EKOLOGIJA DELOVNEGA IN BIVALNEGA OKOLJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	EKOLOGIJA DELOVNEGA IN BIVALNEGA OKOLJA
Course title:	ECOLOGY OF WORKING AND LIVING ENVIRONMENT
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	**Študijska smer**	**Letnik**	**Semestri**	**Izbirnost**
Strojništvo, tretja stopnja, doktorski	Energetske, procesne in okoljske inženirske znanosti (smer)		Celoletni	izbirni

Univerzitetna koda predmeta/University course code:	0033446
Koda učne enote na članici/UL Member course code:	7201

Predavanja /Lectures	**Seminar /Seminar**	**Vaje /Tutorials**	**Klinične vaje /Clinical tutorials**	**Druge oblike študija /Other forms of study**	**Samostojno delo /Individual student work**	**ECTS**
90					160	10

Nosilec predmeta/Lecturer:	Matjaž Prek, Uroš Stritih

Izvajalci predavanj:	Matjaž Prek, Uroš Stritih
Izvajalci seminarjev:	
Izvajalci vaj:	
Izvajalci kliničnih vaj:	
Izvajalci drugih oblik:	
Izvajalci praktičnega usposabljanja:	

Vrsta predmeta/Course type:	Izbirni predmet /Elective course

Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Veljajo splošni pogoji za doktorski študij.	General prerequisites for the third level studies.

Vsebina:	**Content (Syllabus outline):**
Predavanja (izbrana poglavja na tematiko): Uvod v vsebine, namen predmeta in program, kompetence. Človek in ekologija okolja. Vpliv sistemov okolja na delovno in bivalno okolje v korelaciji s človekom. Termoregulacija človeka. Vplivi parametrov atmosfere na delovno in bivalno okolje. Parametri in kriteriji delovnega in bivalnega notranjega okolja ter bivalna cona. Modeli, metode in kriteriji za določevanje, analizo in ovrednotenje (notranjega) okolja. Toplotno okolje in vplivi na ugodje in zdravje človeka in/ali predmet. Kakovost (higiena) zraka in vplivi na človeka in/ali predmet. Higienske zahteve za prezračevanje in klimatizacijo. Škodljive in tipične primesi v zraku. Razporeditev primesi v prezračevanih prostorih. Učinkovitost njihove odstranitve, konservativni in nekonservativni sistemi. Vplivi stavbnih materialov in inštalacij v stavbi na ekologijo človeka in/ali predmet. Sick Building Syndrom (SBS), vzroki, posledice in rešitve. Inženirske zahteve pri ogrevanju, hlajenju, prezračevanju, ovlaževanju in sušenju zraka, ter klimatizaciji. Olfaktometrija. Modeli disperzije vonjav. Fizikalni mehanizem transporta primesi. Prezračevanje, učinkovitost prezračevanja, starost zraka.	Lectures: Introduction in contents, purpose of subject and program, competence. Human being and environmental ecology. Environment systems influence on working and residence environment in correlation with human being. Thermoregulation of human being. Atmosphere parameters influence on working and residence environment. Parameters and criteria of working and residence indoor environment, occupied zone. Models, methods and criteria for determine analysis and valuate (indoor) environment. Thermal environment and influence on comfort and health of human being and/or on exhibits. Air quality (hygiene) and influence on comfort and health of human being and/or on exhibits. Hygiene requirements for ventilation and air-conditioning. Harmful and typical contaminants in air. Contaminant distribution in ventilated rooms. Contaminant removal effectiveness, conservative and non-conservative systems. Influence of building substances and building installations on human being ecology and/or exhibit. Sick Building Syndrome (SBS), causes, consequences and salvations. Engineering’s request for heating, cooling, ventilation, moisten and drying,

