

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	Konstruiranje strojev in naprav (smer)	3. letnik	1. semester	obvezna

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:	Boris Jerman, Jernej Klemenc
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Vrsta predmeta/Course type:	Izbirni strokovni predmet /Elective specialised course
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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.
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Vsebina:

1. Predavanje: Osnove standardov in tehniških predpisov – struktura standardov in tehniških predpisov.
2. Predavanje: Teorija preračuna gredi in osi na utrujanje:
 - Upogibne in torzijske napetosti v gredi;
 - Dinamični faktor obremenitev;
 - Geometrijski prehodi pri gredih in oseh.
3. Predavanje: Podrobni preračun gredi in osi na utrujanje po standardu DIN 743.
4. Predavanje: Teorija preračuna prednapetih vijčnih spojev v nosilnih strojnih konstrukcijah:
 - Prenos osne, prečne in momentne obremenitve na vijake;
 - Razporeditev vijakov v spoju;
 - Princip nošenja obremenitve.
5. Predavanje: Teorija preračuna prednapetih vijčnih spojev v nosilnih strojnih konstrukcijah:
 - Necentrične obremenitve vijakov.
6. Predavanje: Oblikovanje prednapetih vijčnih spojev v nosilnih strojnih konstrukcijah po standardu SIST EN 1993 - 1-8 (iz serije EVROKOD 3).
7. Predavanje: Preračun prednapetih vijčnih spojev v nosilnih strojnih konstrukcijah po standardu SIST EN 1993 - 1-8 (iz serije EVROKOD 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.

Content (Syllabus outline):

1. Lecture: Introduction to standards and technical prescriptions – structure of standards and technical prescriptions.
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: Theory of calculation for pre-stressed bolts in load-carrying structures:
 - Transfer of torques, bending moments, axial and lateral forces to bolts;
 - Distribution of bolts in a bolted joint;
 - Principle of load distribution over the bolts in the joint.
5. Lecture: Theory of calculation for pre-stressed bolts in load-carrying structures:
 - Eccentric bolt loads.
6. Lecture: Design of pre-stressed bolt joints in load-carrying structures according to standard SIST EN 1993 - 1-8 (from a series of EUROCODE 3 standards).
7. Lecture: Calculation of pre-stressed bolt joints in load-carrying structures according to standard SIST EN 1993 - 1-8 (from the series of EUROCODE 3 standards).
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:

<p>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).</p> <p>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).</p> <p>12. Predavanje: Tlačne posode:</p> <ul style="list-style-type: none"> - Mejne vrednosti nosilnosti za različne obremenitvene primere; - Napetostno-deformacijsko stanje v cilindričnem delu tlačne posode; - Izpeljava kotlovske enačbe. <p>13. Predavanje: Oblikovanje dna in priključkov tlačne posode:</p> <ul style="list-style-type: none"> - 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. <p>14. Predavanje: Preračun tlačnih posod po Direktivi 2014/68-EU in standardu SIST EN 13445-3.</p> <p>15. Predavanje: Uporaba numeričnih metod pri preračunu tlačnih posod.</p>	<ul style="list-style-type: none"> - Loading spectrum of a welded joint; - Influence of a mean stress in the welded joint; - Geometric and allowable stress in the welded joint. <p>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).</p> <p>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).</p> <p>12. Lecture: Pressure vessels:</p> <ul style="list-style-type: none"> - Limiting strength criteria for different load cases; - Stress-strain distribution in a cylindrical part of a pressure vessel; - Derivation of a boiler equation. <p>13. Lecture: Designing a bottom and the attachments of the pressure vessel:</p> <ul style="list-style-type: none"> - 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. <p>14. Lecture: Calculation of pressure vessels according to directive 2014/68-EU and standard SIST EN 13445-3.</p> <p>15. Lecture: Application of numerical methods for calculation of the pressure vessels.</p>
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Temeljna literatura in viri/Readings:

1. Shigley J.E., Mischke C.R., Budynas R.G. Mechanical Engineering Design – 7th edition. McGraw-Hill, 2004.
2. Wittel H., Jannasch D., Vossiek J., Spura C. Roloff/Matek Maschinenelemente – 23. Auflage. Springer Vieweg, 2017.
3. Standard SIST EN 1993 - 1-8 (iz serije EVROKOD 3).
4. Standard in SIST EN 1993 - 1-9 (iz serije EVROKOD 3).
5. Standard SIST EN 1999 - 1-1 (iz serije EVROKOD 9).
6. Standard SIST EN 1999 - 1-3 (iz serije EVROKOD 9).
7. EU Direktiva 2014/68-EU.
8. Pravilnik o tlačni opremi (Uradni list RS, št. 66/16 in 59/18)

Cilji in kompetence:

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 and competences:

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:

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

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:

- Understanding a technical standardisation system.
- Deep understanding of principles

