

KLIMATIZACIJA, OGREVANJE, OHLAJEVANJE, PREZRAČEVANJE

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Klimatizacija, ogrevanje, ohlajevanje, prezračevanje
Course title:	AIR-CONDITIONING, HEATING, REFRIGERATION, VENTILATION
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo - Razvojno raziskovalni program, druga stopnja, magistrski	Procesno strojništvo (smer)	1. letnik	2. semester	obvezni

Univerzitetna koda predmeta/University course code:

0566919

Koda učne enote na članici/UL Member course code:

6017-M

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			65	5

Nosilec predmeta/Lecturer:

Uroš Stritih

Izvajalci predavanj:

Izvajalci seminarjev:

Izvajalci vaj:

Izvajalci kliničnih vaj:

Izvajalci drugih oblik:

Izvajalci praktičnega usposabljanja:

Vrsta predmeta/Course type:

Obvezni strokovni predmet na smeri Procesno strojništvo, ki je izbirni strokovni predmet na ostalih smereh./Compulsory specialised course in the study of Process Engineering, which is an elective specialised course in other fields of study.

Jeziki/Languages:

Predavanja/Lectures:

Slovenščina

Vaje/Tutorial:

Slovenščina

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

Izpolnjevanje pogojev za vpis v Magistrski študijski program II. stopnje Strojništvo - Razvojno raziskovalni program.

Meeting the enrollment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.

Vsebina:**Content (Syllabus outline):**

1. Fiziološke, termodinamične in meteorološke osnove:
 - Termoregulacija človeka;
 - Ugodnje v prostoru (PMV-PPD);
 - Meteorološke osnove.
2. Prenos toplote in snovi v stavbah:
 - Prehod toplote v stavbah;
 - Akumulacija toplote v stavbah;
 - Prenos snovi preko stavbnih konstrukcij.
3. Izračun toplotnih izgub (zimsko transmisija):
 - Transmisijske toplotne izgube;
 - Ventilacijske toplotne izgube;
 - Dodatek zaradi prekinitve ogrevanja.
4. Viri in naprave za ogrevanje stavb:
 - Viri energije za ogrevanje stavb;
 - Karakteristike naprav za ogrevanje;
 - Dimenzioniranje naprav za ogrevanje.
5. Razvod in ostala oprema za ogrevanje v stavbah:
 - Izbira in dimenzioniranje cevne mreže;
 - Določevanje tlačnih padcev;
 - Izbira in dimenzioniranje armatur in črpalk.
6. Naprave za oddajo toplote v

1. Physiological, thermodynamic and meteorological basis:
 - Human thermoregulation;
 - Space benefits (PMV-PPD);
 - Meteorological basics.
2. Heat and mass transfer in buildings:
 - Heat transfer in buildings;
 - Heat accumulation in buildings;
 - Mass transfer through building structures.
3. Calculation of heat losses (winter transmission):
 - Transmission heat losses;
 - Ventilation heat losses;
 - Addition for interruption of heating.
4. Building heating sources and installations:
 - Energy sources for heating of buildings;
 - Characteristics of heating devices;
 - Dimensioning of heating appliances.
5. Distribution and other heating equipment:
 - Selection and dimensioning of pipe network

