

FOAM – Week 08

8.1 Data Description – part 2

Objective: Describe data with multiple independent variables

Outline for this week

- Describe three problems
- Same phenomena
- Temperature distribution
 1. On a rod
 2. On a Integrated Circuit (IC)
 3. In a room
- **Objective:**
 - Motivate mathematical concepts
 - Give meaning to equations
 - Expand our visualization
 - Multiple independent variables

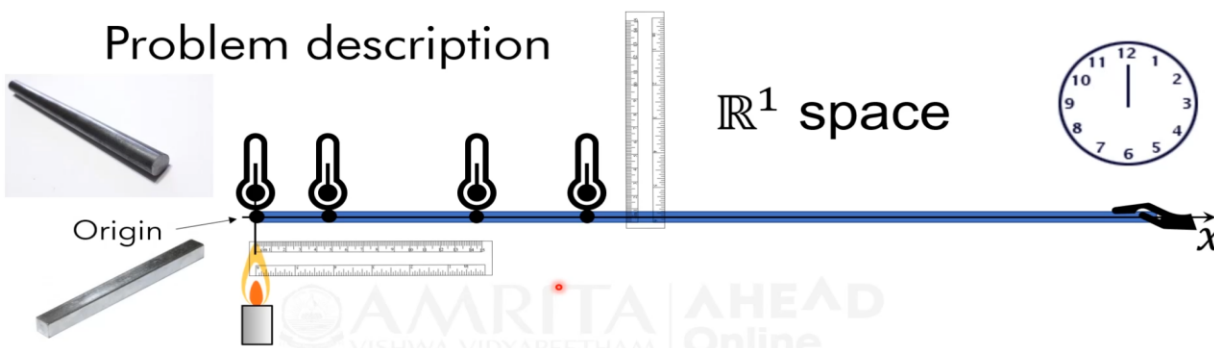
8.2 Data Description – part 2

Problem 1 – Temperature distribution along a rod

We consider two metallic rods made of iron and aluminum

- How long can you hold the metal rod without burning your hand?
- How to describe the problem quantitatively?
- Quantifying the locations or the coordinates
- Quantifying the time
- Two independent variables – location (coordinates) and time
Dependent variable – Temperature

8.3 Data Description – part 2



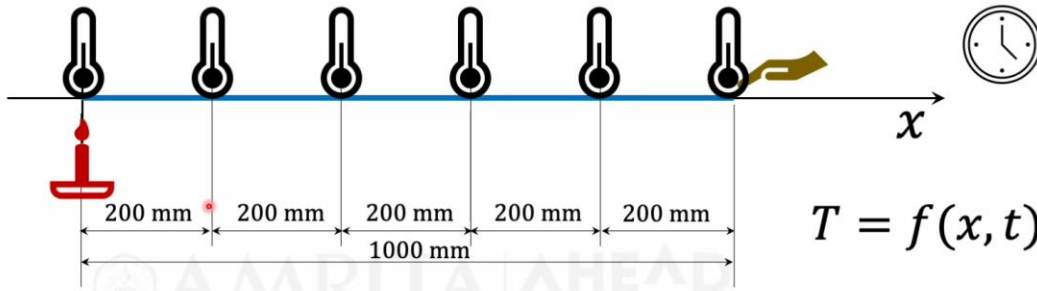
Let's pose some questions

- What is the temperature near the flame at the beginning?
- What is the temperature near the hand at beginning?
- How long can we hold with the hand without burning?
- How far away from the flame should we hold the hand on the rod?
- If at all the metal melts, where would start melting? Where is the highest temperature on the rod?

