FINAL REPORT – Energy and Buildings
A.A. 2021/22

The final report must have a cover page with the student's name, data of the course (Energy and Buildings 2021/22 etc) and date of delivery. The report must contain both Part 1 and Part 2.

The report must be written in English.

Part 1

Mandatory:

1. **Calculation of the linear thermal transmittance Ψ and of the temperature factor f_{si} of a thermal bridge** (ref. ISO 10211), including: 2D section plotted from AutoCAD, schematic description of all the assumptions (materials and their physical properties, boundary conditions, measures), temperature distribution plotted from FEMM 4.2, thermal coupling coefficient (incl. figure with profile of the surface over which the heat flux is calculated) and profile of temperature and temperature factor at the internal surface. Comment the results.

2. **Assessment of surface condensation** (ref. ISO 13788) on the same thermal bridge with two methods: humidity class, constant internal relative humidity RH_i (assume 65%). Compare the results of the two methods.

3. **Assessment of interstitial condensation** (ref. ISO 13788) on a chosen building component for the coldest month of the year. Internal partial vapour pressure calculated with humidity class. The building component can be the same used in (1) and (2) or a different one.

Optional:

Annual evaluation with monthly values of the amount of condensed water following the Glaser method described in ISO 13788.

Part 2

Mandatory:

1. **Each assumption must be clearly included in the description.**

2. **Description of the building,** including scale and plan (with orientations), materials of the envelope (opaque and glazed components), other useful information – e.g. adjacent unheated spaces etc.
   Screenshot of the 3D SketchUp Model.

3. Resume of **climatic data** of the considered location (monthly average air temperature, degree-days, monthly solar irradiance on the horizontal plane, wind speed). Specify data source.

4. Calculation of the **hourly and monthly energy needs of the building for space heating and cooling using the dynamic model of EnergyPlus**; assumptions must be specified clearly (internal loads, schedules used, etc).

5. Evaluation of **final and primary energy consumption** using available data (energy bills from electricity and gas or other energy carriers) and CO_2 emission. Specify data sources for primary energy conversion factors and CO_2 emission factors.

6. **Comparison of energy need for space heating calculated by using EnergyPlus** (4) with the following table, commenting the results obtained. Re-scale monthly energy needs of the building calculated at point (4) according to the weather data of the year corresponding to the energy bills (using Degree Days as scale factor). **Comparison of the result with your bills** (heating and eventually cooling use)

7. Pattern of **indoor temperature** in bedrooms, kitchen and living room, if any, from June to August without cooling setpoint (cooling system switched off) – add a brief comment.

Table of the specific heating energy demand based on the type of building and the year of construction (Tabula project)

Year of built	Single Family House [kWh/(m² year)]	Multi Family House [kWh/(m² year)]	Apartment [kWh/(m² year)]
Before 1975	140	120	100
1976 – 1990	100	90	70
1991 - 2005	80	75	70
After 2005	65	60	50

Note: The values shown in the table represent non-retrofitted buildings, **Climatic class E**, with precise boundary conditions. Therefore, if your house/apartment has been recently retrofitted, the energy need should be 15% – 30% lower or more. If your house is recent (built up after 2012) the energy needs are even lower (15-25 kWh/(m² year)).

Remember that you made some assumptions when you developed the model (geometry, envelope properties, etc.). The values shown in the table are *representative* of the year and type of building, and they are supposed to be a reference for you to understand if the magnitude of your results is correct.

Example: If my model of a Single Family House built in 1995 has a heating energy demand of 85 kWh/(m² year) or 75 kWh/(m² year) this is realistic and it can be considered as correct. On the contrary, if you get as a result 200 kWh/(m² year), this is clearly strange.

Cooling energy demand can be lower.

Optional:
Proposal of an energy efficiency measure or comfort improvement measure. Brief description and analysis of the simulation results.

Delivery

Required attachments:

Part 1

1. FEMM files and all input files needed to run the simulations (e.g. .dxf imported in FEMM etc);
2. Excel files with calculation of thermal transmittance and surface condensation;
3. Excel files with calculation of interstitial condensation;

Part 2

4. CAD drawing or Power Point drawing of the footprint building unit (.pdf), including the zoning description;
5. OpenStudio/EnergyPlus files and any other file needed to run the simulation (.osm, .idf, .epw file, etc.);
6. Excel file with zones' temperature, heating/cooling loads, monthly energy demand, and peak load calculation (template in moodle).

Due date	11:50 pm, **11/02/2022** for the students who want to take the exam in the winter period (January-Febraury) 11:50 pm, **XX/07/2022** for the students who want to take the exam in the summer period (June, July) 11:50 pm, **XX/09/2022** for the students who want to take the exam in the autumn period (September)
Minimum-maximum number of pages	20-30 excluding attachments and cover page
Evaluation criteria	1. Completeness of all mandatory points described above; 2. Clarity of presentation of calculation, including assumptions; 3. Coherence of the numerical results and comment (justification/interpretation) of the results; 4. Complexity of the considered case-study (building and thermal bridge); 5. Additional, facultative calculations. **Please note: units of measurement must be correct and significant figures consistent, with titles or captions and axes labels. The number of digits in tables or text should be appropriate.**

IMPORTANT: mode of delivery

The following data must be delivered by the due date indicated above:

- Compressed folder (.zip or .rar) with PDF version of the final report and all the require attachments listed above on the Moodle home-page of the course. Maximum size of the folder: 100 MB. The folder must be named as follows: "*SURNAME_NAME_EB22*" (Example: "PRATAVIERA_ENRICO_EB22.zip").

Individual e-mails, delivery overdues or any other modes of delivery will not be considered for the final evaluation.

Good luck!
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