DIMENZIONIRANJE IN PREDPISI

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Dimenzioniranje in predpisi
Course title:	Dimensioning and Norms
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)	Konstruiranje strojev in naprav (smer)	3. letnik	1. semester	obvezni

Univerzitetna koda predmeta/University course code:	0563428
Koda učne enote na članici/UL Member course code:	3045-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. Boris Jerman, prof. dr. Jernej Klemenc, izr. prof. dr. Domen Šeruga

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:	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.

Vsebina:	Content (Syllabus outline):
1. Predavanje: Osnove standardov in tehniških predpisov – struktura standardov in tehniških predpisov.	1. Lecture: Introduction to standards and technical prescriptions – structure of standards and technical prescriptions.

2. Predavanje: Teorija preračuna gredi in osi na utrujanje: - Upogibne in torzijske napetosti v gredi; - Dinamični faktor obremenitev; - Geometrijski prehodi pri gredeh in oseh. 3. Predavanje: Podrobni preračun gredi in osi na utrujanje po standardu DIN 743. 4. Predavanje: Preračun gredi glede na dopustne deformacije in glede na kritično vrtilno hitrost. 5. Predavanje: Pregled in izhodišča standardov s področja valjastih zobnikov (geometrija, točnost izdelave, vrednotenje). Optimiranje profilnih premikov na zobnikih po standardu DIN 3962. 6. Predavanje: Bočna nosilnost valjastih zobnikov. Vrednotenje zobnikov na bočno nosilnost po standardu SIST ISO 6336-2. 7. Predavanje: Izračun upogibne napetosti v korenu zoba evolventnega zobnika. Določanje korenske nosilnosti po standardu SIST ISO 6336-3. 8. Predavanje: Preračun zvarnih spojev v nosilnih strojnih konstrukcijah: - Zaostale napetosti v zvarnih spojih; - Oblike zvarnih spojev in določitev napetosti v njih. 9. Predavanje: Preračun zvarnih spojev v nosilnih strojnih konstrukcijah: - Obremenitveni spekter zvara; - Vpliv srednje obremenitve v zvaru; - Oblikovna in dopustna napetost zvara. 10. Predavanje: Preračun zvarnih spojev v jeklenih nosilnih strojnih konstrukcijah po standardih SIST EN 1993 - 1-8 in SIST EN 1993 - 1-9 (oba iz EVROKOD 3). 11. Predavanje: Preračun zvarnih spojev v aluminijastih nosilnih strojnih konstrukcijah po standardih SIST EN 1999 - 1-1 in SIST EN 1999 - 1-3 (oba iz EVROKOD 9). 12. Predavanje: Tlačne posode: - Mejne vrednosti nosilnosti za različne obremenitvene primere; - Napetostno-deformacijsko stanje v cilindičnem delu tlačne posode; - Izpeljava kotlovske enačbe. 13. Predavanje: Oblikovanje dna in priključkov tlačne posode: - Različne oblike dna tlačne posode; - Napetostno-deformacijsko stanje v ravnem in sferičnem dnu tlačne posode; - Napetostno-deformacijsko stanje med prehodom v dno tlačne posode; - Priključki na tlačnih posodah. 14. Predavanje: Preračun tlačnih posod po Direktivi 2014/68-EU in standardu SIST EN 13445-3. 15. Predavanje: Uporaba numeričnih metod pri preračunu tlačnih posod.	2. Lecture: Theory of fatigue evaluation for shafts and axles: - Bending and torsional stresses in shafts; - Dynamic factor of loading; - Geometric details for shafts and axles. 3. Lecture: Strength calculation for shafts and axles according to DIN 743 standard. 4. Lecture: Evaluation of the shafts with respect to permissible deformations and with respect to the critical rotational speed. 5. Lecture: Outline of standards in the area of spur gears (geometry, accuracy, evaluation). Optimization of profile shift on gears according to standard DIN 3962. 6. Lecture: Surface durability of cylindrical gears. Calculation of surface durability (pitting) according to standard SIST ISO 6336-2. 7. Lecture: Determination of the stresses at the tooth root of the spur gear. Calculation of tooth bending strength according to standard SIST ISO 6336-3. 8. Lecture: Calculation of welded joints in load-carrying structures: - Residual stresses in welded joints; - Geometry of welded joints and stress calculation according to the welded-joint geometry. 9. Lecture: Calculation of welded joints in load-carrying structures: - Loading spectrum of a welded joint; - Influence of a mean stress in the welded joint; - Geometric and allowable stress in the welded joint. 10. Lecture: Calculation of welded joints in load-carrying structures according to standards SIST EN 1993 - 1-8 and SIST EN 1993 - 1-9 (both from the series of EUROCODE 3 standards). 11. Lecture: Calculation of welded joints in load-carrying structures according to standards SIST EN 1993 - 1-8 and SIST EN 1993 - 1-9 (both from the series of EUROCODE 3 standards). 12. Lecture: Pressure vessels: - Limiting strength criteria for different load cases; - Stress-strain distribution in a cylindrical part of a pressure vessel; - Derivation of a boiler equation. 13. Lecture: Designing a bottom and the attachments of the pressure vessel: - Different geometries of pressure vessel bottoms; - Stress-strain distribution in a flat and spherical bottom of the pressure vessel; - Stress-strain distribution in a toroidal transition between the cylindrical and spherical parts of the pressure vessel; - Attachments of the pressure vessel. 14. Lecture: Calculation of pressure vessels according to directive 2014/68-EU and standard SIST EN 13445-3. 15. Lecture: Application of numerical methods for calculation of the pressure vessels.