Industrijsko prezračevanje. Čisti prostori. Simulacija toplotnega okolja in kakovosti zraka na delovnem mestu z uporabo računalniške dinamike fluidov. Računalniška dinamika fluidov pri načrtovanju prezračevanja (matematične osnove, modeli turbulence, numerične metode, robni pogoji, kontrola kakovosti, CFD v kombinaciji z drugimi napovedanimi modeli, aplikacija CFD zakonitosti pri načrtovanju stavb). Notranje okolje in produktivnost. Kvantitativna zveza med notranjo okoljsko odličnostjo, lastnostmi dela v pisarnah in zdravstvenimi težavami oz. vplivi na predmete. Napoved kakovosti zraka z računalniško dinamiko fluidov. Napredno notranje okolje -delovna storilnost – stroški - zdravje. Seminarji (kot primer): Nizkoenergijske stavbe in ekologija notranjega okolja. Nizkoemisijsko okolje (stavbe). Produktivnost in delovno okolje. Vpliv gibanja zraka in turbulence na ugodje in zdravje človeka. Inženirske zahteve načrtovanja pri specifičnih delovnih ali bivalnih okoljih. Vpliv vtoka svežega zraka na delovno storilnost. Kako integrirati produktivnost v stroške življenjske dobe stavbnega vzdrževanja? Delovno in bivalno okolje v korelaciji z zdravstvenim absentizmom. Individualno izbrane teme.	and air-conditioning. Olfactometry. Odour dispersion modeling. Physical mechanism of contaminant transportation. Ventilation, ventilation effectiveness, age of air. Industrial ventilation. Cleans spaces. Computational fluid dynamics in ventilation design. Mathematical background. Turbulence models. Numerical methods. Boundary conditions. Quality control. CFD combined with other predictions models, applications of CFD codes in building design. Indoor climate and productivity. Quantitative relationships between indoor environmental quality (IEQ), effects of IEQ on performance of work. Sick leave and influence on exhibits. Prediction of air quality by computational fluid dynamics. Advanced indoor environment – productivity – costs – health. Seminars (such as example): Low energy buildings and indoor environment ecology. Low pollutant environment (buildings). Productivity and working environment. Influence of air movement and turbulence on comfort and health of human being. Engineer’s design requirements at specific working or residence environments. Influence of fresh air supply on productivity. How to integrate productivity in life-cycle costs analysis of building services? Working and residence environment on correlation with sick person’s absent. Individual chosen themes.

Temeljna literatura in viri/Readings:

[1] C. Streffer all: Environmental standards. Combined exposures and their effects on human beings and their environment. Springer – Verlag, Berlin, 2003.–Izbrana poglavja.

[2] R.N. Reeve: Introduction to environmental analysis. Analytical techniques in

the sciences. John Wiley & Sons, Chichester, 2002. – Izbrana poglavja.

[3] de N. Nevers: Air pollution control engineering. McGraw-Hill, New York, 1995.

[4] E. Mundt and all: Ventilation effectiveness, REHVA Guidebook 2, Brussels 2004.

[5] Wargocki P. and all. Indoor climate and productivity in offices, REHVA Guidebook 6, Brussels, 2006.

[6] R. Reeve: Introduction to Environmental analysis. John Willey & sons, LTD., Chichester, 2002. - Izbrana poglavja.

[7] P. Pasanen et all: Cleanless of ventilation system. REHVA Guidebook 8, Brussels, 2007.

Cilji in kompetence:	**Objectives and competences:**
Cilji: Cilj predmeta je razumevanje in poznavanje vsebine, ki je potrebna za poglobljeno analizo in sintezo okoljskega inženirstva v stavbah. Študentu se prikaže povezava prostorske umeščenosti uporabnika prostora - človeka v delovnem in bivalnem okolju s poznavanjem, ocenjevanjem in vrednotenjem realnega okolja na podlagi tehničnih zakonitosti (npr.: kakovost (higiena) zraka, toplotno okolje, osvetljenost, itn.); vplive na ugodje in tveganje za zdravje človeka, kakor tudi korelacijo med okoljem in delovno storilnostjo. Študent prouči ključne parametre delovnega in bivalnega (notranjega) okolja in s tem povezane metode, metodologije in modele za analizo ter kriterije okolja. Pridobil bo kompetence o razumevanju procesa načrtovanja in revidiranja ter bo tako celovitejše obravnaval kompleksna okolja in projekte predvsem v luči novih spoznanj. **Kompetence:** Pridobljena znanja v študijskem procesu bodo omogočila, da bo študent sposoben samostojno razumeti, oceniti in ovrednotiti delovno in bivalno (notranje) okolje, z vidika ugodja, tveganja za zdravje uporabnika okolja (prostora) in z vidika delovne storilnosti, posredno pa tudi z vidika rabe energije. Pridobljeno znanje mu bo omogočalo boljše	**Goals:** Goal of the subject is understanding and knowledge of the content that is required for a student to obtain a deepened analysis of the environmental engineering in buildings. The connection between the user in place, person in working and living environment, and with the evaluation of realistic environment – based on technical legitimations (e.g.: air quality and hygiene, temperature of the environment, lighting,…) will be introduced to the student. In addition, possible impacts of indoor environment on human health hazard and the correlation between the indoor environment and work productivity will be discussed. Student will get an insight into key working and living (indoor) parameters and criteria that describe the situation indoors and will obtain knowledge of methods and models that are needed for analysis. By gaining understanding in planning a process and revising will enable student to study more complex environments and projects. **Competences:** Gained knowledge’s during the study process will give students capability to independently understand, estimate and to evaluate working and living (indoor) environment from the point of view of health hazard of humans living indoors,