stavbah:	
- Vrste naprav za ogrevanje prostorov;	- Determination of pressure drops;
- Izračuni toplotne oddaje naprav za ogrevanje;	- Selection and dimensioning of fittings and pumps.
- Dimenzioniranje naprav za ogrevanje.	6. Heat emission devices in buildings:
7. Prezračevanje prostorov:	- Types of space heating appliances;
- Pomen prezračevanja (sindrom bolnih stavb);	- Calculations of the heat power of heating appliances;
- Lokalni in centralni sistemi prezračevanja;	- Dimensioning of heating appliances.
- Tehnologije za izrabo odpadnega zraka (rekuperacija, regeneracija).	7. Room ventilation:
8. Izračun toplotnih dobitkov (letna transmisija):	- The importance of ventilation (sick building syndrome);
- Notranji toplotni dobitki;	- Local and central ventilation systems;
- Zunanji toplotni dobitki;	- Technologies for the utilization of waste air heat (requperation, regeneration).
- Dobitki zaradi prezračevanja.	8. Calculation of heat gains (summer transmission):
9. Naprave za hlajenje v stavbah:	- Internal heat gains;
- Vrste naprav za hlajenje;	- External heat gains;
- Izračun oddaje hladu naprav;	- Ventilation gains.
- Dimenzioniranje naprav za hlajenje.	9. Cooling units in buildings:
10. Klimatizacija ter elementi klimatskih naprav:	- Types of cooling devices;
- Lastnosti klimatizacije zraka v prostorih;	- Calculation of the heat emission of cooling devices;
- Elementi klimatske naprave;	- Dimensioning of cooling devices.
- Dimenzioniranje klimatske naprave.	10. Air conditioning and elements:
11. Priprava in razvod zraka za klimatizacijo:	- Air-conditioning properties;
- Čiščenje zraka;	- Elements of air-conditioning;
- Preračun kanalske mreže;	- Dimensioning of Air-conditioning device.
- Dimenzioniranje ventilatorjev.	11. Preparation and distribution of air:
12. Vpihovanje zraka v prostor:	- Air purification;
- Določevanje gibanja zraka v prostoru;	- Calculation of the air ducts;
- Koanda efekt;	- Sizing of fans.
- Dometna razdalja.	12. Blowing air into a room of buildings:
13. Regulacija notranjih sistemov ogrevanja, hlajenja in klimatizacije:	- Determination of air movement;
- Osnovne zračnosti regulacije;	- Coanda effect;
- Vrste regulatorjev;	- Range distance.
- Uporaba in primeri regulacije sistemov.	13. Regulation of internal heating, cooling and air-conditioning systems:
14. Raba in znižanje rabe energije v sistemih:	- Basic properties of regulation;
- Definicija učinkovite rabe energije (URE);	- Types of regulators;
- Računske metode in metode merjenja;	- Use and examples of system regulation.
- Ukrepi za znižanje rabe energije v stavbah.	14. Energy use and reduction in systems:
15. Prikaz delovanja sistema v praksi:	- Definition of energy efficiency (EEU);
	- Calculation and measurement

<ul style="list-style-type: none"> - Prikaz glavnih sestavnih delov sistema; - Predstavitev dimenzioniranja sistema; - Prikaz delovanja sistema v različnih obdobjih. 	<p>methods;</p> <ul style="list-style-type: none"> - Energy use reduction in buildings. <p>15. Demonstration of system operation in practice:</p> <ul style="list-style-type: none"> - Presentation of the main components of the system; - System dimensioning presentation; - Demonstration of system operation at different periods.
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Temeljna literatura in viri/Readings:

1. Recknagel, H. ; Sprenger, E. ; Hönnmann, W. Recknagel: Taschenbuch für Heizung und Klimatechnik : einschließlich Warmwasser- und Kältetechnik, München ; Wien : R. Oldenbourg, 1995, [COBISS.SI-ID [1518107](#)]
2. B. Labudović: Priročnik za ogrevanje, Energetika Marketing, 2006 [COBISS.SI-ID [229592832](#)]
3. B. Labudović: Priručnik za ventilacijo i klimatizacijo, Energetika Marketing, 2000, [COBISS.SI-ID [5391894](#)]
4. ASHRAE Pocket Guide for heating, refrigeration, ventilation, air-conditioning, 1993, [COBISS.SI-ID [12926235](#)]
5. ASHRAE Handbook — HVAC Applications, 2011 [COBISS.SI-ID [15736091](#)]
6. ASHRAE Handbook — Refrigeration, 2010 [COBISS.SI-ID [15736347](#)]
7. ASHRAE Handbook — Fundamentals, 2009 [COBISS.SI-ID [11003675](#)]
8. ASHRAE Handbook — HVAC Systems and Equipment, 2008 [COBISS.SI-ID [15736603](#)]

Cilji in kompetence:

Cilji:

1. Spoznati vsebine in delovanje ogrevalnih naprav in sistemov.
2. Spoznati vsebine in delovanje hladilnih naprav in sistemov.
3. Spoznati vsebine in delovanje prezračevalnih naprav in sistemov.
4. Spoznati vsebine in delovanje klimatizacijskih naprav in sistemov.

