Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Tehnike hlajenja**
Course title:	**Cooling technics**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		1. ali 2.	**1., 2. ali 4.**
PHYSICS, 3rd cycle		1. or 2.	**1., 2. or 4.**

Vrsta predmeta / Course type	Izbirni za vse module
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
10	**5**				**165**	**6**

Nosilec predmeta / Lecturer:	**Milan Marčič**
Jeziki / Languages: **Predavanja / Lectures:**	slovenski/Slovenian in/and angleški s slovenskim prevodom/English with translation in Slovenian
Vaje / Tutorial:	slovenski/Slovenian in/and angleški s slovenskim prevodom/English with translation in Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Predznanje iz klasične in moderne fizike, termodinamike.	Basic knowledge of classical and modern physics, thermodynamics.

Vsebina:	**Content (Syllabus outline):**
1. Osnove hlajenje in gretja: procesi hlajenja in gretja v T,s; p,v; logp,h; e,h in h,x diagramih, lastnosti hladilnih sredstev , 2. Kompresorski hladilni sistemi:	1. Fundamentals of cooling and heating: cooling and heating processes in T,s; p,v; logp,h; e,h in h,x diagrams, refrigerants properties 2. Compression cooling systems:

realni kompresorski hladilni proces v T,s; p,v; logp,h; e,h diagramih, večstopenjski in kaskadni hladilni sistemi 3.Toplotne črpalke: sistemi toplotnih črpalk voda-voda in voda – zrak 4. Absorpcijski in adsorbcijski haladilni sistemi: absorpcijski in adsorbcijski procesi v h,x diagramih, večstopenjski sistemi 5. Philipsov plinski hladilni stroj: Joule-Thompsonov efekt, Lindejev proces, Stirlingov proces 6. Elektromagnetni hladilni sistemi 7. Termoelektrični hladilni sistemi na osnovi Peltierjevega efekta 8. Magnetno-kalorični hladilni sistemi 9. Polprevodniško hlajenje na osnovi Ettinnghaussenovega efekta	real compression cooling cycle in T,s; p,v; logp,h; e,h diagrams, multi stage and cascade colling system 3. Heat pumps: Heat pumps water-water and air-water 4. Absorption and adsorption cooling systems: Absorption and adsorption cycles in h,x diagrams, multistage systems 5. Philips cooling machine: Joule-Thompsonov effect, Lindejev cycle, Stirlingov cycle 6. Electromagnetic cooling systems 7. Thermoelectric cooling systems based on Peltier cycle 8. Magnetic-thermal cooling systems 9. Semiconductor cooling systems based on Ettinnghaussen effect

Temeljni literatura in viri / Readings:

1) Milan Marčič, Jurij Avsec, Hladilna tehnika, Fakulteta za strojništvo, Univerza v Mariboru, 2003
2) Faye McQuiston, Jerald Parker, Jefrey Spitler, Heating, Ventilating and Air-Conditioning, John Wiley&Sons 2000
3) G. K. White, Experimental techniques in low temperature physics, Clarendon Press, Oxford 1989.
4) John Howell, Richard Buckius, Fundamentals of Engineering Thermodynamics, McGraw-Hill Book Company,1987
5) A. Bejan, Advanced engineering thermodynamics, John Wiley&Sons, 1997
6) A. L. Fetter, J. D. Walecka, Quantum theory of many-particle systems, McGraw-Hill, 1971

Cilji in kompetence:	**Objectives and competences:**
Študent si pridobi poglobljena teoretična in uporabna znanja o tehnikah hlajenja in gretja.	Students acquire advanced theoretical and practical knowledge of cooling and heating systems.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje:	Knowledge and understanding:
Poglobljeno teoretično razumevanje različnih hladilnih tehnik.	Advanced theoretical knowledge and understanding of various cooling technics
Prenesljive/ključne spretnosti in drugi atributi:	Transferable/Key Skills and other attributes:
Poglobljeno teoretično znanje o tehnikah hlajenja je mogoče uporabiti za projektiranje hladilnih sistemov.	Advanced theoretical knowledge and understanding of cooling technics can be used for designing of cooling systems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminar, izdelava projektne naloge.	Lectures, seminar, to work out project work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
projektna naloga	**50 %**	project
ustni izpit	**50 %**	oral examination

Reference nosilca / Lecturer's references:

1. STRUŠNIK, Dušan, MARČIČ, Milan, GOLOB, Marjan, HRIBERNIK, Aleš, ŽIVIĆ, Marija, AVSEC, Jurij. Energy efficiency analysis of steam ejector and electric vacuum pump for a turbine condenser air extraction system based on supervised machine learning modelling. *Applied energy*, ISSN 0306-2619, jul. 2016, vol. 173, str. 386-405, graf. prikazi, doi: 10.1016/j.apenergy.2016.04.047. [COBISS.SI-ID 1024226652]

2. MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Computer simulation of the common rail accumulator fuel-injection system. *Journal of mechanical and automobile engineering*, ISSN 2472-6281, Jan. 2016, vol. 1, iss. 1, str. 1-15. http://crescopublications.org/pdf/JMAE/JMAE-1-001.pdf. [COBISS.SI-ID 19767830]

3. MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Mathematical model for the injector of a common rail fuel-injection system. *Engineering*, ISSN 1947-3931. [Print ed.], June 2015, vol. 7, no. 6, str. 307-321. http://www.scirp.org/Journal/Home.aspx?IssueID=6596#.VZKVsxuvG70. [COBISS.SI-ID 18801942]

4. MARČIČ, Simon, MARČIČ, Milan. *Zrcalno vakuumski sončni kolektor : patent št. SI 23912 A, 30. 4.2013; patentna prijava št. P-201300011 z dne 16. 1. 2013*. Ljubljana: Urad RS za intelektualno lastnino, 2013. [5] str. [COBISS.SI-ID 16952598]