CASE STUDY 1: Multi Room Heat Balance (Conduction only)

INTRODUCTION

The multi-room heat balance method is used to analyze heat transfer between interconnected rooms and the surroundings. In this study, only conduction heat transfer through walls and partitions is considered. Each room is treated as a control volume, and energy balance equations are applied.The approach helps determine steady-state room temperatures based on thermal resistances

Mathematical Expression

Case study - 1

Multi Room Heat Balance (Conduction Only)

Assumptions

↳ steady state Condition
↳ One dimension heat Conduction
↳ uniform temperature in each room
↳ No Convection & Radiation

⇒ For multi Room heat is transfered mainly due to temperature difference

⇒ Convection & Radiation are neglected
Conduction Only

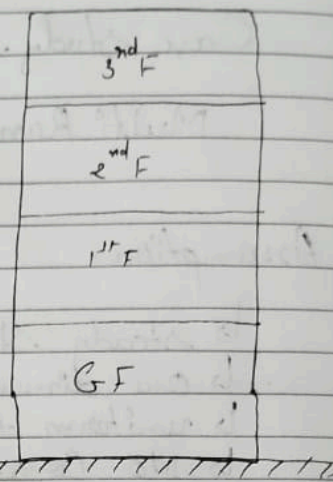
⇒ According to Fouriers law of heat Conduction

$$Q = \frac{T_1 - T_2}{R}$$

where,
Q = heat Transfer rate
T_1, T_2 = temp. of two rooms
R = Thermal resistance

No. of rooms = 4

Heat Transfer mode
= Conduction



each room exchange heat
with adjecent rooms th

~~Res~~ Thermal resistance
between two rooms R_1
between room and ambient
R_2

ambient temperature = $T_a = 35^\circ c$

Internal heat generations occours in the ~~b~~ top Floor

∵ For any room at steady state

$$\Sigma Q_{in} - \Sigma Q_{out} + Q_{gen} = 0$$

$$G = 1/R \quad , \quad G = \text{Conductance.}$$

$$\therefore \Sigma\, G_1 (T_1 - T_2) + G_2 (T_1 - T_a) = Q_{gen}$$

$$G_1 = 1/R_1 \quad , \quad G_2 = 1/R_2$$

⇒ Ground Floor

$$G_1 (T_0 - T_1) + G_2 (T_0 - T_a) = 0$$

$$\because (G_1 + G_2) T_0 - G_1 T_1 = G_2 T_a$$

⇒ Middle room (1 & 2)