Kompetence:

1. S6-RRP, P4-RRP: Sposobnost ocenjevanja, vrednotenja in načrtovanja ogrevalnih in hladilnih naprav in sistemov.
2. S6-RRP, P4-RRP: Sposobnost ocenjevanja in načrtovanja prezračevalnih in klimatizacijskih naprav in sistemov.

Objectives and competences:

Education goals:

1. To get know the contents and functioning of heating devices and systems.
2. To get know the contents and operation of refrigeration systems and systems.
3. To get know the contents and operation of ventilation devices and systems.
4. To get know the contents and operation of air conditioning systems and systems.

Student competence:

1. S6-RRP, P4-RRP: Ability to evaluate and design heating and cooling systems and systems.
2. 2. S6-RRP, P4-RRP: Ability to evaluate and design ventilation and

	air-conditioning systems and systems.
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Predvideni študijski rezultati:	Intended learning outcomes:
<p>Znanja:</p> <p>Z2: Poglobljeno teoretično, metodološko in analitično znanje na področju ogrevanja, ohlajevanja, prezračevanja in klimatizacije.</p> <p>Spretnosti:</p> <p>S2.1: Obvladovanje zelo zahtevnih kompleksnih delovnih procesov na področju ogrevanja, ohlajevanja, prezračevanja in klimatizacije.</p> <p>S2.3: Diagnosticiranje in reševanje problemov na področju ogrevanja, ohlajevanja, prezračevanja in klimatizacije.</p>	<p>Knowledge:</p> <p>Z2: Advanced theoretical, methodological and analytical knowledge in the fields of heating, cooling, ventilation and air conditioning.</p> <p>Skills:</p> <p>S2.1: Dealing with very complex challenges in the areas of heating, cooling, ventilation and air conditioning.</p> <p>S2.3: Diagnosis and problem solving in the fields of heating, cooling, ventilation and air conditioning.</p>

Metode poučevanja in učenja:	Learning and teaching methods:
<p>Klasične oblike poučevanja:</p> <p>P1: Avditorna predavanja z reševanjem izbranih - za področje značilnih - teoretičnih in praktično uporabnih primerov.</p> <p>P3: Avditorne vaje, kjer se teoretično znanje s predavanj podkrepi z računskimi primeri.</p> <p>P4: Laboratorijske vaje z namenskim didaktičnim pripomočki (tudi z dostopom na daljavo).</p> <p>Moderne oblike poučevanja:</p> <p>P6: Interaktivna predavanja.</p> <p>P8: Izdelava in predstavitev aplikativnih seminarskih nalog.</p> <p>P9: Skupinsko delo (razprave za-proti, strukturirana diskusija, projektno delo...).</p> <p>P10: Uporaba anket v realnem času.</p> <p>P12: Individualizirane domače naloge v spletni učilnici.</p>	<p>Classic forms of teaching:</p> <p>P1: Classroom lectures by solving selected - typical and practical examples.</p> <p>P3: Tutorials where theoretical knowledge of lectures is supported by calculation examples.</p> <p>P4: Laboratory exercises with dedicated didactic aids (also with remote access).</p> <p>Advance forms of teaching:</p> <p>P6: Interactive Lectures.</p> <p>P8: Design and presentation of applied seminar work.</p> <p>P9: Group work (discussions for and against, structured discussion, project work...).</p> <p>P10: Use of real-time surveys.</p> <p>P12: Individualized homework in an online classroom.</p> <p>P13: Individualized self-correcting tests.</p>

P13: Individualizirani kolokviji s samodejnim popravljanjem.	P15: Using video content to prepare for lectures and tutorials.
P15: Uporaba video vsebin kot priprava na predavanja in vaje.	