9.1 Data Description – part 2

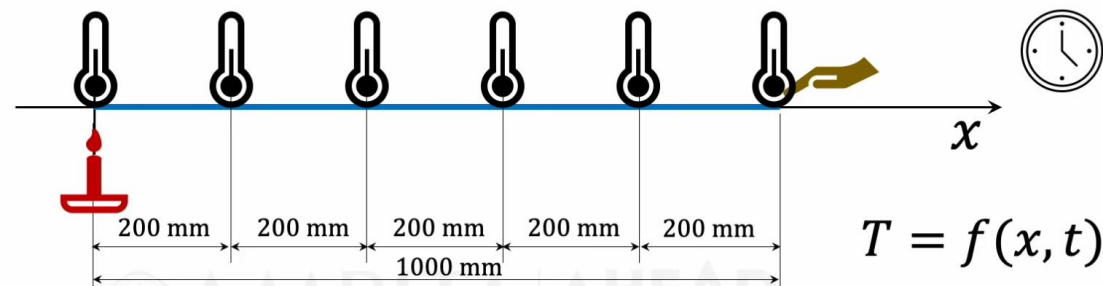
➤ Temperature distribution on a rod – Recording data

Temperature distribution on a rod – Recording data



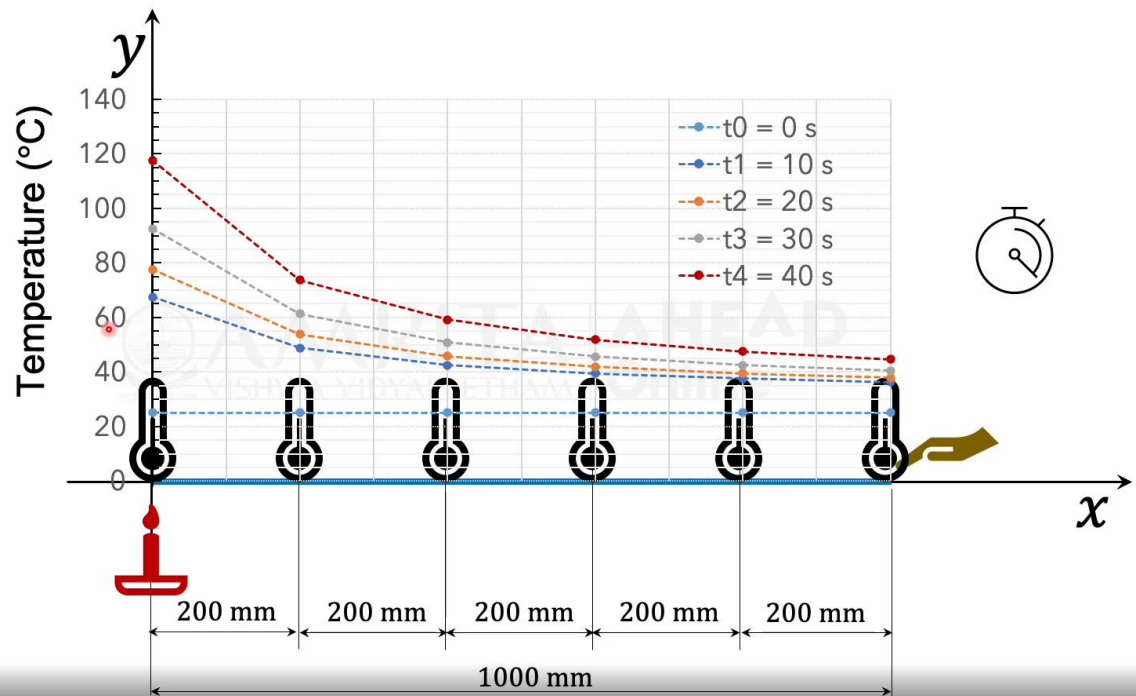
x (mm)	$T(x, t = 0 \text{ sec})$	x (mm)	$T(x, t = 1 \text{ sec})$	x (mm)	$T(x, t = 2 \text{ sec})$	x (mm)	$T(x, t = 1800 \text{ sec})$
0		0		0		0	
200		200		200		200	
400		400		400		400	
600		600		600		600	
800		800		800		800	
1000		1000		1000		1000	