poznavanje vplivnih okoljskih parametrov pri zagotavljanju javnega zdravja in pri analizi posameznih specifičnih primerov. Sposoben bo izvajati simulacije in napovedovanje kakovosti okolja, kot npr.: kakovosti zraka z uporabo računske dinamike fluidov. Študent spozna pomen človeka v ekologiji okolja; potencialne vplive okolja na tveganja v katerem živi in dela.	living delight, work productivity and indirectly also of the energy use. The gained knowledge will give students an insight into how to determine the essential environmental parameters needed to assure public health and will enable them the ability to also deal with the individual specific cases. They will be capable of running simulations and predicting the quality of the indoor environment, as e.g.: predicting the quality of the air by calculating the fluid dynamics. Student will realize meaning of humans in environmental ecology and potential hazardous impacts of environment, in which one lives and works, on human health.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Pridobljena znanja v študijskem procesu bodo omogočila, da bo študent sposoben samostojno razumeti, oceniti in ovrednotiti delovno in bivalno (notranje) okolje, z vidika ugodja, tveganja za zdravje uporabnika okolja (prostora) in z vidika delovne storilnosti, posredno pa tudi z vidika rabe energije. Pridobljeno znanje mu bo omogočalo boljše poznavanje vplivnih okoljskih parametrov pri zagotavljanju javnega zdravja in pri analizi posameznih specifičnih primerov. Sposoben bo izvajati simulacije in napovedovanje kakovosti okolja, kot npr.: kakovosti zraka z uporabo računske dinamike fluidov. Študent spozna pomen človeka v ekologiji okolja; potencialne vplive okolja na tveganja v katerem živi in dela.	Gained knowledge’s during the study process will give students capability to independently understand, estimate and to evaluate working and living (indoor) environment from the point of view of health hazard of humans living indoors, living delight, work productivity and indirectly also of the energy use. The gained knowledge will give students an insight into how to determine the essential environmental parameters needed to assure public health and will enable them the ability to also deal with the individual specific cases. They will be capable of running simulations and predicting the quality of the indoor environment, as e.g.: predicting the quality of the air by calculating the fluid dynamics. Student will realize meaning of humans in environmental ecology and potential hazardous impacts of environment, in which one lives and works, on human health.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, seminarsko delo, e-izobraževanje, konzultacije. Seminarsko delo v čim večji meri navezujoče se na področje doktorskega raziskovanja. Študij z	Lectures, laboratory practice & seminar work, e-education, consulting. The seminar work is related, as much as possible, to the student's doctoral research field. Study on a recommended

uporabo priporočene literature.	literature basis.

Načini ocenjevanja:	Delež/ Weight	Assessment:
Ustni izpit, poročilo o seminarskem delu. Pogoj za opravljanje ustnega izpita je uspešno izdelano in pozitivno ocenjeno seminarsko delo. Način (ustno izpraševanje, naloge, projekt): • pisna projektna naloga/seminar (60%) • ustno izpraševanje (40%)		Oral exam, report on seminar work. The condition for admission to oral exam is successful completion of seminar work, rewarded with a passing grade. Method (oral examination, assignments, project): • written project assignment/seminar (60%) • oral examination (40%)

Reference nosilca/Lecturer's references:

doc.dr. Matjaž PREK

PREK, Matjaž, BUTALA, Vincenc. Principles of exergy analysis of human heat and mass exchange with the indoor environment. International journal of heat and mass transfer, ISSN 0017-9310. [Print ed.], Dec. 2010, vol. 53, iss. 25/26, str. 5806-5814, doi: 10.1016/j.ijheatmasstransfer.2010.08.003.

