Annex 1
Recommended template: "Course Description, Syllabus, Course Requirements"

COURSE SYLLABUS AND COURSE REQUIREMENTS
ACADEMIC YEAR 2023/24 SEMESTER 2

Course title	*Building Physics and Energy*
Course Code	MSM088ANEP
Hours/Week: le/pr/lab	0/2/0
Credits	2
Degree Programme	MSc
Study Mode (TVSZ-ben training schedule)	*Structural Engineering*
Requirements	midterm grade
Teaching Period	2nd semester
Prerequisites	
Department(s)	Civil Engineering
Course Director	
Teaching Staff	*Dr. László FÜLÖP prof. emeritus*

COURSE DESCRIPTION

A short description of the course (max. 10 sentences).
Neptun: Instruction/Subjects/Subject Details/Basic data/Subject description

Introduction to the aims. Thermal comfort basics. Fundamental ways of heat transfer, thermal transmittance coefficient. Multidimensional heat flux, thermal bridges. Linear heat transfer coefficient and resulting heat transfer coefficient. Heat flow of surfaces in contact with the ground. Temperature profile of multi-layer structures. Properties of wet air. Moisture uptake of porous materials, sorption isotherm. Surface condensation, capillary condensation, mould growth. Room humidity balance. Evaporative diffusion in steady state and non-steady state cases. Moisture content of the structures. Radiant thermal gain and load of glazed structures. Ecliptic diagram, insolation and shading. Non-steady state thermal processes, attenuation and time lag, thermal mass. Energy requirements for buildings, building energy standards, regulations. The basics of energy in buildings. Energy balance of glazing. To prevent the risk of summer overheating.

SYLLABUS

Neptun: Instruction/Subjects/Subject Details/Syllabus

1. GOALS AND OBJECTIVES

Goals, student learning outcome.
Neptun: Instruction/Subjects/Subject Details/Syllabus/Goal of Instruction (ez szerepel a neptunban)

The main goal is to introduce the fundamentals of building physics including thermal processes, energy aspects, humidity problems and to provide support to the students to understand the physical processes.
How to achieve the best comfort possible while taking the energy matters into the consideration.

Learning Outcomes

Get to know the thermal basics, comfort aspects, energy conservation requirements, regulations and EU directives of building physics and energy in buildings.

Methodology:

Presentations illustrated by projection. The material of the lectures and handouts are to be sent via the Neptun system or in Teams.
Practice solving numerical examples and consulting on homework assignments.
The course is based on through collaboration, participation and discussions trough lessons. This is an interaction between Students and Faculty; used the teaching methods like 'Problem-based learning' and 'learning-by-doing'. The communication and work should be reflecting a respect for fellow students and their desire to work. (Tools needed: ruler scale, sketchbook, pencils, pens, rulers, callipers, pocket calculator.)

