

	UČNI NAČRT PREDMETA/COURSE SYLLABUS
Predmet	Prenos toplote in snovi v stavbah z osnovami KGH
Course title	Heat and Mass Transfer in Buildings with HVAC Fundamentals

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Tehnologije in sistemi v strojništvu/ 2. stopnja	Ni smeri študija	2. letnik	3.
Technologies and systems in mechanical engineering/ 2 nd Cycle	No study field	2 nd year	3 rd

Vrsta predmeta/Course type

Modularni/module

Univerzitetna koda predmeta/University course code

TSS M3 UN 2

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
30			30		120	6

Nosilec predmeta/Lecturer:

prof. dr. Ivan Bajsić

Jeziki/ Predavanja/Lectures:
Languages: Vaje/Tutorial:

slovenski/Slovenian
slovenski/Slovenian

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

Prerequisites:

<ul style="list-style-type: none"> Vpis v drugi letnik študijskega programa. Študent mora pred izpitom pripraviti in predstaviti ter zagovarjati projektno seminarsko nalogo. 	<ul style="list-style-type: none"> A prerequisite for inclusion is enrolment in the second year of study. Student has to prepare, present and defend a project seminar before the exam.
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Vsebina:

Content (Syllabus outline):

<ul style="list-style-type: none"> <i>Osnove gradbene fizike.</i> Meteorološke projektne osnove. Notranji bivalni pogoji in toplotno ugodje. Vlažen zrak. Kakovost zraka in vonjave. Prehod toplote skozi gradbene konstrukcije. Prehod vlage skozi gradbene konstrukcije. Toplotna izolacija stavb. <i>Zimske izgube toplote.</i> Izračun izgub toplote. <i>Letni dobitki toplote.</i> Izračun toplotnih obremenitev. <i>Letna raba energije.</i> <i>Raba primarne energije za ogrevanje in hlajenje.</i> <i>Metode numeričnih simulacij stavb in sistemov.</i> <i>Osnove KGH:</i> 	<ul style="list-style-type: none"> <i>Fundamentals of building physics.</i> Meteorological bases. Indoor environment and thermal comfort. Humid air. Indoor air quality and odors. Heat transfer through building structures. Mass transfer through building structures. Thermal insulation of buildings. <i>Winter heat demand.</i> Calculation of heat losses. <i>Annual energy use.</i> <i>Use of primary energy for heating and cooling.</i> <i>Numerical simulations of buildings and systems.</i> <i>Fundamentals of HVAC:</i>
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<ul style="list-style-type: none"> • Grelni sistemi. Elementi grelnih sistemov. Generatorji toplote. Ogrevala (radiatorji, konvektorji, sevalno in ploskovno ogrevanje). Sprejemniki sončne energije. Izračun grelnih naprav. • Prezračevalni in klimatizacijski sistemi. Delitev. Procesi klimatizacije. Klimatizacijski sistemi. Rekuperacija toplote. • Hladilna tehnika. Teoretične osnove. Hladiva. Hladilni sistemi. Toplotne črpalke. 	<ul style="list-style-type: none"> • Heating systems. Elements of heating systems. Heat generators. Heaters (radiators, convectors, radiant and surface heating). Solar collectors. Calculation of heating devices. • Ventilation and air conditioning systems. Classification. Air conditioning processes. Air conditioning systems. Heat recovery. • Refrigeration. Theoretical introduction. Refrigerants. Cooling systems. Heat pumps.
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Temeljna literatura in viri/Readings:

Temeljna literatura/Basic literature

- MUHIČ, Simon. *Prenos toplote in snovi v stavbah*. Novo mesto: Fakulteta za tehnologije in sisteme, 2017. ISBN 978-961-6770-38-5.
- MUHIČ, Simon in Bogdan BLAGOJEVIČ. *Tehniška termodinamika*. Novo mesto: Fakulteta za tehnologije in sisteme, 2016. ISBN 978-961-6770-34-7.
- ASHRAE. *2020 ASHRAE Handbook—HVAC Systems and Equipment*. Atlanta: ASHRAE, 2020.
- ASHRAE. *2019 ASHRAE Handbook—HVAC Applications*. Atlanta: ASHRAE, 2019.
- ASHRAE. *2018 ASHRAE Handbook—Refrigeration*. Atlanta: ASHRAE, 2018.
- ASHRAE. *2017 ASHRAE Handbook—Fundamentals*. Atlanta: ASHRAE, 2017.
- RECKNAGEL, Herman idr. *Grejanje i klimatizacija 2012*. Vrnjačka Banja: Interklima, 2012. ISBN 978-86-82685-29-6.

