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~~NEW~~ (REFORMED) STUDY PROGRAMME

ENERGY EFFICIENT AND GREEN ARCHITECTURE

Draft version 1.2

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PROGRAMME SCHEME

Specialized studies Energy Efficent and Green Architecture – Spec. Eng. Arch

Semester 1

Sustainable architecture – Green and EE buildings design principles
Elements of Heat transfer science
Building physics
Thermal- technical systems and sustainable architecture
Lighting and EE
EE Building certification – calculation methods *(reformed)*
Laws and economic aspects of EE buildings
Professional practice *(reformed)*

30 ECTS

corresponds to a training program for the license 381

Semester 2

Green building certification	*LEED GA*
Elective course 1	Green materials
	Water and waste treatment *(reformed)*
Elective course 2	Verification tools - measurements and simulations *(new)*
	Facility management *(new)*
Elective studio	Design and certification of EE buildings – Case study
	Design, energy rehabilitation and certification of Existing buildings – Case study

15 ECTS

Thesis preparation
Thesis work

15 ECTS

Total number of credits - 60 ECTS

PROGRAMME DESCRIPTION

- General description

Specialized academic programme "Energy efficient and green architecture" is established by the Department of Architectural Technology as a continuation of the master academic studies in architecture at the Faculty of Architecture, University of Belgrade.

Having in mind that the modern concept of design and construction of buildings is increasingly including sustainability issues, i.e. respect and care for the environment in which we build which includes integrated and multidisciplinary knowledge of the behavior of the building and its installation systems, the active care of the energy and resource consumption, there is a need to deepen the knowledge necessary for the design, construction and evaluation of energy efficient and green buildings. Hence, this study program represents a concrete response to the needs of current architectural practice.

The programme of specialized academic studies should enable students to deepen their knowledge necessary to understand, design and construct energy efficient and green buildings, to acquire complementary expertise in other areas of technical sciences that are relevant for such buildings and to gain the ability to integrate knowledge that are necessary to solve this complex design and construction task and to be introduced in the research process and work at the same time.

- Aims and objectives

The basic aim of the study programme is achievement of competences and academic skills needed in the design, construction and evaluation of energy efficient and green buildings, including the development of creative abilities considering the problems and the formation of critical thinking. It also strives to develop skills for teamwork as a prerequisite for dealing with complex issues of sustainable architecture, as well as to develop the ability for better communication and presentation of results to other experts and the general public.

The aim of the study is to educate professionals who will possess in-depth and complex knowledge necessary for dealing with the problems of sustainable, i.e. energy-efficient and green architecture, which includes the mastery in knowledge of principles of architectural & urban design and materialization of such buildings, as well as a good knowledge of installation systems in buildings, with the aim of a comprehensive understanding of the overall energy and environmental performance of buildings.

In addition, study program aims to provide mastery of specific practical skills that would enable the acquisition of professional qualifications for jobs in the field of feasibility studies of energy efficiency and energy certification of buildings (as a basis for licensed engineer for energy efficiency building), as well as professional qualifications as the basis for entrance exams and obtaining the title of LEED - G (reen) A (ssociate).

Since this programme represents a possible way of continuation of master academic studies, its specific objective is to raise students' awareness to the need of permanent education.

- Purpose

The main purpose of the study programme is to educate students for the profession of specialist in energy-efficient and green architecture, in accordance with the needs of society. Study programme is designed to train students for the development and implementation of technical and scientific developments in the field of design and construction of energy efficient and green buildings, i.e. to ensure the acquisition of specific professional qualifications as input basis for appropriate professional licenses.

The programme is based on the social needs for the development of experts of the special profile that would act in the field of sustainable architecture, in the first place on the need to create a new engineering profile of the engineer of energy efficiency which possesses multidisciplinary knowledge and competences from different fields of technical sciences. Consequently, the purpose of this program is to expand the education system of architects and other engineers involved in the construction process, and to focus directly on the area and the problems of energy efficient and green building, as well as to educate experts of energy efficient and green architecture that possess competence both in the national as well as in European and world scale.

- Competencies

The programme trains the students to solve real problems in practice as well as to continue their education at the doctoral or other advanced studies.

