# ME 345 – HTx Fall 2021 Conduction Take-Home Exam

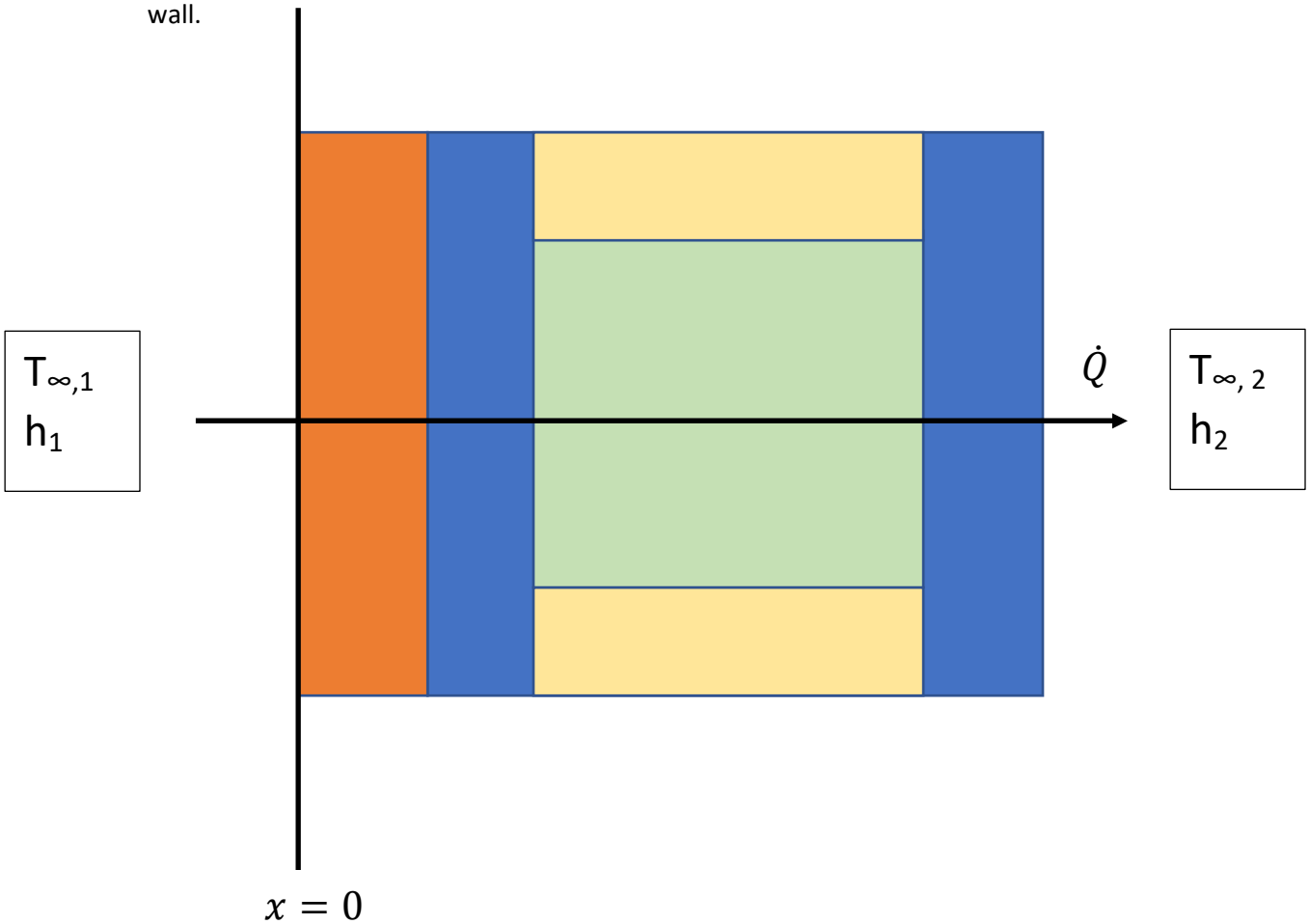
## Problem 1 – Composite Wall

You have a wall that is made up of many pieces (each with 0.33 $m^2$ area) with the cross-section shown in the figure below

- The convection coefficient on the left side is 10 W/($m^2$ °C)
- The orange section has a thickness in the x-direction of 0.02 m, a thermal conductivity of 0.026 W/m-°C, and an area of 0.33 $m^2$.
- Each blue section has a thickness in the x-direction of 0.02 m, a thermal conductivity of 0.22 W/m-°C, and an area of 0.33 $m^2$.
- Each yellow section has a thickness in the x-direction of 0.18 m, a thermal conductivity of 0.22 W/m-°C, and an area of 0.015 $m^2$.
- The green section has a thickness in the x-direction of 0.18 m, a thermal conductivity of 0.72 W/m-°C, and an area of 0.30 $m^2$.
- The convection coefficient on the right side is 20 W/($m^2$ °C)

