UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	TEORIJA ZGOREVANJA
Course title:	COMBUSTION THEORY

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

Univerzitetna koda predmeta/University course code: 7207

Predavanja	**Seminar**	**Vaje**	**Klinične vaje**	**Druge oblike študija**	**Samostojno delo**	**ECTS**
90					160	10

Nosilec predmeta/Lecturer:	Andrej Senegačnik, Tomaž Katrašnik

Izvajalci predavanj:	Tomaž Katrašnik, Andrej Senegačnik
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:	Slovenščina, Angleščina
	Vaje/Tutorial:	Slovenščina, Angleščina

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):**
Fizikalni procesi v plamenu, termodinamična izhodišča, kemijski procesi in reakcijska kinetika. Transportni pojavi in dinamika zgorevanja v stacionarnih kuriščih, pečeh, kotlih. Fizikalne interpretacije zgorevanja različnih goriv in različnih sistemov kurjenja. Zagotavljanje kakovosti zgorevalnih procesov. Potencial kemične energije goriv in njena transformacija. Uplinjanje, ukapljevanje in transformiranje goriv, biomase. Pridobivanje vodika. Napredne premogove tehnologije, alternativna sintetična goriva. Tehnologije zajemanja in shranjevanja ogljikovega dioksida. Nastanek okolju škodljivih snovi pri zgorevalnih procesih in ukrepi za njihovo zmanjševanje, čiščenje produktov zgorevanja.	Physical processes in flame, thermodynamical rudiments, chemical processes and the kinetics of reactions. Transport phenomena and dynamics of combustion in stationary combustion chambers and in internal combustion engines (ICE). Physical interpretation of combustion of various fuels and various combustion systems. Combustion processes in fixed and variable geometry combustion chambers. Providing quality of combustion processes. Chemical energy potential of fuels and transformation. Gasification and liquefaction of fuels and biomass. Hydrogen production. Advanced technologies of coal usage, alternative synthetic fuels. Process of fuel-air mixture preparation in internal combustion engines. Technologies of carbon dioxide capturing and storing. Formation of pollutants at combustion processes and measures for its reduction, cleaning of combustion products.

Temeljna literatura in viri/Readings:

[1] C. K. Law, Combustion Physics, Cambridge University Press, 2006.
[2] T. Poinsot, D. Veynante, Theoretical and Numerical Combustion, Second Edition, R.T. Edwards, Inc, 2005.
[3] C. Higman, M. Burgt. Gasification, Second Edition, Gulf Professional Publishing, 2008.

Cilji in kompetence:	**Objectives and competences:**
Cilji: Študentu približati in na njegovem konkretnem primeru pokazati principe raziskovalnega dela na področju zgorevanja. Študent izvede pregled literature širšega področja in nato najnovejših dognanj ožjega področja. Študent je poleg razumevanja obravnavanega procesa usposobljen da proces popiše tudi z numeričnim modelom, ki ga potem lahko ovrednoti s pomočjo eksperimenta. Dobljene rezultate samostojno analizira in o ugotovljenih dognanjih sestavi poročilo v obliki članka. **Kompetence:** Študent po končanem doktorskem študiju superiorno obvladuje neko ozko tehnično področje. V obravnavanem primeru je to določena podrobnost iz širokega področja zgorevanja. Kandidat z uspešnim raziskovalnim in eksperimentalnim delom pokaže, da je sposoben ustvariti nek nov izviren izdelek, metodo, oziroma odkriti novo tehnično spoznanje in ga predstaviti svetovni javnosti v obliki članka v mednarodni reviji. Obenem je kandidat sposoben svoje trditve in dognanja tudi kompetentno zagovarjati.	**Goals:** Student is introduced to the principles of research work in the field of combustion processes through case studies. Overview of the references from the wider field of interest as well as the studies of the most recent discoveries is made by the student. Besides understanding the discussed process the student is also capable of describing the process with numerical model as well as experimental evaluation of the model. Students perform autonomous analyses of the results and present them in the form of an article. **Competences:** After completing the doctoral studies the student possesses superior expertise in a certain narrow technical field of interest, namely a particular detail from the wide field of combustion processes. Through successful research and experimental work the candidate shows ability to develop a new, original product, method, to make new technical discoveries and to present the results to the publics in the form of an article in an international technical or scientific journal. The candidate is also capable of competent verbal presentation of his or her findings and statements.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent po končanem doktorskem študiju superiorno obvladuje neko ozko tehnično področje. V obravnavanem primeru je to določena podrobnost iz širokega področja zgorevanja. Kandidat z uspešnim raziskovalnim in eksperimentalnim delom pokaže, da je sposoben ustvariti nek nov izviren izdelek, metodo, oziroma odkriti novo tehnično spoznanje in ga predstaviti svetovni javnosti v obliki članka v mednarodni reviji. Obenem je kandidat sposoben svoje trditve in dognanja tudi kompetentno zagovarjati.	After completing the doctoral studies the student possesses superior expertise in a certain narrow technical field of interest, namely a particular detail from the wide field of combustion processes. Through successful research and experimental work the candidate shows ability to develop a new, original product, method, to make new technical discoveries and to present the results to the publics in the form of an article in an international technical or scientific journal. The candidate is also capable of competent verbal presentation of his or her findings and statements.

