Univerza v Mariboru

Fakulteta za strojništvo

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Optimiranje topologije konstrukcij**
Course title:	**Structural topology optimization**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Strojništvo	Nelinearna mehanika	1	poletni
Mechanical Engineering	Nonlinear mechanics	1	Spring

Vrsta predmeta / Course type:

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Avdit. Vaje Tutorial	Lab. vaje Lab. work	Teren. vaje Field work	Rač. vaje Comp. work	Samost. delo Individ. work	ECTS
30	30	-	-	-	-	120	6

Nosilec predmeta / Lecturer: Marko Kegl

Jeziki / Languages:

Predavanja / Lectures:	Slovenski jezik / Slovene language
Vaje / Tutorial:	Slovenski jezik / Slovene language

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

-

Prerequisits:

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Vsebina:

- Uvod. Optimizacija topologije z razporejanjem materiala.
- Formulacija problema: optimizacija glede na deformacijsko energijo, optimizacija glede na lastne frekvence, parametrizacija konstrukcije, alternativne možnosti
- Metode reševanja: evolucijske in level-set metode, koeficienti občutljivosti, priprava modela, učinkovito modeliranje nelinearnih vplivov.
- Formulacija in vsiljevanje tehnoloških pogojev, konfiguriranje domene, volumski, lupinski in rešetkasti konfiguratorji.
- Učinkovita numerična implementacija procesa optimizacije in izboljševanje rezultata.

Content (Syllabus outline):

- Introduction. Topology optimization by distribution of material.
- Problem formulation: minimum strain energy design, maximum lowest eigenfrequency design, design parametrization, alternative possibilities
- Methods of solution: evolutionary and level-set methods, sensitivity coefficients, preparation of the model, efficient modeling of nonlinear effects.
- Formulation and enforcement of technological constraints, configuring of the domain, solid, shell and lattice configurators.
- Efficient numerical implementation of the optimization process and result enhancement.

Temeljni literatura in viri / Readings:

- X. Huang, Y.M. Xie, Evolutionary Topology Optimization of Continuum Structures, John Wiley & Sons, 2010.
- M. P. Bendsoe, O. Sigmund: Topology Optimization: Theory, Methods and Applications, Springer Verlag, 2003.

Cilji in kompetence:

Cilji:

- pridobitev potrebna znanja za uporabo optimizacije topologije kot orodja za konstruiranje;

Kompetence:

- kombiniranje predhodno pridobljenih znanj, spretnosti in veščin iz matematike in mehanike za oblikovanje nosilnih delov na osnovi MKE analize.

Objectives and competences:

Objectives:

- to give the student the necessary knowledge for use of topology optimization as a design tool;

Competences:

- combination of knowledge, skills and behavior from mathematics and mechanics for FEA-driven design of load-carrying parts.

Predvideni študijski rezultati:

Znanje in razumevanje:
Po zaključku tega predmeta bo študent sposoben

- izkazati znanje iz področja optimizacije topologije konstrukcij
- načrtovati in izdelati optimizacijski model ter ga rešitve
- ovrednotiti dobljene rezultate in potencialne možnosti za nadaljnje izboljšanje konstrukcije

Prenesljive/ključne spretnosti in drugi atributi:

- Spretnosti komuniciranja: ustni zagovor seminarja, ustni izpit
- Uporaba informacijske tehnologije: razvoj računalniške kode ter uporaba programskih orodij za optimizacijo

  Reševanje problemov: analiziranje, načrtovanje in reševanje optimizacijskih nalog

Intended learning outcomes:

Knowledge and understanding:
On completion of this course the student will be able to

- demonstrate knowledge from the field of structural topology optimization
- plan and formulate the optimization model and solve it
- evaluate the results and potential possibilities for further improvement of the structure

Transferable/Key skills and other attributes:

- *Communication skills:* oral seminar work defence, manner of expression at oral examination.
- *Use of information technology:* development of software code and use of software tools for optimization
- *Problem solving:* break down, planning and solving of optimization tasks

Metode poučevanja in učenja:

- predavanja
- seminarska naloga

Learning and teaching methods:

- lectures
- seminar work

Načini ocenjevanja: Delež (v %) / Weight (in %) **Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):

• opravljena seminarska naloga • ustni izpit	**50%** **50%**	• completed seminar work • oral examination

Reference nosilca / Lecturer's references:

1. HARL, Boštjan, PREDAN, Jožef, GUBELJAK, Nenad, KEGL, Marko. On configuration-based optimal design of load-carrying lightweight parts. *International journal of simulation modelling*, ISSN 1726-4529, June 2017, vol. 16, no. 2, str. 219-228, doi: 10.2507/IJSIMM16(2)3.369. [COBISS.SI-ID 20622614]

2. KEGL, Breda, KEGL, Marko. Experimental investigation review of biodiesel usage in bus diesel engine. *Thermal science*, ISSN 0354-9836, 2017, vol. 21, iss. 1, Part B, str. 639-654. http://thermalscience.vinca.rs/pdfs/papers-2016/TSCI160601224K.pdf, doi: 10.2298/TSCI160601224K. [COBISS.SI-ID 19860246]

3. KEGL, Marko, HARL, Boštjan. Topology optimization using nonlinear finite elements and control-point-based parametrization. *International journal of nonlinear sciences and numerical simulation*, ISSN 1565-1339. [Print ed.], Jul. 2013, vol. 14, iss. 5, str. 275-283, graf. prikazi, doi: 10.1515/ijnsns-2012-0041. [COBISS.SI-ID 17160982]