2. COURSE CONTENT

Neptun: Instruction/Subjects/Subject Details/Syllabus/Subject content

	TOPICS
LECTURE	1. *Introduction, main tasks and aims. Climate and architecture. Main fields of heat and humidity technologies in architecture. Comfort standards, Design criteria for the indoor environment. Energy certificate of buildings. Thermal balance, Steady state air-to-air conductance, Thermal conductivity. Radiant heat exchange, Thermal transmittance through a multi-layer structure. Heat transfer coefficient. Convective heat transfer coefficients. U-value calculations* 2. *Multidimensional heat transfer, thermal bridges. Main categories of thermal bridges. Linear thermal transmittance coefficient. Thermal bridge calculation methods, software packages, standards. Resultant thermal transmittance coefficient* 3. *Structural thermal bridges. Constructions with industrialized technology. Approximate linear thermal transmittance coefficient of various junctions. Resultant heat transfer coefficients of constructions with industrialized technology* 4. *Exemptions. Point thermal transmittance. Steel rods pierced thermal insulation. Average U-value of timber structures.* 5. *Heat transfer via the ground. Slab-on-ground floor, ways of thermal insulation. Linear thermal transmittance coefficient of ground contact floor and wall. Related calculation examples.* 6. *Temperature profile through the building envelope. Temperature profile calculation. Frost zone within a multi-layer structure.* 7. *Humid air, water vapour in air, vapour pressure, diffusion, gas mixture. Saturation and relative humidity. Mollier h-x diagram. Carrier Psychrometric Chart. Moisture storage function of porous materials. Capillary condensation. Calculation of the U-value related to condensation and capillary condensation temperature.* 8. *Moisture vs ventilation. Water vapour balance of a room. Simplified calculation method. Temperature ratio (factor) at the surface (Θ). Water vapour concentration reduction (Δc). Determination of the surface temperature threshold in order to reduce ventilation requirement.* 9. *Moisture penetration, vapour diffusion. Acceptable moisture content. Vapour transfer flux. Analysing the partial pressure diagram. Convective moisture transport. Calculation of vapour transfer flux and pressure distribution across the structure. Drawing of the partial pressure diagram.* 10. *Vapour diffusion in non-steady state case. Simplified calculation methods. Calculating the time to reach equilibrium. Conclusion. How to prevent structural dampness? Applying vapour barrier and/or ventilated air gap.* 11. *Non steady state heat transfer. Heat storage capacity, thermal mass. Daily heat storage cycle. Temperature fluctuation in the structure by location and time. Attenuation, time lag (summer case). Thermal mass of a room / building, classification by thermal mass. Effect of the thermal mass (capacity). Thermal mass calculations* 12. *Radiation heat exchange. Transparent and opaque bodies. Solar radiation. Radiation transmission of glass. Greenhouse effect. Transmission heat transfer of multilayer glazing. Solar radiation transmission of multilayer glazing. Intelligent glazing. Stereographic ecliptic diagram. Drawing the shadow mask for a façade.* 13. *Heat transfer coefficient of windows. Low emissivity surface coatings. Shading, smart glazing. Energy balance of windows. Window energy balance calculations.* 14. *Energy balance in buildings. Energy loss and energy gain in the heating season. Transmission and ventilation heat losses. Power and energy. Degree Day and Degree Hours method. Room energy balance calculations.*
PRACTICE	1. *U-value calculation of multi-layer structures* 2. *Thermal bridge calculations, linear thermal transmittance coefficients* 3. *Structural thermal bridges reinforced concrete beam.* 4. *Structural thermal bridges, steel rods pierced thermal insulation. Timber rafter or beam structures.* 5. *Ground contact floor and wall* 6. *Temperature profile in case of a multi-layer structure, finding the frost zone.* 7. *Finding the condensation and the capillary condensation temperature. Specifying the U-value criteria to prevent mould growth.* 8. *Specifying the ventilation volume flow requirements to prevent mould growth.*

	9. *Water vapour pressure profile within a structure* 10. *Calculation of the time to reach vapour equilibrium.* 11. *Thermal mass calculations* 12. *Drawing the shadow mask for a façade* 13. *Window energy balance calculations* 14. *Thermal power and energy requirement of buildings.*
LABORATORY PRACTICE	-

DETAILED SYLLABUS AND COURSE SCHEDULE

ACADEMIC HOLIDAYS INCLUDED

LECTURE

week	**Topic**	**Compulsory reading; page number of presentation slides handout (from … to …)**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	Main fields of heat and humidity technologies in architecture. Comfort standards, Design criteria for the indoor environment. Energy certificate of buildings. Thermal balance, Steady state air-to-air conductance, Thermal conductivity. Radiant heat exchange, Thermal transmittance through a multi-layer structure. Heat transfer coefficient. Convective heat transfer coefficients. U-value calculations	1 - 16	Studying the handouts	Tuesday of the actual week
2.	Multidimensional heat transfer, thermal bridges. Main categories of thermal bridges. Linear thermal transmittance coefficient. Thermal bridge calculation methods, software packages, standards. Resultant thermal transmittance coefficient	17 - 36	Studying the handouts	Tuesday of the actual week
3.	Structural thermal bridges. Constructions with industrialized technology. Approximate linear thermal transmittance coefficient of various junctions. Resultant heat transfer coefficients of constructions with industrialized technology.	36 - 39	Studying the handouts	Tuesday of the actual week
4.	Exemptions. Point thermal transmittance. Steel rods pierced thermal insulation. Average U-value of timber structures	40 - 42	Studying the handouts	Tuesday of the actual week
5.	Heat transfer via the ground. Slab-on-ground floor, ways of thermal insulation. Linear thermal transmittance coefficient of ground contact floor and wall.	43 - 46	Studying the handouts	Tuesday of the actual week
6.	Temperature profile through the building envelope. Temperature profile calculation. Frost zone within a multi-layer structure.	47 -48	Studying the handouts	Tuesday of the actual week
7.	Humid air, water vapour in air, vapour pressure, diffusion, gas mixture. Saturation and relative humidity. Mollier h-x diagram. Carrier Psychrometric Chart. Moisture storage function of porous materials. Capillary condensation.	49 - 65	Studying the handouts	Tuesday of the actual week