Temeljna literatura in viri/Readings:

1. Wittel H., Jannasch D., Vossiek J., Spura C. Roloff/Matek Maschinenelemente – 23. Auflage. Springer Vieweg, 2017. [COBISS.SI-ID 15706907]
2. Standard SIST EN 1993 - 1-8 (iz serije EVROKOD 3). Prosto dostopno na spletu
3. Standard in SIST EN 1993 - 1-9 (iz serije EVROKOD 3). Prosto dostopno na spletu
4. Standard SIST EN 1999 - 1-1 (iz serije EVROKOD 9). Prosto dostopno na spletu
5. Standard SIST EN 1999 - 1-3 (iz serije EVROKOD 9). Prosto dostopno na spletu
6. EU Direktiva 2014/68-EU. Prosto dostopno na spletu
7. Pravilnik o tlačni opremi (Uradni list RS, št. 66/16 in 59/18). Prosto dostopno na spletu

Cilji in kompetence:	**Objectives and competences:**
Cilji: 1. Spoznati ustroj tehničnih standardov in njihovo uporabo v praksi. 2. Poglobljeno spoznati teoretično ozadje in uporabo standardov na izbranih področjih strojnih nosilnih konstrukcij. 3. Spoznati omejitve posameznih standardov. 4. Spoznati uporabnost standardov tudi v povezavi z numerično analizo strojnih konstrukcij. Kompetence: 1. S1-PAP: Sposobnost uporabe tehniških standardov v praksi. 2. S9-PAP: Sposobnost upoštevanja s standardi predpisanih varnostnih, in funkcionalnih omejitev pri vrednotenju strojnih konstrukcij. 3. P6-PAP: Obvladovanje samostojnega projektnega dela na področju analize varjenih in vijačenih konstrukcij, tlačnih posod ter rotirajočih strojnih elementov. 4. P7-PAP: Poznavanje programskih orodij za računalniško analizo konstrukcij: Ansys, Abaqus. 5. P8-PAP: Obvladovanje osnovnih in specifičnih znanj s področja snovanja, obratovanja in vzdrževanja strojnih konstrukcij.	Objectives: 1. To learn structure of technical standards and their application in practice. 2. To get a deep knowledge of theoretical background and a skill of standard application in selected fields of structure design. 3. To understand the limits of the individual standards. 4. To train application of standards in combination with numerical analyses of mechanical structures. Competences: 1. S1-PAP: The ability to use the technical standards in the practice. 2. S9-PAP: Considering the safety, functional, economic and environmental principles in their work that are prescribed with standards. 3. P6-PAP: Mastering independent project work in the field of analysis of bolted and welded structures, pressure vessels and rotating machine elements. 4. P7-PAP: Knowing some software tools necessary for computer aided analysis: Ansys, Abaqus. 5. P8-PAP: Mastering the basic and required specific knowledge from the field of engineering design, machine operation and maintenance.