



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		1. ali 2.	1., 2. ali 3.
PHYSICS		1. or 2.	1., 2. or 3.

Vrsta predmeta / Course type

Izbirni za modula Biofizika 3 in Fizika 1, 2, 3

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				435	15

Nosilec predmeta / Lecturer:

Milan Marčič

Jeziki /
Languages:

Predavanja / slovenski/Slovenian
Lectures:
Vaje / Tutorial:

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

Predznanje iz klasične in moderne fizike, termodinamike.

Prerequisites:

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:

realni kompresorski hladilni proces v T,s; p,v; logp,h; e,h diagramih, večstopenjski in kaskadni hladilni sistemi

3. Toplotne črpalke:

sistemi toplotnih črpalok voda-voda in voda – zrak

4. Absorpcijski in adsorpcijski hladilni sistemi:

absorpcijski in adsorpcijski 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 Ettinngausenovega efekta

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:

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 Ettinngausen 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, Jeffrey 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:

Znanje in razumevanje:

Poglobljeno teoretično razumevanje različnih hladilnih tehnik.

Prenosljive/ključne spretnosti in drugi atributi:

Poglobljeno teoretično znanje o tehnikah hlajenja je mogoče uporabiti za projektiranje hladilnih sistemov.

Intended learning outcomes:

Knowledge and understanding:

Advanced theoretical knowledge and understanding of various cooling technics

Transferable/Key Skills and other attributes:

Advanced theoretical knowledge and understanding of cooling technics can be used for designing of cooling systems.

Metode poučevanja in učenja:

Predavanja, seminar, izdelava projektne naloge.

Learning and teaching methods:

Lectures, seminar, to work out project work.

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

Reference nosilca / Lecturer's references:

1. PRAUNSEIS, Zdravko, MARČIČ, Simon, AVSEC, Jurij, MARČIČ, Milan. Computer simulation of a diesel spray ignition and common rail accumulator fuel-injection system = Računalniška simulacija samovžiga dizelskega spreja in vbrizgalnega sistema s skupnim vodom. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], feb. 2012, vol. 5, iss. 1, str. 55-83, ilustr. http://www.fe.uni-mb.si/images/stories/jet/e-jet/jet_5-1.pdf. [COBISS.SI-ID 1024081756]
2. MARČIČ, Milan, AVSEC, Jurij, WENSING, Michael, SCHMIDT, Marcus, LEIPERTZ, Alfred, FETTES, Christian. Calculation and measurements of self-ignition nuclei in diesel combustion. *Energy & fuels*, ISSN 0887-0624. [Print ed.], 2010, 24, 2, str. 811-820, doi: [10.1021/ef900695w](https://doi.org/10.1021/ef900695w). [COBISS.SI-ID 13778710]
3. AVSEC, Jurij, WATANABE, Koichi, MARČIČ, Milan, PREDIN, Andrej. An application of statistical chain theories on thermodynamic properties of binary and ternary hydrocarbon mixtures. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Feb. 2009, vol. 2, iss. 1, str. 85-102. [COBISS.SI-ID 1024002908]
4. AVSEC, Jurij, NATERER, Greg F., MARČIČ, Milan. Non-equilibrium statistical mechanics

formulation of thermal transport properties for binary and ternary gas mixtures. *Archives of Thermodynamics*, ISSN 1231-0956, 2008, vol. 29, no. 2, str. 21-46. [COBISS.SI-ID [12483350](#)]

5. MARČIČ, Milan. Sensor for injection rate measurements. *Sensors*, ISSN 1424-8220, 2006, vol. 6, str. 1367-1382. [COBISS.SI-ID [10794262](#)]