<p>strojnih elementov in nosilnih strojnih konstrukcij;</p> <ul style="list-style-type: none"> • Poglobljeno razumevanje principov oblikovanja za izbrane konstrukcije in/ali konstrukcijske elemente. <p>Spretnosti:</p> <p>S1.1 Izvajanje kompleksnih operativno-strokovnih opravil, ki vključujejo tudi uporabo metodoloških orodij:</p> <ul style="list-style-type: none"> • Izvedba natančnih trdnostnih preračunov v skladu s standardi za izbrane konstrukcije in/ali konstrukcijske elemente. <p>S1.2 Obvladovanje zahtevnih, kompleksnih delovnih procesov ob samostojni uporabi znanja v novih delovnih situacijah:</p> <ul style="list-style-type: none"> • Uporaba računalniško podprtih tehnologij za načrtovanje in analizo obnašanja naprav v realnih obratovalnih razmerah. 	<p>related to load-carrying capacity and failure of rotating machine elements and structures with a load-carrying function.</p> <ul style="list-style-type: none"> • Deep understanding of design principles for the selected structural and machine elements. <p>Skills:</p> <p>S1.1 Executing complex operational-professional tasks that incorporate usage of methodological tools:</p> <ul style="list-style-type: none"> • Performing exact strength calculations according to the corresponding standards for the selected structural and machine elements. <p>S1.2 Mastering demanding and complex work processes by independent usage of knowledge in new working situations:</p> <ul style="list-style-type: none"> • Application of computer aided technologies for design and analysis of machines in real operating conditions.
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Metode poučevanja in učenja:

<ol style="list-style-type: none"> 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. 	<ol style="list-style-type: none"> 1. P1: Auditorial lectures with solving selected field-specific theoretical and applied use cases. 2. P3: Auditorial exercises, 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.
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Načini ocenjevanja:

Delež/ Weight

Assessment:

Teoretična znanja (pisni kolokviji in izpit z opcijskim ustnim zagovorom).	50,00 %	Theoretical knowledge (written colloquia and exam with an optional oral examination).
Aplikativne seminarske naloge (poročila s predstavitvami).	20,00 %	Applied seminar exercises (reports with presentations).
Avditorne vaje (poročila).	10,00 %	Auditorial exercises (reports).
Pisni preskus praktičnega znanja, osvojenega na vajah.	20,00 %	Written examination of practical knowledge that was acquired in exercises.

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. MIKLAVEC, Matej, **KLEMENC, Jernej**, KOSTANJEVEC, Andrej, FAJDIGA, Matija. Properties of a metal/nonmetal hybrid joint with an improved shape of the metal insert. Experimental techniques, vol. 39, iss. 1, str. 69-76, doi: 10.1111/ext.12003. [COBISS.SI-ID 12583707]
3. BIŽAL, Ana, **KLEMENC, Jernej**, FAJDIGA, Matija. Modelling the fatigue life reduction of an AlSi9Cu3 alloy caused by macro-porosity. Engineering with computers, vol. 31, iss. 2, str. 259-269, doi: 10.1007/s00366-013-0345-7. [COBISS.SI-ID 13241627]
4. ŠKRLEC, Andrej, **KLEMENC, Jernej**, ZUPANC, Mirko, MALNARIČ, Vili. Numerical simulation of the whiplash test for a front car seat according to ECE and Euro NCAP regulations. V: GOLOBIČ, Iztok (ur.), CIMERMAN, Franc (ur.). Engineering - development and innovations for new employments 2014: proceedings of the 4th AMES International Conference, Ljubljana, Slovenia, October 23th, 201 1st ed. Ljubljana: Association of Mechanical Engineers of Slovenia - AMES. 2015, str. 205-212. [COBISS.SI-ID 14141467]
5. FRANKO, Mitja, ZOBEC, Peter, **KLEMENC, Jernej**. Simulacija gredi in grednih vezi elektromotorja : poročilo. Ljubljana: Fakulteta za strojništvo, Katedra za strojne elemente in razvojna vrednotenja, 2016. 160 str. [COBISS.SI-ID 15099419]

Boris Jerman:

1. **JERMAN, Boris**, KRAMAR, Janez. A study of the horizontal inertial forces acting on the suspended load of slewing cranes. International journal of mechanical sciences, ISSN 0020-7403. [Print ed.], 2008, letn. 50, št. 3, str. 490-500. <http://dx.doi.org/10.1016/j.ijmecsci.2007.09.013>. [COBISS.SI-ID 10484507]
2. BOŠNJAK, Srđan, PETKOVIĆ, Zoran, GNJATOVIĆ B., Nebojša, MILENOVIĆ LJ., Ivan, **JERMAN, Boris**. Impact of the track wheel axles on the strength of the bucket wheel excavator two-wheel bogie. Tehnički vjesnik : znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku, ISSN 1330-3651, 2013, god. 20, br. 5, str. 803-810, ilustr. [COBISS.SI-ID 13212443]
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.
4. ČUK, Metod, **JERMAN, Boris**. Finite element investigation on the structural behaviour of longitudinal joints of sandwich panels. V: BOŠNJAK, Srđan (ur.), KARTING, George (ur.), ZRNIĆ, Nenad Đ. (ur.). XX International Conference on "Material Handling, Constructions and Logistics" - MHCL'12, 3-5 October 2012, Belgrade, Serbia. Belgrade: Faculty of Mechanical Engineering. 2012, str. 297-302, ilustr. [COBISS.SI-ID 12710427]
5. RUPAR, Domen, **JERMAN, Boris**. Digestor : spoj plašča posode in prirobnice dna tlačne posode. Ljubljana: Fakulteta za strojništvo, 2018. 5 f., ilustr.

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