$$G_1 (T_i - T_{i-1}) + G_1 (T_i - T_{i+1}) + G_2 (T_i - T_a) = 0$$

$$\because (G_2 + 2G_1) T_i - G_1 T_{i-1} - G_1 T_{i+1} = G_2 T_a$$

⇒ Top Floor

$$\because (G_1 + G_2) T_3 - G_1 T_2 = G_2 T_a + Q_{gen}$$

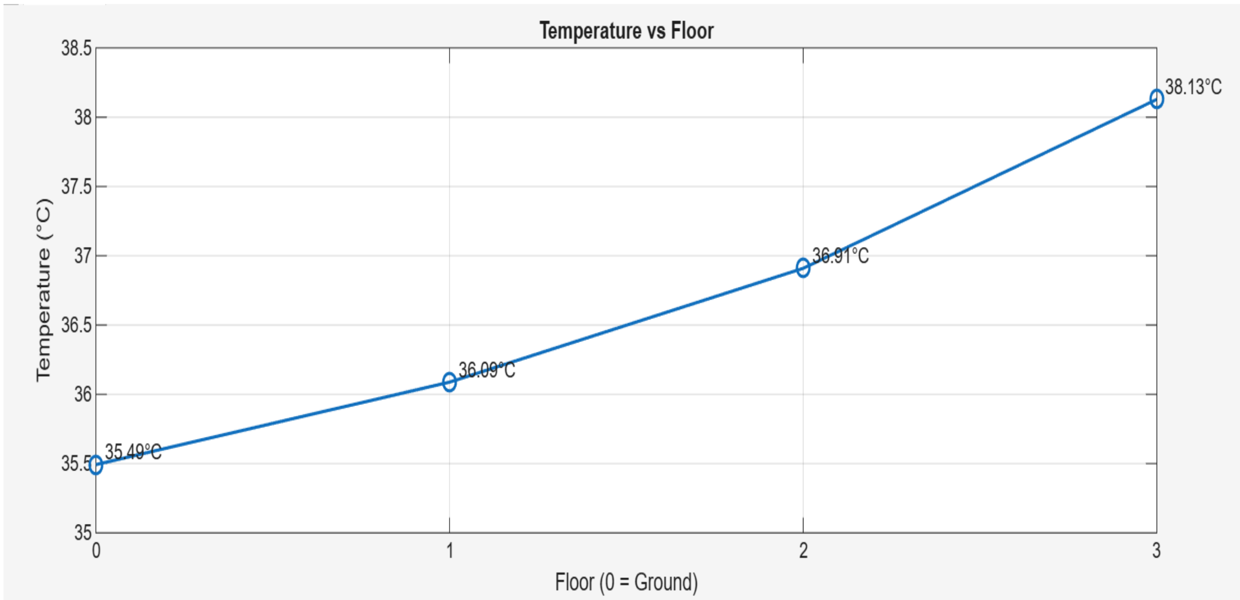
Matrix $[A][T] = [B]$

$$A = \begin{bmatrix} G_2 + 2G_1 & -G_1 & 0 & 0 \\ -G_1 & G_2 + 2G_1 & -G_1 & 0 \\ 0 & -G_1 & G_2 + 2G_1 & -G_1 \\ 0 & 0 & -G_1 & G_2 + 2G_1 \end{bmatrix}$$

$$T = \begin{bmatrix} T_0 \\ T_1 \\ T_2 \\ T_3 \end{bmatrix} \qquad B = \begin{bmatrix} (G_1 + G_2) T_a \\ G_2 T_a \\ G_2 T_4 \\ (G_1 + G_2) T_a + Q \end{bmatrix}$$

CODE

```
clc;
clear;

R1 = 0.1;
R2 = 0.48;

Tamb = 35;

Qgen = 50;

G1 = 1/R1;
G2 = 1/R2;

A = [ (G2+G1+G1)    -G1             0             0;
     -G1         (G2+G1+G1)      -G1             0;
      0             -G1         (G2+G1+G1)      -G1;
      0              0             -G1         (G2+G1+G1)];

B = [ Tamb*(G2+G1);
     Tamb*(G2);
     Tamb*(G2);
     Tamb*(G2+G1) + Qgen ];

T = inv(A)*B;

fprintf('Temperature at Ground Floor (T0) = %.2f °C\n', T(1));
fprintf('Temperature at 1st Floor (T1)    = %.2f °C\n', T(2));
fprintf('Temperature at 2nd Floor (T2)    = %.2f °C\n', T(3));
fprintf('Temperature at 3rd Floor (T3)    = %.2f °C\n', T(4));
floors = 0:3;

figure;
plot(floors, T, '-o', 'LineWidth', 1.5, 'MarkerSize', 8);
grid on;
xlabel('Floor (0 = Ground)');
ylabel('Temperature (°C)');
title('Temperature vs Floor');
xlim([0 3]);
xticks(floors);

for k = 1:numel(T)
   text(floors(k), T(k), sprintf('  %.2f°C', T(k)),
'VerticalAlignment','bottom');
end
```



Temperature vs Floor
Temperature (°C)
38.5
38
37.5
37
36.5
36
35.5
35
0
1
2
3
Floor (0 = Ground)
35.49°C
36.09°C
36.91°C
38.13°C