PLAN I PROGRAM NASTAVE / COURSE SYLLABUS	
Naziv predmeta:	**OSNOVI TERMALNE NAUKE I METODOLOGIJA OBRAČUNA ENERGETSKIH PERFORMANSI OBJEKTA**
Course title:	**BASICS OF THERMAL SCIENCE AND METHODOLOGY OF CALCULATION OF OBJECT ENERGY PERFORMANCE**

Šifra predmeta / Course code	Status predmeta / Course type	Semestar / Semester	ECTS kredita / ECTS credits	Fond časova / Number of classes
P_9.7.3.	**izborni / elective**	**IX**	**2.0**	**2P+0V+0L**

Studijski program:	ARHITEKTURA. Akademske studije sa integrisanim masterom. Dužina trajanja: 10 semestara i 300 kredita.
Study programme:	ARCHITECTURE. Academic studies with the integrated Master. Duration: 10 semesters and 300 credits.

Uslovljenost drugim predmetima:

Nema uslovljenost.

Prerequisites:

No prerequisites.

Ciljevi izučavanja predmeta:

Studenti se upoznaju sa principima nauke o toploti, mehanizmima transfera toplote, zakonima i pojmovima iz oblast transfera energije u zgradama, vrstama KGH instalacija u zgradama i upotrebom obnovljivih izvora energije u KGH instalacijama. Poseban osvrt dat je na pristupe u proračunu potrebnog kapaciteta KGH sistema u režimu grijanja i u režimu hlađenja, na aspekt klimatskih uslova, te na razumijevanje pojmova toplotnih gubitaka/dobitaka i toplotnog opterećenja. Kroz računske primjere i lab.praksu obrađeni su karakteristični primjeri, u cilju fizičkog upoznavanja sa KGH sistemima, savremenim rešenjima, i sticanja osjećaja za uticaj karakteristika objekta, zadatih klimatskih uslova i primijenjenih KGH rešenja - na ukupne EE performanse projektovanog objekta.

Course aims:

Students are introduced into thermal science principles, hea transfer mechanisms, laws and terms related to the energy transfe in buildings, types of HVAC installations in buildings and use o renewable energy sources in HVAC. Special attention is given to th approaches in calculating the required HVAC system capacity, i heating and in cooling regime, to the climatic conditions aspect, an the understanding of the terms of heat gains/losses and heat loads Trough calculated examples and laboratory praxis caracteristi examples are treated, with the scope of familiarizing students wit the HVAC installations, modern solutions, and the gain of feel for the influence of building design properties, climatic conditions input and the applied HVAC solutions - to the overall EE performance o the designed building.

Predmetni nastavnik – saradnici u nastavi / Lecturer – teaching assistants	Prof. dr Dušan Vuksanović
	/

Metode nastave i savladavanje gradiva:

Predavanja, vježbe i konsultacije.

Teaching methods and learning activities:

Lectures, tutorial and consultations.

SADRŽAJ PREDMETA:

Pripremna nedjelja	Priprema i upis semestra
I nedjelja	Uvod u fiziku toplote. Pritisak, temperatura, vlažnost, gustina
II nedjelja	Stanje gasa, dijagrami (idealni gas, vazduh, Molier, p-h, relativna i apsolutna vlažnost)
III nedjelja	Kinetička, potencijalna, unutrašnja energija, toplota, rad, entalpija
IV nedjelja	I zakon termodinamike za otvoren sistem. II zakon: neravnoteža, potencijal, entropija, definicije efikasnosti, eksergija.
V nedjelja	Prenos toplote: kondukcija, konvekcija, prolaz.

SUBJECT CONTENT:

Preliminary week	Preparation and enrollment of semester.
1st week	Introduction to thermal science. Pressure, temperature, humidity, density
2nd week	State of gas, diagrams (ideal gas, air, Molier, p-h relativne and absolute humidity)
3rd week	Kinetic, potential, internal energy, heat, work, enthalpy
4th week	I law of thermodynamics for open systems. II law: non-equilibrium, potential, entrophy, definitions of efficiency, exergy
5th week	Heat transfer: conduction, convection,

VI nedjelja	Prenos toplote: IC zračenje. Bilans toplote.
VII nedjelja	KOLOKVIJUM I
VIII nedjelja	Osvetljenje: lumen, lux. Efikasnost, klasične i efikasne svjetiljke.
IX nedjelja	KGH instalacije - tipovi; provjetravanje; savremena rešenja; upotreba obnovljivih izvora;
X nedjelja	KGH instalacije - režim grijanja: stepen dan; projektni dan; primarna energija goriva; efikasnosti i potrebna primarna energija; indikatori EE performanse objekta.
XI nedjelja	KGH instalacije - režim hlađenja: sunce i građevinski objekat; toptlotni dobici/gubici i toplotno opterećenje - uzajamni odnos; projektni dan;
XII nedjelja	Praksa / teren / laboratorija
XIII nedjelja	Računski primjeri
XIV nedjelja	Računski primjeri
XV nedjelja	II kolokvijum.
XVI nedjelja	*Završni ispit*
XVII nedjelja	Ovjera semestra i upis ocjena.
XVIII-XXI nedjelja	Dopunaska nastava i popravni ispitni rok.