Načini ocenjevanja:	Delež/ Weight	Assessment:
Teoretične vsebine (predavanja).	50,00 %	Theory.
Samostojno delo na vajah.	30,00 %	Tutorials.
Delo na laboratorijskih vajah (vključno s poročili).	20,00 %	Individual lab work (with written reports).

Ocenjevalna lestvica:	Grading system:

Reference nosilca/Lecturer's references:

Uroš Stritih:

1. ZAVRL, Eva, ZUPANC, Gašper, **STRITIH, Uroš**, DOVJAK, Mateja. Overheating reduction in lightweight framed buildings with application of phase change materials. *Strojniški vestnik*. Jan. 2020, vol. 66, no. 1, str. 3-14, ilustr. ISSN 0039-2480. <https://www.sv-jme.eu/article/overheating-reduction-in-lightweight-framed-buildings-with-application-of-phase-change-materials/>, DOI: [10.5545/sv-jme.2019.6244](https://doi.org/10.5545/sv-jme.2019.6244). [COBISS.SI-ID [17015835](https://cobiss.si/17015835)]
2. ZAVRL, Eva, EL MANKIBI, Mohamed, DOVJAK, Mateja, **STRITIH, Uroš**. Experimental investigation of air-based active-passive system for cooling application in buildings. *Sustainable cities and society*. [Spletna izd.]. Oct. 2022, vol. 85, str. 1-13, ilustr. ISSN 2210-6715. <https://www.sciencedirect.com/science/article/pii/S2210670722003511>, <https://repozitorij.uni-lj.si/IzpisGradiva.php?id=140154>, DOI: [10.1016/j.scs.202104031](https://doi.org/10.1016/j.scs.202104031). [COBISS.SI-ID [117204483](https://cobiss.si/117204483)]
3. MLAKAR, Urška, STROPNIK, Rok, KOŽELJ, Rok, MEDVED, Sašo, **STRITIH, Uroš**. Experimental and numerical analysis of seasonal solar-energy storage in buildings. *International journal of energy research*. 2019, vol. 43, iss. 12, str. 6409-6418, ilustr. ISSN 0363-907X. <https://onlinelibrary.wiley.com/doi/abs/10.1002/er.4449>, DOI: [10.1002/er.4449](https://doi.org/10.1002/er.4449). [COBISS.SI-ID [16558619](https://cobiss.si/16558619)],
4. **STRITIH, Uroš**, OSTERMAN, Eneja, BUTALA, Vincenc. Annual operation of LHT storage system for offices. V: HEISELBERG, Per Kvols (ur.). *CLIMA 2016 : proceedings of the 12th REHVA World Congress, 22-25 May 2016, Aalborg, Denmark*. Vol. 4. 12th REHVA World Congress, 22-25 May 2016, Aalborg, Denmark. [Aalborg: University, 2016]. F. 2-11, ilustr. ISBN 87-91606-29-2, ISBN 87-91606-36-5. http://vbn.aau.dk/files/233718256/paper_738.pdf. [COBISS.SI-ID [14672923](https://cobiss.si/14672923)]
5. OSTERMAN, Eneja, HAGEL, K., RATHGEBER, C., BUTALA, Vincenc, **STRITIH, Uroš**. Parametrical analysis of latent heat and cold storage for heating and

cooling of rooms. *Applied thermal engineering*. [Print ed.]. Jun. 2015, vol. 84, str. 138-149, ilustr. ISSN 1359-4311. DOI: 10.1016/j.applthermaleng.2015.02.081. [COBISS.SI-ID [13978139](#)]