8.	Moisture vs ventilation. Water vapour balance of a room. Simplified calculation method. Temperature ratio (factor) at the surface (Θ). Water vapour concentration reduction (Δc). Determination of the surface temperature threshold in order to reduce ventilation requirement.	65 - 72	Studying the handouts	Tuesday of the actual week
9.	Moisture penetration, vapour diffusion. Acceptable moisture content. Vapour transfer flux. Analysing the partial pressure diagram. Convective moisture transport.	72 - 79	Studying the handouts	Tuesday of the actual week
10.	Vapour diffusion in non-steady state case. Simplified calculation methods. Calculating the time to reach equilibrium. Conclusion. How to prevent structural dampness? Applying vapour barrier and/or ventilated air gap.	79 - 87	Studying the handouts	Tuesday of the actual week
11.	Non-steady state heat transfer. Heat storage capacity, thermal mass. Daily heat storage cycle. Temperature fluctuation in the structure by location and time. Attenuation, time lag (summer case). Thermal mass of a room / building, classification by thermal mass. Effect of the thermal mass (capacity). Thermal mass calculations	88 - 100	Studying the handouts	Tuesday of the actual week
12.	Radiation heat exchange. Transparent and opaque bodies. Solar radiation. Radiation transmission of glass. Greenhouse effect. Transmission heat transfer of multilayer glazing. Solar radiation transmission of multilayer glazing. Intelligent glazing. Stereographic ecliptic diagram.	100 - 120	Studying the handouts	Tuesday of the actual week
13.	Heat transfer coefficient of windows. Low emissivity surface coatings. Shielding, smart glazing. Energy balance of windows. Window energy balance calculations. Radiant heat exchange of opaque building envelope	120 - 128	Studying the handouts	Tuesday of the actual week
14.	Energy balance in buildings. Energy loss and energy gain in the heating season. Transmission and ventilation heat losses. Power and energy. Degree Day and Degree Hours method.	129 - 137	Studying the handouts	Tuesday of the actual week
15.				

PRACTICE, LABORATORY PRACTICE

week	**Topic**	**Compulsory reading; page number (from … to …)**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	U-value calculation	1 - 16	Calculation test in the Neptun system	Wednesday of the actual week
2.	Thermal bridge calculations, resultant thermal transmittance coefficient calculation	17 - 36	Calculation test in the Neptun system	Wednesday of the actual week
3.	Linear thermal transmittance coefficient of reinforced concrete beams, ribs, resultant heat transfer coefficient	36 - 39	Calculation test in the Neptun system	Wednesday of the actual week
4.	Average thermal conductance of steel rods pierced thermal insulation. Average U-value of timber structures	40 - 42	Calculation test in the Neptun system	Wednesday of the actual week

5.	Linear thermal transmittance coefficient of ground contact floor and wall	43 - 46	Calculation test in the Neptun system	Wednesday of the actual week
6.	Temperature profile calculation, seeking for the frost zone.	47 -48	Calculation test in the Neptun system	Wednesday of the actual week
7.	Resultant U-value threshold to prevent condensation on the surface	49 - 65	Calculation test in the Neptun system	Wednesday of the actual week
8.	Calculation example of ventilation requirement	65 - 72	Calculation test in the Neptun system	Wednesday of the actual week
9.	Calculation of vapour transfer flux and pressure distribution across the structure. Drawing of the partial pressure diagram.	72 - 79	Calculation test in the Neptun system	Wednesday of the actual week
10.	Calculation of the time to reach vapour equilibrium	79 - 87	Calculation test in the Neptun system	Wednesday of the actual week
11.	Calculation examples of thermal mass.	88 - 100	Calculation test in the Neptun system	Wednesday of the actual week
12.	Drawing the shadow mask for a façade.	100 - 120	Submitting a drawing	Wednesday of the actual week
13.	Window energy balance calculations.	121 - 128	Calculation test in the Neptun system	Wednesday of the actual week
14.	Room energy balance calculations.	129 - 137	Calculation test in the Neptun system	Wednesday of the actual week
15.				

3. ASSESSMENT AND EVALUATION

(Neptun: Instruction/Subjects/Subject Details/Syllabus/Examination and Evaluation System) *így szerepel a neptunban*

ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

Method for monitoring attendance *(e.g.: attendance sheet / online test/ register, etc.)*

Attendance sheet, online tests

ASSESSMENT

Cells of the appropriate type of requirement is to be filled out (course-units resulting in mid-term grade or examination). Cells of the other type can be deleted.