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanja: Z1: Poglobljeno strokovno teoretično in praktično znanje na določenem področju, podprto s širšo teoretično in metodološko osnovo: • Razumevanje sistema standardizacije s področja tehnike. • Poglobljeno razumevanje principov nosilnosti in odpovedi rotirajočih strojnih elementov in nosilnih strojnih konstrukcij; • Poglobljeno razumevanje principov oblikovanja za izbrane konstrukcije in/ali konstrukcijske elemente. Spretnosti: S1.1 Izvajanje kompleksnih operativno-strokovnih opravil, ki vključujejo tudi uporabo metodoloških orodij: • Izvedba natančnih trdnostnih preračunov v skladu	Knowledge: Z1: Thorough professional theoretical and practical knowledge in a selected field of expertise that is supported with a broad theoretical and methodological basis: • Understanding a technical standardisation system. • Deep understanding of principles related to load-carrying capacity and failure of rotating machine elements and structures with a load-carrying function. • Deep understanding of design principles for the selected structural and machine elements. Skills: S1.1 Executing complex operational-professional tasks that incorporate usage of methodological tools: • Performing exact strength calculations according to the corresponding standards for the selected structural and machine elements.

s standardi za izbrane konstrukcije in/ali konstrukcijske elemente. S1.2 Obvladovanje zahtevnih, kompleksnih delovnih procesov ob samostojni uporabi znanja v novih delovnih situacijah: • Uporaba računalniško podprtih tehnologij za načrtovanje in analizo obnašanja naprav v realnih obratovalnih razmerah.	S1.2 Mastering demanding and complex work processes by independent usage of knowledge in new working situations: • Application of computer aided technologies for design and analysis of machines in real operating conditions.

Metode poučevanja in učenja:	**Learning and teaching methods:**
1. P1: Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov. 2. P3: Avditorne vaje, kjer se teoretično znanje s predavanj podkrepi z računskimi primeri. 3. P7: Študij literature in razprava. 4. P8: Izdelava in predstavitev aplikativnih seminarskih nalog. 5. P12: Individualizirane domače naloge v spletni učilnici.	1. P1: Auditorial lectures with solving selected field-specific theoretical and applied use cases. 2. P3: Auditorial execises, in which theoretical content from the lectures is supplemented with practical examples. 3. P7: Literature study and discussion. 4. P8: Making and presenting applied seminar exercises. 5. P12: Individualised homeworks in a web classroom.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Teoretična znanja (pisni kolokviji in izpit z ustnim zagovorom).	50,00 %	Theoretical knowledge (written colloquia and exam with an oral examination).
Aplikativne seminarske naloge (poročila s predstavitvami).	20,00 %	Applied seminar exercises (reports with presentations).
Laboratorijske vaje (poročila).	10,00 %	Laboratory exercises (reports).
Pisni preskus praktičnega znanja, osvojenega na vajah.	20,00 %	Written examination of practical knowledge that was acquired in exercises.