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 uporabo priporočene literature.	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 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) • naloge (20%) • projektni seminar		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) • assignments (20%) •

(50%) • ustno izpraševanje (30%)		project seminar (50%) • oral examination (30%)

Reference nosilca/Lecturer's references:

izr. prof. dr. Andrej SENEGAČNIK

NAROBE, M., GOLOB, J., MELE, J., SEKAVČNIK, M., SENEGAČNIK, A., KLINAR, D. Scale-up research in a dual fluidized bed gasification process. Acta chimica slovenica, 2015.

SMREKAR, J., POTOČNIK, P., SENEGAČNIK, A. Multi-step-ahead prediction of NOx emissions for a coal-based boiler. Applied energy, 2013.

MELE, J., GOLOBIČ, I., SENEGAČNIK, A. A method to detect and control fully fluidized conical beds with a wide size distribution of particles in the vicinity of the minimum fluidization velocity. Thermal science, 2015.

SENEGAČNIK, A., OMAN, J., ŠIROK, B. Annular shaft kiln for lime burning with kiln gas recirculation. Appl. therm. eng., 2008.

OMAN, J., SENEGAČNIK, A., MIRANDOLA, A. Air, fuels and flue gases : physical properties and combustion constants. Padova: Progetto, 2006.

prof.dr. Tomaž KATRAŠNIK

VIHAR, Rok, ŽVAR BAŠKOVIČ, Urban, SELJAK, Tine, KATRAŠNIK, Tomaž. Combustion and emission formation phenomena of tire pyrolysis oil in a common rail Diesel engine. *Energy conversion and management*, ISSN 0196-8904. [Print ed.], 2017, str. 1-16, ilustr. http://www.sciencedirect.com/science/article/pii/S0196890417301024, doi: 10.1016/j.enconman.2017.02.005.

ŽVAR BAŠKOVIČ, Urban, VIHAR, Rok, SELJAK, Tine, KATRAŠNIK, Tomaž. Feasibility analysis of 100% tire pyrolysis oil in a common rail Diesel engine. *Energy*, ISSN 0360-5442. [Print ed.], 2017, str. [1-26], ilustr. http://www.sciencedirect.com/science/article/pii/S036054421730172X, doi: 10.1016/j.energy.2017.01.156.

SELJAK, Tine, ŠIROK, Brane, KATRAŠNIK, Tomaž. Advanced fuels for gas turbines : fuel system corrosion, hot path deposit formation and emissions. *Energy conversion and management*, ISSN 0196-8904. [Print ed.], Oct. 2016, vol. 125, str. 40-50, ilustr. http://www.sciencedirect.com/science/article/pii/S0196890416301947,doi: 10.1016/j.enconman.2016.03.056.

KATRAŠNIK, Tomaž. An advanced real-time capable mixture controlled combustion model. *Energy*, ISSN 0360-5442. [Print ed.], Jan. 2016, vol. 95, str. 393-403, ilustr., doi: 10.1016/j.energy.2015.11.066.

KATRAŠNIK, Tomaž. Innovative 0D transient momentum based spray model for real-time simulations of CI engines. *Energy*, ISSN 0360-5442. [Print ed.], Oct. 2016, vol. 112, str. 494-508, ilustr. http://ac.els-cdn.com/S0360544216308751/1-s2.0-S0360544216308751-main. pdf?_tid=dfd0351c-5d3b-11e6-b379-00000aab0f6c&acdnat=1470642422_fc88ee531aca13ee7205cacfc9e5ba65,doi: 10.1016/j.energy.2016.06.101.

VIHAR, Rok, SELJAK, Tine, RODMAN OPREŠNIK, Samuel, KATRAŠNIK, Tomaž. Combustion characteristics of tire pyrolysis oil in turbo charged compression ignition engine. *Fuel*, ISSN 0016-2361. [Print ed.], Jun. 2015, vol. 150, str. 226-235, ilustr., doi: 10.1016/j.fuel.2015.01.087.

SELJAK, Tine, RODMAN OPREŠNIK, Samuel, KUNAVER, Matjaž, KATRAŠNIK, Tomaž. Effects of primary air temperature on emissions of a gas turbine fired by liquefied spruce wood. *Biomass & bioenergy*, ISSN 0961-9534. [Print ed.], 2014, vol. 71, str. 394-407, ilustr., doi: 10.1016/j.biombioe.2014.09.016.

SELJAK, Tine, RODMAN OPREŠNIK, Samuel, KATRAŠNIK, Tomaž. Microturbine combustion and emission characterisation of waste polymer-derived fuels. *Energy*, ISSN 0360-5442. [Print ed.], 2014, vol. 77, str. 226-234, ilustr., doi: 10.1016/j.energy.2014.07.020.