Module 1 Assignment 8

10/7/20

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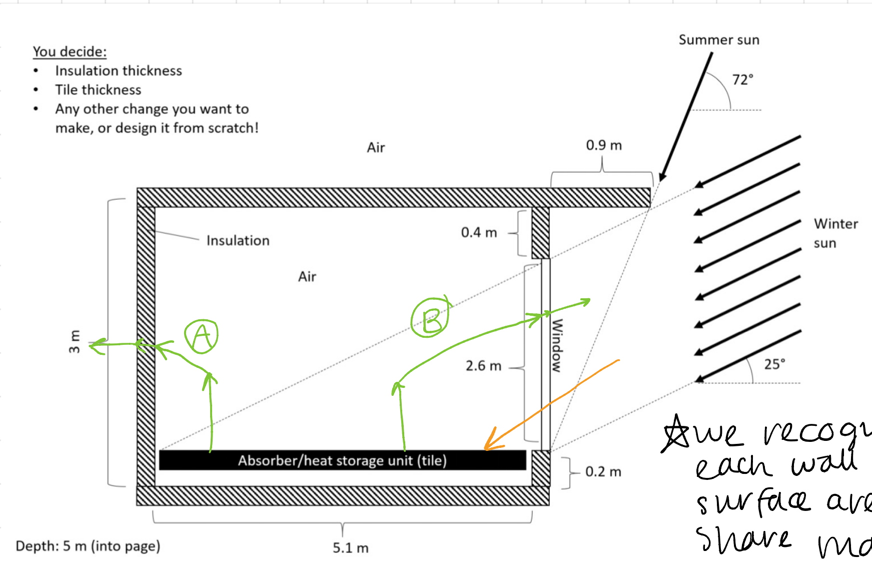


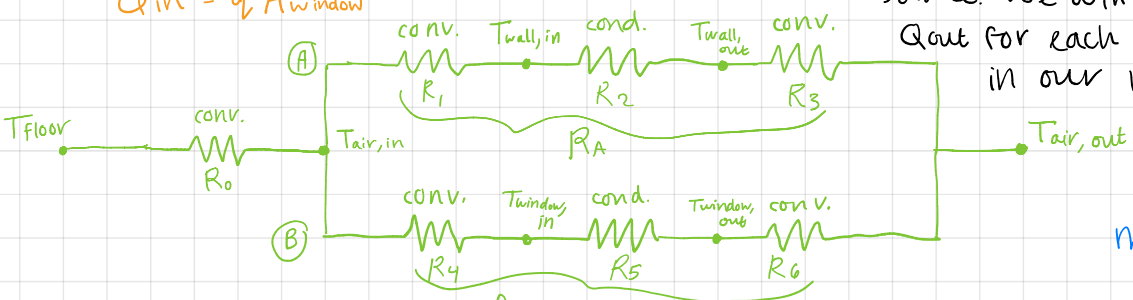
ASSUMPTIONS

- Floor suspended in air, so same resistance network from floor out thru bottom
- uniform air temperature inside house
- Heat storage unit in floor is only storage body in house

☆ we recognize that each wall has a different surface area, but they share material properties. The resistance network for each wall is otherwise the same. we will calculate Qout for each specific wall in our model.

Qout

$Q_{in} = q\, A_{window}$



$$R_{conv} = \frac{1}{hA} \qquad R_{cond} = \frac{\delta}{kA}$$

$$R_{A+B} = \frac{1}{\left(\frac{1}{R_1+R_2+R_3}\right) + \left(\frac{1}{R_4+R_5+R_6}\right)}$$

$$R_{total} = R_0 + R_{A+B} = R_0 + \left(\frac{1}{\frac{1}{(R_1+R_2+R_3)} + \frac{1}{(R_4+R_5+R_6)}}\right)$$

$$R_A = R_1 + R_2 + R_3 \qquad R_B = R_4 + R_5 + R_6$$

$$R_0 = \frac{1}{h_{in} A_{floor}}$$

$$R_1 = \frac{1}{h_{in} A_{wall}}$$ ← see note on wall area above

$$R_2 = \frac{\delta_{wall}}{k_{wall} A_{wall}}$$

k_{wall} = thermal conductivity of insulation

$$R_3 = \frac{1}{h_{out} A_{wall}}$$

$$R_4 = \frac{1}{h_{in} A_{window}}$$

$$R_5 = \frac{\delta_{window}}{k_{window} A_{window}}$$

k_{window} = thermal conductivity of window (glass)

$$R_6 = \frac{1}{h_{out} A_{window}}$$

$$mc\frac{dT}{dt} = \dot{Q}_{in} - \dot{Q}_{out}$$

$$\frac{dT}{dt} = \frac{\dot{Q}_{in} - \dot{Q}_{out}}{mc}$$

$mc =$

$$\dot{Q}_{out} = \frac{\Delta T}{R_{total}} = (T$$

$$= (Q_{out\,A} + Q_{out\,B})$$

ODE

T_{air}

Module 1 Assignment 8 cont.

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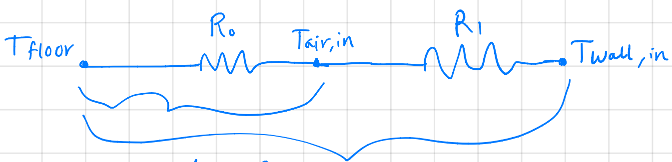
$$\boxed{\underbrace{mc}_{\text{floor}} \frac{dT_F}{dt} = Q_{in} - \left(\frac{T_F - T_{air,out}}{R_{total}}\right)}$$

so we can find $T_{wall,in}$ to get $T_{air,in}$

$$\boxed{mc\frac{dT_w}{dt} = \frac{(T_{air,in} - T_{wall,in})}{(R_0+R_1)} - \frac{(T_{wall,out} - T_{air,out})}{(R_2+R_3)}}$$



using model from 7.5.5

$$Q_{F-air,out} = \frac{T_{Floor} - T_{wall,in}}{(R_0+R_1)} = \frac{T_{Floor} - T_{air,in}}{R_0}$$

$$T_{Floor} - T_{air} = R_0\left(\frac{T_{Floor} - T_{wall,in}}{(R_0+R_1)}\right)$$

$$\boxed{T_{air} = T_{Floor} - R_0\left(\frac{T_{Floor} - T_{wall,in}}{(R_0+R_1)}\right)}$$

Still developing all the components to solve for this, plan to ask in class.

Equation Brainstorm

Floor → Air in

$$\underbrace{mc}_{\text{floor}}\frac{dT_F}{dt} = Q_{in} - \frac{T_F - T_{air,in}}{R_0}$$

Air in → air out

$$\underbrace{mc}_{\text{air}}\frac{dT_{air,in}}{dt} = \left(\frac{T_F - T_{air,in}}{R_0}\right) - \left(\underbrace{\frac{T_{air,in} - T_{air,out}}{R_A}}_{\text{Might have to add Qout from all walls in this term}} - \frac{T_{air,in} - T}{R_B}\right)$$

or do we need a separate ODE for heat lost from the window?