General competencies acquired by students include:

- mastering the methods and procedures of research in the process of architectural and urban design of energy efficient and green buildings;
- linking the specific knowledge and its application in the process of solving integrated problems of energy efficient and green buildings;
- the development of critical thinking skills;

- the ability to analyze problems and synthesis solutions, as well as to predict the behavior of the selected solution;
- the development of skills and knowledge directly applicable to the design and construction of energy efficient and green buildings;
- …

- Curriculum structure

	Course	ECTS	STATUS
	Sustainable architecture – Green and EE buildings design principles	4	M
	Elements of Heat transfer science	3	M
	Building physics	4	M
	Thermal- technical systems and sustainable architecture	4	M
	Lighting and EE	4	M
	EE Building certification – calculation methods	5	M
	Laws and economic aspects of EE buildings	3	M
	Professional practice	3	E
	Green building certification	4	M
Elective course 1	*Green materials*	3	E (1/2)
	Water and waste treatment	3	
Elective course 2	*Verification tools - measurements and simulations*	3	E (1/2)
	Facility management	3	
Elective studio	*Design and certification of EE buildings – Case study*	5	E (1/2)
	Design, energy rehabilitation and certification of Existing buildings – Case study	5	
	Thesis preparation	3	E
	Thesis work	12	E

The programme contains elements prescribed by law.

Studies are conducted through academic and general educational, theoretical and methodological, scientific-technical and professional-applicative classes.

Students within classes have mandatory and elective courses. Elective courses are selected from the group of the proposed courses.

- Duration

The total estimated duration of study is one year or 60 ECTS. Classes are organized per semester, in 2 semesters of 30 ECTS per semester, and 15 working weeks of active teaching and 5 to 6 weeks of passive teaching.

- Enrolment

Requirements for admission to the programme are completed master academic studies in architecture or other related fields, and achieved a minimum of 300 ECTS credits. Ranking list for entry is formed on the basis of general average marks at the undergraduate and graduate academic studies.

Name of the study programme	**Specialized academic programme – Energy Efficient and Green Architecture**
An independent higher education institution that performs the study programme	University of Belgrade
Higher education institution that performs the study programme	Faculty of Architecture
Educational-scientific, i.e. educational-artistic field	Technical and technological sciences
Scientific, technical or artistic field	Architectural technologies
Type of studies	Specialized academic studies
Total ECTS credits	60
The title of diploma	Specialist in Architecture - Energy-efficient and Green Architecture; Spec. Eng. Arch.
Duration of studies	1 year
Planned number of students	32
Language	Serbian

TABLE 1. DETAILED DESCRIPTION OF NEW COURSES (SUBJECTS)

s.n.	*Course title*	*Status*	*ECTS*	*Content*	*Methodology*	*Software/ Equipment*	*Coverage with the literature*
1.1.	Sustainable architecture – Green and EE buildings design principles	M	4	▪ Sustainability in architecture and urbanism ▪ Development of the idea of adapting the building to the local climatic conditions, the lessons of traditional architecture and modern approach ▪ Methods of urban and architectural design of the building adaptation to the conditions of the location, climate and man-made ▪ Principles of designing energy efficient buildings ▪ Energy rehabilitation of existing buildings ▪ Development of the idea of green buildings, design principles ▪ Regulations (in the world and national) - relations and development ▪ Achievements of contemporary energy efficient and green building	*theory, workshop*	?	?
1.2.	Elements of Heat transfer science	M	3	▪ General notions and patterns ▪ Steady and non-steady heat transfer ▪ Steady convective heat transfer ▪ Thermal radiation	*theory*	?	*weak*
1.3	Building physics	M	4	▪ Evolution of thermal protection of buildings. Energy performance of the building ▪ Thermal comfort - physiological basis, parameters and comfort conditions ▪ Thermal energy in buildings -heat conduction - types of structures and properties of materials. Heat loss and the shape factor of the building. Thermal mass ▪ Indoor air quality - air comfort. Water vapor diffusion ▪ Acoustics - sound comfort. Sound insulation and sound quality	*theory*	?	*weak*

1.4	Thermal- technical systems and sustainable architecture	M	4	▪ Central heating systems ▪ Methods of calculation of annual energy required for heating ▪ Ventilation and air conditioning systems ▪ Annual energy consumption for cooling and ventilation ▪ Systems for sanitary hot water ▪ Optimization of HVAC systems	*theory*	?	*satisfying*
1.5	Lighting and EE	M	4	▪ History of the use of light in architecture; nature of light ▪ Control of daylight ▪ Light sources and lamps ▪ Parameters of quality of light ▪ Possibilities for achieving energy efficient solutions in the internal and external lighting	*theory*	?	*satisfying*
1.6	EE Building certification – calculation methods (reformed)	M	5	▪ Climate, microclimate and design parameters influencing the energy efficiency of the building ▪ Quantification from architectural projects, digital gifts ▪ Display and explanation of the principles of the software for calculations in the field of building physics, heat losses and gains, and energy certification	*theory, exercises*	?	*weak*
1.7	Laws and economic aspects of EE buildings	M	3	▪ Regulations in the field of EE buildings: Implementation of the EPBD into domestic legislation and its impact on the economic aspect of the construction ▪ Lifespan of the building. Estimates of the cost of life of the building ▪ Investment cost of the project ▪ Elements of costs in the exploitation phase ▪ Cost-benefit analysis	*theory*	?	*not existing*
1.8	Professional practice (reformed)	M	3	▪ Formed for each student in consultation with the responsible teacher and the management of company or institution where the student performs professional practice	*field work*	?	?
2.1.	Green building certification	M	4	▪ Concept of official LEED course, and is in compliance with the methodology of the certification system ▪ Green architecture: Integral philosophy,	*theory*	?	?