PREK, Matjaž. Thermodynamical analysis of human thermal comfort. Energy, ISSN 0360-5442, Vol. 31, Issue 5, 2006. Laussane: Elsevier, 2006, letn. 31, št. 5, str. 732-743. http://dx.doi.org/10.1016/j.energy.2005.05.001.

PREK, Matjaž, BUTALA, Vincenc. An enhanced thermal comfort model based on the exergy analysis approach. International journal of exergy, ISSN 1742-8297. [Print ed.], 2012, vol. 10, iss. 2, str. 190-208, doi: 10.1504/IJEX.2012.045865.

PREK, Matjaž. Thermodynamic analysis of human heat and mass transfer and their impact on thermal comfort. International journal of heat and mass transfer, ISSN 0017-9310. [Print ed.], 2005, letn. 48, št. 3/4, str. 731-739. http://www.sciencedirect.com/science/journal/00179310.

PREK, Matjaž. Environmental impact and life cycle assessment of heating and air conditioning systems, a simplified case study. Energy and buildings, ISSN 0378-7788. [Print ed.], 2004, letn. 36, št. 10, str. 1021-1027. http://www.sciencedirect.com/science/journal/03787788.

PREK, Matjaž. Wavelet analysis of sound signal in fluid-filled viscoelastic pipes. Journal of fluids and structures, ISSN 0889-9746, 2004, letn. 19, št. 1, str. 63-72. http://www.sciencedirect.com/science/journal/08899746.

PREK, Matjaž. Scaling laws of hydrodynamic noise generation for a simple fluid valve model. Journal of vibration and acoustics, ISSN 1048-9002, 2000, vol. 122, no. 3, str. 330-331.

PREK, Matjaž. Induced noise generation in a simple fluid valve model. Noise control engineering journal, ISSN 0736-2501, 2004, vol. 52, no. 1, str. 5-12.

PREK, Matjaž, NOVAK, Peter. Analitična določitev srednje sevalne temperature zapletene geometrijske oblike prostora = An analytical determination of the mean

radiant temperature for a complex room geometry. Strojniški vestnik, ISSN 0039-2480, 2000, letn. 46, št. 8, str. 494-502.

izr.prof.dr. Uroš Stritih

KRESE, Gorazd, KOŽELJ, Rok, BUTALA, Vincenc, STRITIH, Uroš. Thermochemical seasonal solar energy storage for heating and cooling of buildings. Energy and buildings, ISSN 0378-7788. [Print ed.], 2018, [v tisku, 35 str.], ilustr.

STRITIH, Uroš, CHARVÁT, Pavel, KOŽELJ, Rok, KLIMEŠ, Lubomír, OSTERMAN, Eneja, OSTRÝ, Milan, BUTALA, Vincenc. PCM thermal energy storage in solar heating of ventilation air : experimental and numerical investigations. Sustainable cities and society, ISSN 2210-6715. [Spletna izd.], 2017

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, ISSN 1359-4311. [Print ed.], Jun. 2015, vol. 84, str. 138-149

OSTERMAN, Eneja, BUTALA, Vincenc, STRITIH, Uroš. PCM thermal storage system for free heating and cooling of buildings. Energy and buildings, ISSN 0378-7788. [Print ed.], Nov. 2015, vol. 106, str. 125-133

OSTERMAN, Eneja, TYAGI, V. V., BUTALA, Vincenc, RAHIM, N. Abdul, STRITIH, Uroš. Review of PCM based cooling technologies for buildings. Energy and buildings, ISSN 0378-7788. [Print ed.], 2012, vol. 49, str. 37-49

STRITIH, Uroš, BUTALA, Vincenc. Energy savings in building with a PCM free cooling system. Strojniški vestnik, ISSN 0039-2480, feb. 2011, vol. 57, no. 2, str. 125-134

STRITIH, Uroš, BUTALA, Vincenc. Experimental investigation of energy saving in buildings with PCM cold storage. International journal of refrigeration, ISSN 0140-7007. [Print ed.], 2010, vol. 33, iss. 8, str. 1676-1683

BUTALA, Vincenc, STRITIH, Uroš. Experimental investigation of PCM cold storage. Energy and buildings, ISSN 0378-7788. [Print ed.], Mar. 2009, vol. 41, issue 3, str. 354-359