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:

Jernej Klemenc:

1. TOMAŽINČIČ, Dejan, NEČEMER, Branko, VESENJAK, Matej, **KLEMENC, Jernej**. Low-cycle fatigue life of thin-plate auxetic cellular structures made from aluminium alloy 7075-T65 Fatigue & fracture of engineering materials & structures, vol. 42, iss. 5, str. 1022-1036, doi: 10.1111/ffe.12966. [COBISS.SI-ID 16549915]
2. KOCJAN, Tadej, NAGODE, Marko, **KLEMENC, Jernej**, OMAN, Simon. Prediction of actual fatigue test temperature and isothermal fatigue life curves for non-crystallising rubber under fully relaxing uni-axial loading conditions. International journal of fatigue. Apr. 2022, vol. 157, str. 1-13, ilustr. ISSN 0142-1123. https://www.sciencedirect.com/science/article/pii/S0142112321004679, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=141044, DOI: 10.1016/j.ijfatigue.2021.10662 [COBISS.SI-ID 92807171]
3. ZOBEC, Peter, **KLEMENC, Jernej**. Investigation of crack path near cold expanded hole. V: BERTO, Filippo (ur.). 2nd Mediterranean Conference on Fracture and Structural Integrity : MedFract2 : February 14-16, 2022, Catania (Italy) & Web. [Amsterdam]: Elsevier, 2022. Vol. 41, str. 208-214, ilustr. Procedia structural integrity, vol. 41. ISSN 2452-3216. https://www.sciencedirect.com/science/article/pii/S2452321622004814, DOI: 10.1016/j.prostr.2022.05.02 [COBISS.SI-ID 111051523]
4. MIKELJ, Martin, NAGODE, Marko, **KLEMENC, Jernej**, ŠERUGA, Domen. Influence of operating conditions on a cast-iron manhole cover. Technologies. Dec. 2022, vol. 10, iss. 6, str. 1-10, ilustr. ISSN 2227-7080. https://www.mdpi.com/2227-7080/10/6/127, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=143222, DOI: 10.3390/technologies10060127. [COBISS.SI-ID 132950531]

5. OKORN, Ivan, NAGODE, Marko, **KLEMENC, Jernej**, OMAN, Simon. Analysis of additional load and fatigue life of preloaded bolts in a flange joint considering a bolt bending load. Metals. Mar. 2021, vol. 11, iss. 3, str. 1-20, ilustr. ISSN 2075-470 https://www.mdpi.com/2075-4701/11/3/449, https://repozitorij.uni-lj.si/IzpisGradiva.php?id=126175, DOI: 10.3390/met11030449. [COBISS.SI-ID 59147523]

Boris Jerman:

1. HLADNIK, Jurij, SUPEJ, Matej, VODIČAR, Janez, **JERMAN, Boris**. The influence of boot longitudinal flexural stiffness on external mechanical work and running economy during skate roller-skiing : a case study. Proceedings of the Institution of Mechanical Engineers. Part P, Journal of sports engineering and technology (Print). 2019, vol. 233, iss. 4, str. 548-558, ilustr. ISSN 1754-3371. [COBISS.SI-ID 16765211]
2. HLADNIK, Jurij, MAJDIČ, Franc, ČELIK, Anže, **JERMAN, Boris**. Dependence of the preload on the tightening torque for hydraulic plugs. Applied sciences. 2024, vol. 14, iss. 24, [art. no.] 11920, str. 1-12, ilustr. ISSN 2076-3417. https://www.mdpi.com/2076-3417/14/24/11920, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.3390/app142411920. [COBISS.SI-ID 220212995]
3. PODRŽAJ, Primož, **JERMAN, Boris**, SIMONČIČ, Samo. Poor fit-up condition in resistance spot welding. Journal of materials processing technology, ISSN 0924-0136. [Print ed.], Apr. 2016, vol. 230, str. 21-25, ilustr., doi: 10.1016/j.jmatprotec.2015.11.009. [COBISS.SI-ID 14378779]
4. HLADNIK, Jurij, MAJDIČ, Franc, ČELIK, Anže, **JERMAN, Boris**. Hydraulic plug preload in dependence from tightening torque. V: KARTNIG, Georg (ur.), ZRNIĆ, Nenad Đ. (ur.), BOŠNJAK, Srđan (ur.). MHCL 2024 : XXV International Conference on "Material Handling, Constructions and Logistics" September 18th – 19th, 2024, Vienna, Austria. Wien: Technische Universität Wien, Faculty of Mechanical and Industrial Engineering, Institute of Engineering Design and Product Development, 2024. Str. 85-88, ilustr. ISBN 978-3-200-10036-7. [COBISS.SI-ID 210595587]
5. RUPAR, Domen, **JERMAN, Boris**. Digestor : spoj plašča posode in prirobnice dna tlačne posode. Ljubljana: Fakulteta za strojništvo, 2018. 5 f., ilustr. [COBISS.SI-ID 16161051]