	transmission.
6th week	Heat transfer: IR radiation. Heat balance.
7th week	1st TEST (colloquium)
8thweek	Lighting system: lumen, lux. Efficiency, classic and efficient light bulbs.
9th week	HVAC installations - types; ventilation; use of renewable energy;
10th week	HVAC installations - degree day; primary energy of the fuel; efficiency factors and energy use; EE indicators of the building
11th week	HVAC instalations - cooling regime. Sun and the building. Heat gains/losse and heat load - interelations; design day
12th week	Praxis / field examples / Lab
13th week	Calculated examples
14th week	Calculated examples
15thweek	2nd TEST (colloquium)
16thweek	FINAL EXAM.
17th week	Verification of the semester and mark enrollment.
18th-21st week	Additional lessons and exam term.

Opterećenje studenata:

Nedjeljno

2.0 kredita x 40/30 = 3 sata i 6 minuta

Struktura: 2 sata predavanja

1 sat i **6** minuta samostalnog rada, uključujući konsultacije

U toku semestra

Nastava i završni ispit: (3 sata i 6 min) x 16 = **49 sati i 36 min**

Neophodne pripreme prije početka semestra (administracija, upis, ovjera) 2 x (3 sata i 6 minuta) = **6 sati i 12 minuta**

Ukupno opterećenje za predmet 2.0x30 =**60 sati**

Dopunski rad: **4 sata i 12 minuta**

Struktura opterećenja: 49 sati i 36 min. (Nastava) + 6 sati i 12 min. (Priprema) +4 sata i 12 min. (Dopunski rad) = 60 sati

Student workload:

Weekly

2.0 credits x 40/30 = 3 hours and 6 minutes

Structure: 2 hours of lectures

1 hours and **6** minutes of individual work, including consultations

During the semester

Teaching and the final exam: (3 hours and 6 min) x 16 = **49 hours and 36 minutes**

Necessary preparations before the start of the semester (administration, registration, certification) 2 x (8 hours) = **6 hours and 12 minutes**

Total hours for the course: 62.0x30 = **60 hours**

Additional hours: 4 hours and 12 minutes

Structure of workload: 49 hours and 36 min (lectures) + 6 hours and 12 min (preparation) + 4 hours and 12 min (Additional hours) = 60 hours

Literatura / Literature:

- Kažić N., Vuksanović D. Energetska efikasnost zgrada - priručnik. *Univerzitet Crne Gore, Podgorica, 2012.*
- Odabrana poglavlja iz: Todorović, B.:Centralno grejanje, Todorović B: Klimatizacija. *Mašinski fakultet u Beogradu*
- Odabrana poglavlja iz: Kimura, K, Scientific Basis of Air Conditioning. Applied Science Publishers Ltd,Essex, England. Architectural Science Series, 1977.
- Skripta

Oblici provjere znanja i ocjenjivanje:

* Položena oba kolokvijuma i pozitivno ocjenjen sintezni projekat.

- Uredno pohađanje nastave : ukupno 10 poena (svaki izostanak manje 1 poen), maksimalno 3 izostanka
- I kolokvijum : maksimum 20 poena
- II kolokvijum : maksimum 20 poena
- Završni ispit : maksimum 50 poena

Forms of Assessment:

* Student has to pass both tests and positively evaluated synthesis project.

- Regular attendance of classes: 10 points (each one less causefailure point), maximum 3 absences
- First test: maximum 20 points
- Second test: maximum 20 points
- Final exam: maximum 50 points

Očekivani ishodi učenja:

Očekuje se da student, nakon položenog ispita Osnovi nauke o toploti, kgh instalacije i efikasnost:

1. Poznaje osnovne principe nauke o toploti, mehanizmima transfera toplote, zakonima i pojmovima iz oblast transfera energije u zgradama, vrstama KGH instalacija u zgradama i upotrebom obnovljivih izvora energije u KGH instalacijama;
2. Razumije uticaje arhitektonskog objekta na životnu sredinu.

Expected learning outcomes:

It is expected that the student after passing the exam Basics of Science on Heat, HVAC installations and efficiency:

1. Knows basic principles of the science of heat, heat transfer mechanisms, laws and concepts in the field of energy transfer in buildings, types of HVAC installations in buildings and use of renewable energy sources in HVAC installations;
2. Understands influences architectural structure on the environment.

Metode za ocjenu kvaliteta i obezbjeđivanje željenih rezultata učenja:

Kontrola od strane Univerziteta, kontrola nastavnog procesa od strane Fakulteta, spisak prisustva studenata, analize stepena prolaznosti (sistem upravljanja kvalitetom u skladu sa ISO 9001).

Napomena:

Dodatne informacije o predmetu mogu se dobiti kod predmetnog nastavnika, šefa studijskog programa i kod prodekana za nastavu.

Methods for assessing the quality and ensuring preferred learning outcomes:

Control by the University, the control of the teaching process by the faculty, the list of presence of students, analysis of the degree of transience (quality management system in accordance with ISO 9001).

Admonishment:

Further information about the subject can be obtained from the course teacher, Head of the study programme and Vice Dean for Education.