				certification, costs and benefits ▪ Sustainability of the location: the selection, development and maintenance of sites ▪ Water: Efficiency, requirements, use and waste water treatment ▪ Energy and atmosphere: Efficiency, requiring the use of renewable energy sources ▪ Materials: Environmental implications, material selection ▪ Internal environment: health and productivity of building users ▪ LEED: certification system, principles, methods, process			
2.2	Green materials	E	3	▪ Life cycle of materials ▪ Impact / interaction of materials on the environment - resources, energy, pollution ▪ Problem of waste and waste management concepts ▪ Durability of materials and attitude towards the sustainability of the building ▪ Methods for assessing the environmental safety of materials	*theory, workshop*	?	*not existing*
	Water and waste treatment (reformed)	E	3	▪ Principles of water management and waste management ▪ Models of water management in the house and on the plot ▪ Use of wastewater: Principles reuse rainwater and wastewater; ▪ Rainwater storage systems and elements of the system ▪ Waste water treatment systems and system elements - gray water ▪ Treatment of solid waste	*theory*	?	*not existing*
2.3	Verification tools - measurements and simulations (new)	E	3	▪ Building performance verification-simulation principles and methods ▪ Building performance verification-contact and non-contact methods and principles ▪ Infrared inspection ▪ Air tightness inspection ▪ Thermal conduction inspection	*theory, exercises, field work*	Needed E/S: • Flir T660 with additional lenses • Flir Research IR • Design Builder	Not existing

				▪ Reporting principles		Available Equipment: • Flir B20 IR camera • Blower door, standard • Ahlborn multimeter with with measuring plates • Flir Reporter Pro, • AMR Win control • TECTITE Express	
	Facility management (new)	E	3	• Development, basic terms and definitions • Maintenance (typology, concepts, organization, technology, quality assurance) • Maintenance and energy related improvoements • Maintenance and LCA from the point of installations, equipment, buildings structure and materialization • Maintenance and protection from atmospheric influences • Maintenance considerations throughout design and construction process • Maintenance programme development in the design and explatation phases (recommendations, instructions, procedures) • Use of IT in the process of maintenance	*theory*	?	?
2.4	Studio: Design and	E	5	▪ Case study - analysis of thermal	*exercises*	?	?

	certification of EE buildings – Case study			performance of the new building, which can be in one of the following categories: in the design phase (preliminary and-or main project) or in the construction phase or technical acceptance based on the approved design made according to old rules			
	Studio: Design, energy rehabilitation and certification of Existing buildings – Case study	E	5	▪ Case study - analysis of thermal performance of the existing building	*exercises*	?	?
2.5	Thesis preparation	E/T	3	▪ Formed individually according to the specific needs of developing specialist work and its complexity and structure		?	?
2.6	Thesis work	E/T	12	▪ Formed individually in accordance with the area, the needs and the structure of specialist work		?	?

Notes:

- *COLUMN 1: Abbreviation s.n. relates to the semester and the number of the course in that semester*
- *COLUMN 2: the title for every course*
- *COLUMN 3: to insert 'M' for mandatory subject or 'E' for elective subject*
- *COLUMN 4: the number of ECTS for every course*
- *COLUMN 5: to insert course content in bullet points and highlight in blue the themes to be supported by the learning material developed within the project. SELECTED CONTENT MUST BE JUSTIFIED WITH THE WEAK OR NOT EXISTING LITERATURE IN SUBJECT AREA (END RIGHT COLUMN IN THE TABLE).*
- *COLUMN 6: to insert foreseen teaching/learning methodology (methodologies) for every course (subject), for example: theory, exercises, workshop, field work, experimental work, etc.*
- *COLUMN 7: to insert details of the software / equipment necessary for the implementation of every separate course*
- *COLUMN 8: to insert the scope of coverage with relevant literature <u>both in English and in national language</u> (use one of the following 4 descriptors: abundant, satisfying, weak – less than 3 available units in the topic, or not existing) (for version 2 of the draft, all relevant literature units will be presented in detail)*