in primeri.

12. Predavanje: Analiza tipičnih primerov nezgod, iskanje vzrokov zanje, izdelava osnovne analize tveganj za te primere in določanje tehničnih rešitev in drugih ukrepov, ki bi take nezgode preprečili.

13. Predavanje: Zagotavljanje varnosti pri žerjavih. Prikaz primera.

14. Predavanje: Zagotavljanje varnosti pri drugih klasičnih napravah za notranji transport. Prikaz primera.

Zagotavljanje varnosti pri avtonomnih vozilih, robotih in kolaborativnih robotih. Prikaz primera.

15. Predavanje: Zagotavljanje varnosti pri skladiščenju. Prikaz primera.

Zagotavljanje varnosti pri tlačni opremi in procesni tehniki. Prikaz primera.

elements for the safe operation of the machine. Redundancy and diversity.

Lecture: Theory of protection (principles and design of the protection of machinery, appliances and work equipment, factors affecting the selection and performance of safety equipment, typical machine hazards). Residual risk and its management.

Lecture: Determining the required level of protection and safety integrity level of the safety system - presentation of the method and examples. Protection techniques - description, operation and use - (guards, safety switches, Two-hand control device, safety control devices, proximity sensitive devices, lasers, ...). Lecture: Ergonomic aspects in the design of machines and devices, and in the design and selection of safety systems. The principle of avoiding unnecessary repetitive movements and unnecessary lifting and carrying heavy loads.

Lecture: Examples of low-risk safety systems (mechanical, electrical, hydraulic, pneumatic) and their operation.

Lecture: Examples of mid- and high-risk safety systems (electrical, hydraulic, pneumatic) and their operation.

Lecture: Risk assessment using recognized methods - presentation of methods and examples.

Lecture: Analysis of typical accident cases, finding the causes of them, making a basic risk analysis for these cases and identifying technical solutions and other measures to prevent such incidents.

Lecture: Ensuring Crane Safety. Presentation of an example.

Lecture: Provision of safety with other classic material handling equipment. Presentation of an example.

Provision of safety in autonomous vehicles, robots and collaborative robots. Presentation of an example.

Lecture: Provision of safety with warehouses. Presentation of an example. Provision of safety of pressure

	equipment and process engineering equipment. Presentation of an example.
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### **Temeljna literatura in viri/Readings:**

Hughes P, Ferrett E. Introduction to Health and Safety at Work, 4. izdaja. Butterworth-Heinemann. Oxford, 2009;

Ridley J., Channing J. Safety at Work, 7. izdaja. Butterworth-Heinemann. Oxford, 2008;

J. Ridley, D. Pearce. Safety With Machinery. 2. izdaja. Butterworth-Heinemann. Oxford, 2006;

DM. Macdonald. Practical machinery safety. Oxford, 2004;

Zakon o varstvu potrošnikov. Ur.l. RS, št. 98/04 (in spremembe);

Zakon o varnosti in zdravju pri delu (ZVZD-1). Ur.l. RS, št. 43/11;

Zakon o splošni varnosti proizvodov. Ur. l. RS, 101/2003;

Zakon o tehničnih zahtevah za proizvode in o ugotavljanju skladnosti. Ur. l. RS, 17/11;

Pravilnik o varnosti strojev. Ur. l. RS, 75/08 (in spremembe);

Standard SIST EN ISO 12100:2011. Varnost strojev – Splošna načela načrtovanja - Ocena tveganja in zmanjšanje tveganja

### **Cilji in kompetence:**

**Cilji:**

Spoznati osnovne principe zagotavljanja varnosti in zdravja pri delu ter družbeni okvir, v katerega sodijo.

Poglobljeno spoznati principe zagotavljanja varnosti strojev in naprav s pomočjo vgrajene in dodane varnosti. Iterativni postopek zagotavljanja varnosti v procesu snovanja.

Spoznati zanesljivost tehniškega sistema in njen pomen za zagotavljanje varnosti. Spoznati načine za zagotavljanje ustrezne zanesljivosti (zanesljivost posameznih komponent, redundanca, diverziteta)

Spoznati vrste zaščitne opreme in posamezne varnostne naprave. Spoznati varnostne sisteme in nivoje integritete teh sistemov.

Spoznati oceno tveganja, izjavo o skladnosti in oznako CE.

### **Objectives and competences:**

**Objectives:**

To learn the basic principles of health and safety at work and the social context within which they belong.

To get a deep knowledge of the principles of ensuring the safety of machinery and devices using built-in and added safety. An iterative process of ensuring safety within the design process.

To know the reliability of the technical system and its importance for ensuring safety. Find out ways of ensuring adequate reliability (component reliability, redundancy, diversity)

To learn the types of protective equipment and individual safety devices. Know the security systems and their safety integrity levels.