Cilji in kompetence:

Učna enota prispeva predvsem k razvoju naslednjih splošnih in specifičnih kompetenc:

- sposobnost samostojnega in ustvarjalnega raziskovalno-razvojnega dela na področju strojništva,
- sposobnost samostojnega spremljanja in kritične presoje najnovejših dosežkov s področja strojništva in širše,
- sposobnost aktivnega pisnega in ustnega sporazumevanja na visoki strokovni kot tudi na poljudni ravni, odvisno od ciljnega občinstva,
- sposobnost timskega dela s strokovnjaki z različnih področij,
- sposobnost učinkovite uporabe informacijsko-komunikacijske tehnologije,
- sposobnost prevzeti odgovornost za lasten poklicni in osebnostni razvoj,
- sposobnost delovanja v sozvočju s poklicno, okoljsko, socialno in etično odgovornostjo.

Objectives and competences:

The learning unit mainly contributes to the development of the following general and specific competences:

- ability of independent and creative research and development work in the field of mechanical engineering,
- ability to independently perceive and critically assess the latest achievements in the field of mechanical engineering and beyond,
- ability to actively communicate in writing and orally at a high professional as well as at a popular level, depending on the target audience,
- ability to work in teams with experts from different fields,
- ability to effectively use information and communication technology,
- ability to take responsibility for one's own professional and personal development,
- ability to work according to professional, environmental, social and ethical responsibility.

<ul style="list-style-type: none"> • sposobnost samostojnega in ustvarjalnega raziskovalno-razvojnega dela na področju prenosa toplote in snovi v stavbah, • sposobnost samostojnega in ustvarjalnega raziskovalno-razvojnega dela na področju klimatizacije, prezračevanja in gretja stavb, • sposobnost uporabe pridobljenega teoretičnega znanja na področju prenosa toplote in snovi v stavbah ter KGH v inženirski praksi, • sposobnost interdisciplinarnega povezovanja znanja, • sposobnost reševanja konkretnih problemov na področju prenosa toplote in snovi v stavbah ter KGH. 	<ul style="list-style-type: none"> • ability of independent and creative research and development work in the field of heat and mass transfer in buildings, • ability of independent and creative research and development work in the field of air conditioning, ventilation and heating of buildings, • ability to use the acquired theoretical knowledge in the field of heat and mass transfer in buildings and in the HVAC field in engineering practice, • ability to interdisciplinary integrate acquired knowledge, • ability to solve concrete problems in the field of heat and mass transfer in buildings and HVAC.
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Predvideni študijski rezultati:

Študent/šudentka:

- pozna osnove prenosa toplote in snovi v stavbah,
- pozna osnove klimatizacije, gretja in hlajenja stavb,
- spozna drugo tehnično disciplino – arhitekturo in gradbeništvo,
- razume povezavo med prenosom toplote, gradbeno fiziko, meteorološkimi osnovami, ter rabo energije,
- razvije sposobnost uporabe numeričnih orodij za konkretno reševanje inženirskih problemov na področju prenosa toplote in snovi v stavbah ter KGH,
- se usposobi za analizo, sintezo in vrednotenje rezultatov inženirskih problemov na področju prenosa toplote in snovi v stavbah ter KGH,
- se usposobi za analizo, sintezo in vrednotenje vpliva rabe energije stavb na okolje.

Intended learning outcomes:

Students:

- know the basics of heat and mass transfer in buildings,
- know the basics of air conditioning, heating and cooling of buildings,
- get acquainted with another technical discipline - architecture and construction,
- understands the connection between heat transfer, building physics, meteorological base, and energy use,
- develops the ability to use numerical tools to solve engineering problems in the field of heat and mass transfer in buildings and HVAC,
- develop skills to analyze, synthesize and evaluate the results of engineering problems in the field of heat and mass transfer in buildings and HVAC,
- develop skills to analyze, synthesize and evaluate the impact of energy use on the environment.

Metode poučevanja in učenja:

- *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov),
- *laboratorijske vaje*: praktično reševanje več tipičnih problemov v laboratoriju in na računalniku),
- *seminar*: priprava, predstavitev in uspešen zagovor projektne/raziskovalne naloge, (reševanje problemov, študije primera,

Learning and teaching methods:

- *lectures* with active student participation (explanation, discussion, questions, examples, problem solving),
- *laboratory work*: practical solving of several typical problems in laboratory and on a computer),
- *seminar tutorial*: presentation and defence of project/research work (problem solving, studies, critical thinking, discussion, evaluation, project work, team work).

kritično presojanje, diskusija, vrednotenje, projektno delo, timsko delo).	
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Načini ocenjevanja:	Delež (v %) Weight (in %)	Assessment:
Načini: <ul style="list-style-type: none"> • ustni izpit • projektno seminarsko delo Ocenjevalna lestvica: ECTS.	50 % 50 %	Types: <ul style="list-style-type: none"> • oral examination • project seminar Grading scheme: ECTS.