Domen Šeruga:

1. NAGODE, Marko, KLEMENC, Jernej, OMAN, Simon, **ŠERUGA, Domen**. Elasto-viscoplastic material modelling using the multiaxial Prandtl operator approach. International journal of mechanical sciences. 2024, vol. 267, [article no.] 108953, str. 1-16, ilustr. https://www.sciencedirect.com/science/article/pii/S002074032300855X, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.ijmecsci.2023.108953. [COBISS.SI-ID 183728643]
2. TOMAŽINČIČ, Dejan, ZOBEC, Peter, VRH, Marko, GOSAR, Aleš, ŠVEGELJ, Jurij, MUC, Matic, MALNARIČ, Vili, KLEMENC, Jernej, **ŠERUGA, Domen**. Durability prediction of cyclically loaded CP-W800 fillet welds. Solids. 2024, vol. 5, iss. 1, str. 84–97, ilustr. ISSN 2673-6497. https://www.mdpi.com/2673-6497/5/1/6, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.3390/solids5010006. [COBISS.SI-ID 184009475]
3. GABER, Klara, ŠKRLEC, Andrej, KLEMENC, Jernej, **ŠERUGA, Domen**. Design, testing, and sensitivity analysis of a torsional cyclic test adapter. Machines. 2024, vol. 12, iss. 2, [article no.] 90, str. 1-20, ilustr. ISSN 2075-1702. https://www.mdpi.com/2075-1702/12/2/90, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.3390/machines12020090. [COBISS.SI-ID 184011523]
4. **ŠERUGA, Domen**, KLEMENC, Jernej, OMAN, Simon, NAGODE, Marko. Stress-strain simulation of a porous metallic material using femimplemented prandtl operator approach. V: IBRAHIMBEGOVIĆ, Adnan (ur.), DOLAREVIĆ, Samir (ur.), ČOHODAR HUSIĆ, Maida (ur.). ECCOMAS MSF 2023 : 6th International Conference on Multi-scale Computational Methods for Solids and Fluids, June 25-27, 2023, Sarajevo : proceedings. Sarajevo: Faculty of Civil Engineering, 2023. Str. 73-76, ilustr. ISBN 978-9958-638-73-2. https://eccomas.gf.unsa.ba/Eccomas_2023_proceedings.pdf. [COBISS.SI-ID 155649027]
5. **ŠERUGA, Domen**, KLEMENC, Jernej, OMAN, Simon, NAGODE, Marko. Elastoplastic response of a pipe bend using Prandtl operator approach in a finite element analysis. V: YALÇINKAYA, Tuncay (ur.). 2nd International Workshop on Plasticity, Damage and Fracture of Engineering Materials (IWPDF 2021), 18-20 August 2021, Ankara, Turkey. 2nd International Workshop on Plasticity, Damage and Fracture of Engineering Materials (IWPDF 2021), 18-20 August 2021, Ankara, Turkey. [S. l.: s. n.], 2022. Vol. 35, str. 150-158, ilustr. Procedia structural integrity, Vol. 35. ISSN 2452-3216. https://www.sciencedirect.com/science/article/pii/S2452321621003061, Repozitorij Univerze v Ljubljani – RUL, DOI: 10.1016/j.prostr.2021.12.059. [COBISS.SI-ID 93442563]