Course resulting in mid-term grade *(PTE TVSz 40§(3))*

Mid-term assessments, performance evaluation and their ratio in the final grade *(The samples in the table to be deleted.)*

Type	Assessment max points	Ratio in the final grade
Test 1 U-value calculation	*8*	*3%*
Test 2 Thermal bridge calculations	*12*	*5%*
Test 3 Reinforced concrete ribs	*25*	*11%*
Test 4 Steel rods and timber structure	*6+18*	*10%*
Test 5 Ground contact floor and wall	*6+9*	*7%*
Test 6 Temperature profile calculation, drawing	*18+5*	*10%*
Test 7 U-value threshold to prevent condensation	*18*	*8%*
Test 8 Ventilation requirement calculation	*14*	*6%*
Test 9 Vapour pressure distribution calculation	*30*	*13%*
Test 10 Non-steady state vapour flux	*23*	*10%*
Test 11 Thermal mass calculation	*5*	*2%*
Test 12 Shadow mask drawing	*10*	*4%*
Test 13 Window energy balance calculation	*8*	*3%*
Test 14 Room energy balance calculation	*15*	*7%*

Opportunity and procedure for re-takes (PTE TVSz 47§(4))

The specific regulations for improving grades and resitting tests must be read and applied according to the general Code of Studies and Examinations. E.g.: all tests and assessment tasks can be repeated/improved at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

All tests can be repeated/improved at one time in one go at the end of the semester or in the first two weeks of the examination period. The last grade will be the final one.

Grade calculation as a percentage

based on the aggregate performance according to the following table

Course grade	Performance in %
excellent (5)	85 % …
good (4)	70 % ... 85 %
satisfactory (3)	55 % ... 70 %
pass (2)	40 % ... 55 %
fail (1)	below 40 %

The lower limit given at each grade belongs to that grade.

Course-unit with final examination

N.A.

Mid-term assessments, performance evaluation and their weighting as a pre-requisite for taking the final exam

(The samples in the table to be deleted.)

Type	Assessment	*Weighting as a proportion of the pre-requisite for taking the exam*
1.		
2.		
3.		
4.		

Requirements for the end-of-semester signature

(Eg.: mid-term assessment of 40%)

Mid-term assessment of 40%)

Re-takes for the end-of-semester signature (PTE TVSz 50§(2))

The specific regulations for grade betterment and re-take must be read and applied according to the general Code of Studies and Examinations. E.g.: all the tests and the records to be submitted can be repeated/improved each at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

All tests can be repeated/improved at one time in one go at the end of the semester or in the first two weeks of the examination period. The last grade will be the final one.

Type of examination *(written, oral):* *no examination, mid-term grade only*

The exam is successful if the result is minimum ***N.A. %.*** *(The minimum cannot exceed 40%.)*

Calculation of the grade *(TVSz 47§ (3))*

The mid-term performance accounts for ***N.A.*** %, the performance at the exam accounts for ***N.A*** % in the calculation of the final grade.

Calculation of the final grade based on aggregate performance in percentage.

Course grade	Performance in %
excellent (5)	85 % …
good (4)	70 % ... 85 %
satisfactory (3)	55 % ... 70 %
pass (2)	40 % ... 55 %
fail (1)	below 40 %

The lower limit given at each grade belongs to that grade.

4. SPECIFIED LITERATURE

In order of relevance. (In Neptun ES: Instruction/Subject/Subject details/Syllabus/Literature)

COMPULSORY READING AND AVAILABILITY

[1.] EN 832:2002 standard
[2.] EN ISO 6946:2007 (Thermal conductance resistance and Heat transfer coefficient)
[3.] EN ISO 13789:2000 (Thermal behaviour of buildings)
[4.] EN ISO 13790 (Thermal performance of buildings)
[5.] EN ISO 10211-1:1998 (Heat flux at thermal bridges and surface temperatures)
[6.] EN ISO 14683:2003 (Thermal bridges, linear heat transfer coefficients)
[7.] EN 12207:2001 (Air tightness of doors and windows)
[8.] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.
[9.] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast) Nearly zero energy building (nZEB)
[10.] Directive 2018/844 EU: Revised EPBD (19. June 2018)
[11.] Handout of the presentation slides
[12.] Task specific handouts to be submitted during the semester.

RECOMMENDED LITERATURE AND AVAILABILITY

[1.] Gudni A. Jóhannesson, Building Physics, TERC Kft. • Budapest, 2013
[2.] Victor and Aladar Olgyay: Solar Control and Shading Devices – February 21, 1977 2nd Bioclimatic Approach to Architecture, Design with Climate: Bioclimatic Approach to Architectural Regionalism, 1963
[3.] Carl-Eric Hagentoft (Author), Introduction to Building Physics – January 1, 2001