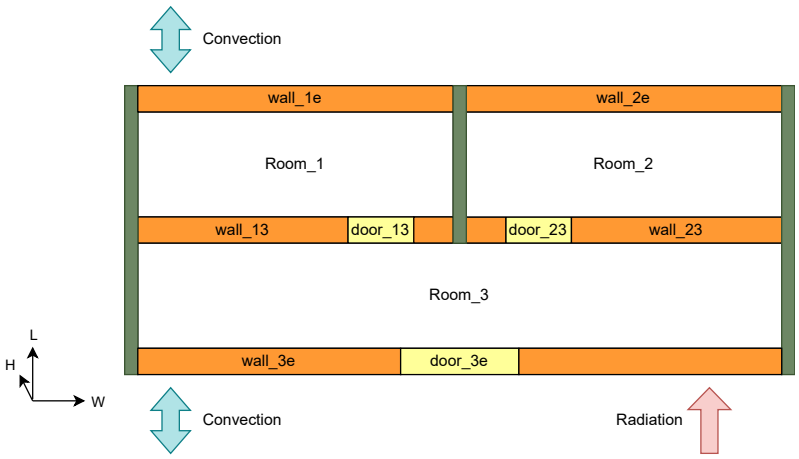
Automation of Energy Systems – A. Leva

Project for the academic year 2023/2024

Consider an extremely simplistic three-room building (that could be for example a small house) having the floorplan depicted in the figure below.



The walls in dark green colour are adiabatic, while the others exchange with interior and/or exterior by convection; as indicated, only wall 3 receives heat by radiation. All rooms are equipped with a heating/cooling actuator, and are affected by disturbance heat rates coming from occupants as well as from installed equipment such as lighting, appliances, computers and so forth.

Together with this document comes the `AES_project_2023_2024` Modelica library, that in the `ProcessComponent` package contains models for the considered building (`Building`) and the heating/cooling actuator (`HCactuator`), as well as signal generators for the external boundary conditions (`TePrad`), the door openings (`DoorOpenings`) and the disturbance heat rates (`PowerDisturbances`). All models have parameters already set for the tasks you have to carry out, hence feel free to experiment with those parameters for your learning but *for the activities of this project stick to the provided values*. The library also contains the `ProjectIntroExamples` package, where you can find a model for the open-loop behaviour of the building with the provided actuation and boundary conditions, together with an example about using the `CombiTimeTable` component in the Modelica Standard Library (hereafter MSL for short) to generate set point profiles. There is finally a package named `ProjectGroupWork`, empty in the provided library, where you shall put your Modelica models.

All of the above said, your task is to carry out the assignments listed below.

1. Study the library models mentioned above and firmly understand their operation. *Do not skip this step*: contrary to possible expectations, doing so would subsequently result in a significant waste of time.

2. Create an electric equivalent for `Building` using components from the MSL package `Electrical`: resistor, capacitor and the like can be found in package `Analog.Basic`, while switches are in `Analog.Ideal`. Name the created model `Building_ee` and give it the same interface as Building. Then create a model containing an instance of `Building` and one of `Building_ee` subjected to the same inputs (you can take that part from the

open loop building example in `ProjectIntroExamples`); name this model `Building_thermal_electrical_comparison` and run it to verify your work. Put all the created models in the `ProjectGroupWork` package.

3. Create a model named `Controlled_building_1` to make the three room temperatures follow the set points provided (on a 10-days period) by the time table contained in the example model in `ProjectIntroExamples`. The structure of the controller is completely up to you, and you can take the required blocks from the MSL, from the AES course library, or even write your own if you deem this convenient. Run that model to verify your work, and here too put all the models you create in the `ProjectGroupWork` package. Do not duplicate models that you take unmodified from other libreries, however, as that is bad practice from the maintenance standpoint.

4. Duplicate `Controlled_building_1` into `Controlled_building_2` and endow the latter with three variables named `Eheat`, `Ecool` and `Etot` to contain the energy expenditures for heating, for cooling and total. Again, put everything in the `ProjectGroupWork` package.

5. Suppose that the temperature set point for room 3 must be followed strictly only from 10AM till 4PM; from 4PM till 9PM it is enough to keep the temperature of room 3 it in a 4°C range centred on the set point, and for the rest of the 24 hours the corresponding heating/cooling actuator can just be switched off. Modify the controller in `Controlled_building_2` as per the requirements just set forth, compare the energy expenditure with that obtained in `Controlled_building_1`, and comment on the result.

Once you carried out the task required above, proceed as follows.

- Create a presentation of approximately 15 slides to describe your work.
- With the aid of the said presentation, create a screencast of maximum 15 minutes (first sharp constraint) where all the team members (second sharp constraint) have to participate into the explanation to a significant extent.
- Name the presentation **`Slides.xxx`** and the screencast **`Video.yyy`**, the **`xxx`** and **`yyy`** extensions depending on the file formats you use (for the screencast **`mp4`** is preferred, but not mandatory).
- Create a text file named **`Team-members.txt`**, containing the family name(s), given name(s) and person codes of all the members of the team.
- Pack the **`AES_project_2023_2024`** library (completed with your models in the `ProjectGroupWork` package) and the three files above into a **single** compressed file; name that file **`AES-2024-Name.zzz`**, where the **`zzz`** extension depends on the employed compressed format, while **`Name`** is the (first) family name of the team member who comes alphabetically first.
- Upload **only** the so created compressed file using the Webeep folder **before taking the written test**. Only the member whose family name appears in the compressed file name needs to upload, that will be valid for the whole team.