To learn the risk assessment, the declaration of conformity and the CE

<p>Spoznati namen in strukturo navodil za delo.</p> <p>Spoznati osnovne načine zagotavljanja varnosti delovne opreme ter posebnosti pri posameznih vrstah strojev in naprav.</p> <p>Kompetence:</p> <p>S1-PAP: Sposobnost uporabe pridobljenega znanja s področja zagotavljanja varnosti strojev in naprav v praksi in sicer pri snovanju strojev in naprav, pri izdelavi navodil za uporabo in vzdrževanje ter pri izdelavi izjave o skladnosti z oceno tveganja.</p> <p>S9-PAP: Upoštevanje varnostnih, funkcionalnih, gospodarskih in okoljevarstvenih načel pri snovanju strojev in naprav, izbiri varnostnih naprav in njihove integritete ter snovanju navodil za uporabo in vzdrževanje. Upoštevanje ogljičnega odtisa strojev in naprav.</p> <p>S10-PAP: Sposobnost strokovnega sporazumevanja in pisnega izražanja pri ocenjevanju tveganja in izdelavi navodil.</p> <p>S15-PAP: Razvijanje profesionalne odgovornosti in etičnosti, ki je poglobljena sestavina področij varnosti strojev in naprav, varnosti in zdravja pri delu ter vplivov strojev in naprav na okolje.</p> <p>P6-PAP: Obvladovanje samostojnega projektnega dela pri zagotavljanju varnosti strojev in naprav med njihovim načrtovanjem, pri izdelavi navodil za uporabo in vzdrževanje ter pri izdelavi izjave o skladnosti.</p> <p>P8-PAP: Obvladovanje osnovnih in specifičnih znanj s področja zagotavljanja vgrajene in dodane varnosti strojev in naprav.</p>	<p>marking.</p> <p>To learn the purpose and structure of the instruction manual.</p> <p>To learn the basic ways to ensure the safety of work equipment and the specificities of particular types of machinery and equipment.</p> <p>Competencies:</p> <p>S1-PAP: The ability to use the attained knowledge in the field of machinery and equipment safety in practice, especially in the design of machinery and equipment, in the preparation of instructions for use and for maintenance and during preparation of the declaration of conformity with risk assessment.</p> <p>S9-PAP: Considering the safety, functional, economic and environmental principles in the design of machinery and equipment, in the selection of safety devices and their safety integrity, and the design of operating and maintenance instructions. Consideration of the carbon footprint of machines and appliances.</p> <p>S10-PAP: The ability to communicate professionally and express oneself in writing in risk assessment and in design of instructions for use.</p> <p>S15-PAP: Developing professional responsibility and ethics, which is a major component of the fields of machinery and equipment safety, occupational safety and health, and the environmental impacts of machines and devices.</p> <p>P6-PAP: Mastering independent project work for ensuring the safety of machines and appliances during their design, the preparation of operating and maintenance instructions, and the preparation of a declaration of conformity.</p> <p>P8-PAP: Mastering the basic and required specific knowledge in the field of providing built-in and added safety machines and appliances.</p>
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**Predvideni študijski rezultati:****Znanja:**

Z1: Poglobljeno strokovno teoretično in praktično znanje na določenem področju, podprto s širšo teoretično in metodološko osnovo:

poznavanje osnovnih principov zagotavljanja varnosti in zdravja pri delu ter družbenega okvirja, v katerega sodijo;

poglobljeno poznavanje principov zagotavljanja varnosti strojev in naprav s pomočjo vgrajene in dodane varnosti ter iterativnega postopka zagotavljanja varnosti v procesu snovanja;

poznavanje zanesljivosti tehniškega sistema in njenega pomena za zagotavljanje varnosti. Poznavanje načinov za zagotavljanje ustrezne zanesljivosti;

poznavanje ocene tveganja, izjave o skladnosti in oznake CE ter strukture navodil za delo;

poznavanje osnovnih načinov zagotavljanja varnosti delovne opreme ter posebnosti pri posameznih vrstah strojev in naprav.

**Spretnosti:**

S1.1 Izvajanje kompleksnih operativno-strokovnih opravil, ki vključujejo tudi uporabo metodoloških orodij:

izvedba ocene tveganja;

izvedba zasnove varnega stroja oz. naprave po iterativnem postopku zagotavljanja varnosti;

izvedba analize potrebnega nivoja integritete varnostnega sistema ter njegova zasnova.

S1.2 Obvladovanje zahtevnih, kompleksnih delovnih procesov ob samostojni uporabi znanja v novih delovnih situacijah pri zagotavljanju varnosti določenih strojev in naprav v

**Intended learning outcomes:****Knowledge:**

Z1: Thorough professional theoretical and practical knowledge in a selected field of expertise that is supported with a broad theoretical and methodological basis:

knowledge of the basic principles of safety and health at work and of the social framework to which they belong;

in-depth knowledge of the principles of ensuring the safety of machinery and appliances by using of built-in and added safety, and of the iterative process of ensuring safety in the design process;

knowledge of the reliability of the technical system and its importance for ensuring safety. Knowledge of ways of ensuring adequate reliability;

knowledge of the risk assessment, the declaration of conformity, the CE marking and the structure of the instructions for use;

knowledge of the basic ways of ensuring the safety of work equipment and the specificities of particular types of machinery and equipment.