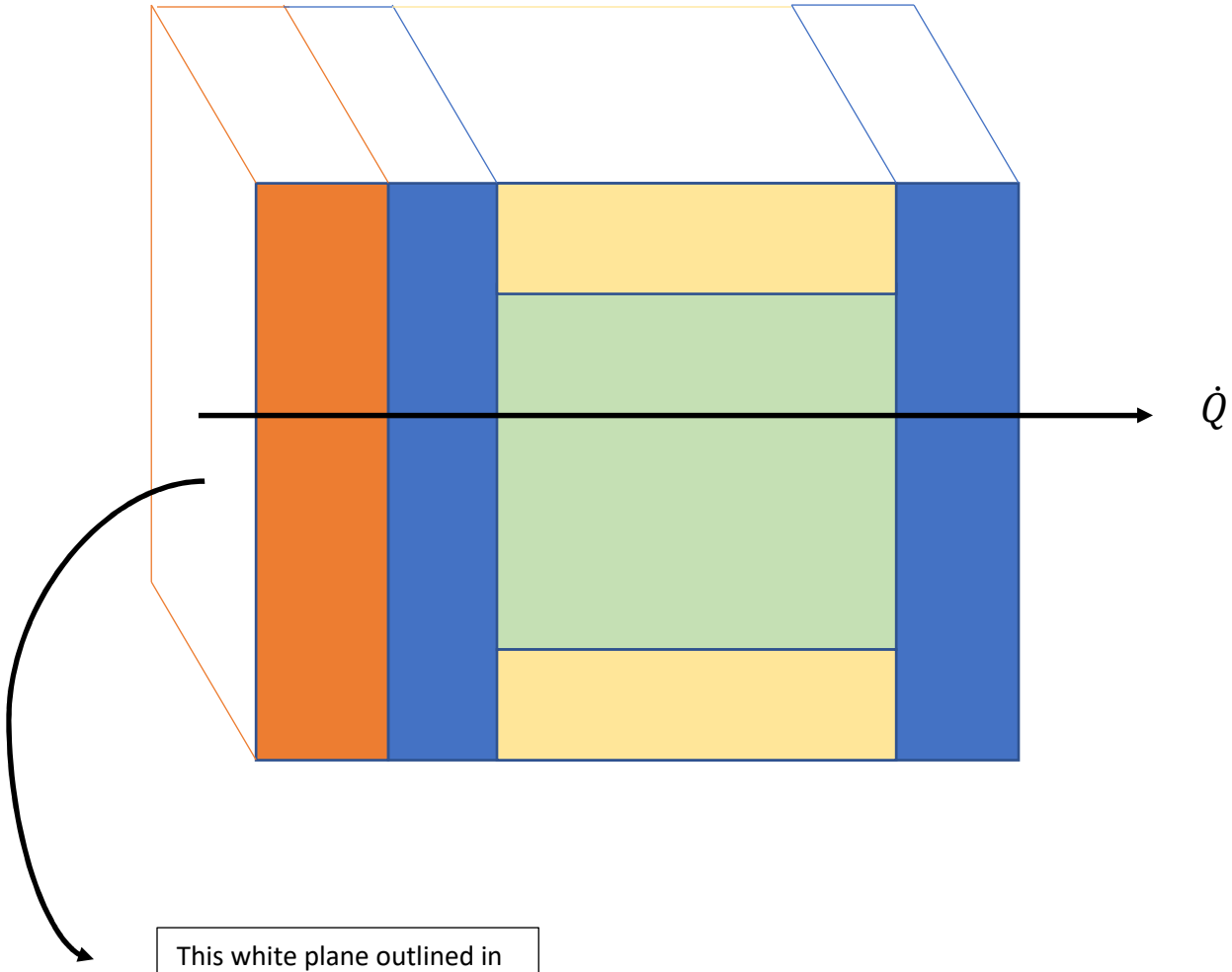
**Calculate the following:**

1. Using the thermal resistance model, calculate $R_{total}$ [°C/W] through one section of wall.
2. Calculate the heat rate [W] through one section of wall if $T_{infinity,1}$ = 22 °C and $T_{infinity,2}$ = -4 °C.
3. If the entire wall has a surface area of 4 m x 6 m, calculate the heat rate [W] through the whole wall.



**Further Explanation**

Each block has an area (perpendicular to the flow of heat) that is 0.33 $m^2$. Because of this, the orange and blue sections each have an area of 0.33 $m^2$. But the yellow and green areas (perpendicular to the flow of heat) are smaller (but do add up to 0.33 $m^2$.




This white plane outlined in orange is the 0.33 $m^2$ area.

## Problem 2 – Cylindrical Conduction

You have 1D SS conduction without heat generation through a cylindrical shell with inner and outer radius of $r_1$ and $r_2$. If the temperature profile through the wall was linear (as in the figure to the right), what conditions would be necessary for that to occur?
Use the heat equation in cylindrical coordinates to justify your answer(s).