**Skills:**

S1.1 Executing complex operational-professional tasks that incorporate usage of methodological tools:

carrying out a risk assessment;

design of the safe machine or devices following an iterative process for assurance of safety;

carrying out an analysis of the required safety integrity level of the safety system and the design of safety system.

S1.2 Mastering demanding and complex work processes by independent usage of knowledge in new working situations:

risk assessment;

designing appropriate safety

določenih okoliščinah; ocenjevanje tveganj; načrtovanje ustreznih varnostnih ureditev.	arrangements.
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### **Metode poučevanja in učenja:**

1. P1 Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.
2. P2 Obravnava snovi po urejeni in vnaprej razloženi sistematiki.
3. P7 Študij literature in razprava.
4. P3 Avditorne vaje, kjer se teoretično znanje s predavanj podkrepi z računskimi primeri.
5. P4 Laboratorijske vaje z namenskimi didaktičnimi pripomočki:
a. preskuševališče za demonstracijo dinamičnih vplivov pri nezgodnih dogodkih med obratovanjem žerjava;
b. preskuševališče za prikaz pomembnih funkcij kolaborativnih robotov;
c. preskuševališče z reprezentativnimi varnostnimi napravami/sistemi.
6. P5 Uporaba študijskega gradiva v obliki:
a. knjige,
b. standrdi,
c. skripta,
d. prosojnice s predavanj.
7. P8 Izdelava in predstavitev aplikativnih seminarskih nalog.

### **Learning and teaching methods:**

1. P1 Auditorial lectures with solving selected field-specific theoretical and applied use cases.
2. P2 Treatment of the subject matter according to an orderly and pre-explained systematic system.
3. P7 Literature study and discussion.
4. P3: Auditorial exercises, in which theoretical content from the lectures is supplemented with practical examples.
5. P4 Laboratory exercises with dedicated teaching aids:
a. a test facility to demonstrate the dynamic effects of accidents during crane operation;
b. a test facility to demonstrate important safety functions of collaborative robots;
c. a test facility comprising representative safety devices/systems.
6. P5 Use of study materials in the form of:
a. books,
b. standards,
c. script,
d. slides from lectures.
7. P8 Making and presenting applied seminar exercises.

### **Načini ocenjevanja:**

### **Delež/ Weight**

### **Assessment:**

Teoretična znanja (pisni kolokviji in izpit z opsijskim ustnim zagovorom).	50,00 %	Theoretical knowledge (written colloquia and exam with an optional oral examination).
Aplikativne seminarske naloge (poročila s predstavitvami).	50,00 %	Applied seminar exercises (reports with presentations).

### **Reference nosilca/Lecturer's references:**

Boris Jerman:

**JERMAN, Boris**, ZRNIC, Nenad Đ., JENKO, Matjaž, LERHER, Tone. Energy

regeneration in automated high bay warehouse with stacker cranes: Elektronski vir. Tehnički vjesnik, ISSN 1848-6339, 2017, vol. 24, iss. 5, str. 1411-1416. [http://hrcak.srce.hr/index.php?show=clanak&id\\_clanak\\_jezik=277460](http://hrcak.srce.hr/index.php?show=clanak&id_clanak_jezik=277460), doi: 10.17559/TV-20161219112306. [COBISS.SI-ID 512884797].

VUJIČIĆ, Andrija, ZRNIĆ, Nenad Đ., **JERMAN, Boris**. Ports sustainability : a life cycle assessment of zero emission cargo handling equipment. Strojniški vestnik, ISSN 0039-2480, Sep. 2013, vol. 59, no. 9, str. 547-555, SI 104, ilustr., doi: 10.5545/sv-jme.2012.933. [COBISS.SI-ID 13112859].

DRUSANY, Vladimir, **JERMAN, Boris**. Varnostna naprava z gibljivim zaslonom za ekscentrične stiskalnice. V: Strokovni posvet o varnosti in zdravju pri delu 2004, Bled, 25. november 2004 : delodajalčeva odgovornost za varnost in zdravje pri delu ter posledice slabegavodenja varnosti in zdravja pri delu v podjetjih. [S. l.: s. n.]. 2004, 8 str. [COBISS.SI-ID 10163995].

**JERMAN, Boris**. Ocena potresne ogroženosti portalnega dvigala v skladišču NSRAO v Krškem. Ljubljana: Fakulteta za strojništvo, LASOK, 2019. 20 f., graf. prikazi. [COBISS.SI-ID 16810267]

**JERMAN, Boris**. Ocena tveganja pri cevovodih. V: Varstvo pri delu, varstvo pred požari in medicina dela : dvodnevni posvet z mednarodno udeležbo, Portorož 2005, 17.-18. 5. 2005. Ljubljana: Fakulteta za kemijo in kemijsko tehnologijo, Oddelek za tehniško varnost. 2005, 15 str. [COBISS.SI-ID 10163483]