Temperature distribution on a rod – Recording data



t (s)	$T(x = 0 \text{ m})$	$T(x = 0.2 \text{ m})$	$T(x = 0.4 \text{ m})$	$T(x = 0.6 \text{ m})$	$T(x = 0.8 \text{ m})$	$T(x = 1 \text{ m})$
0						
1						
2						
⋮						
1799						
1800						

Temperature distribution on a rod – Visualizing data



9.2 Data Description – part 2

Temperature distribution on an integrated circuit

Problem 2: Temperature distribution on IC

Cell phone, laptops



Server



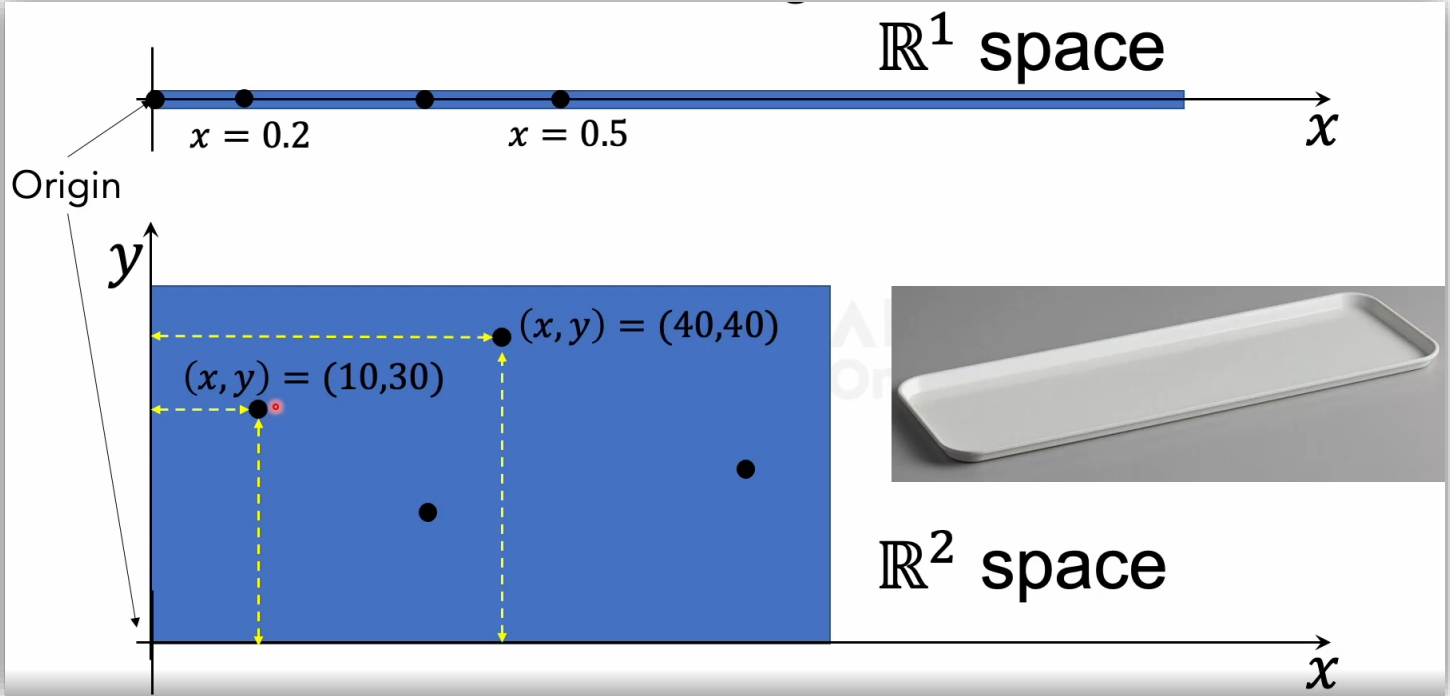
Integrated Circuits (IC)



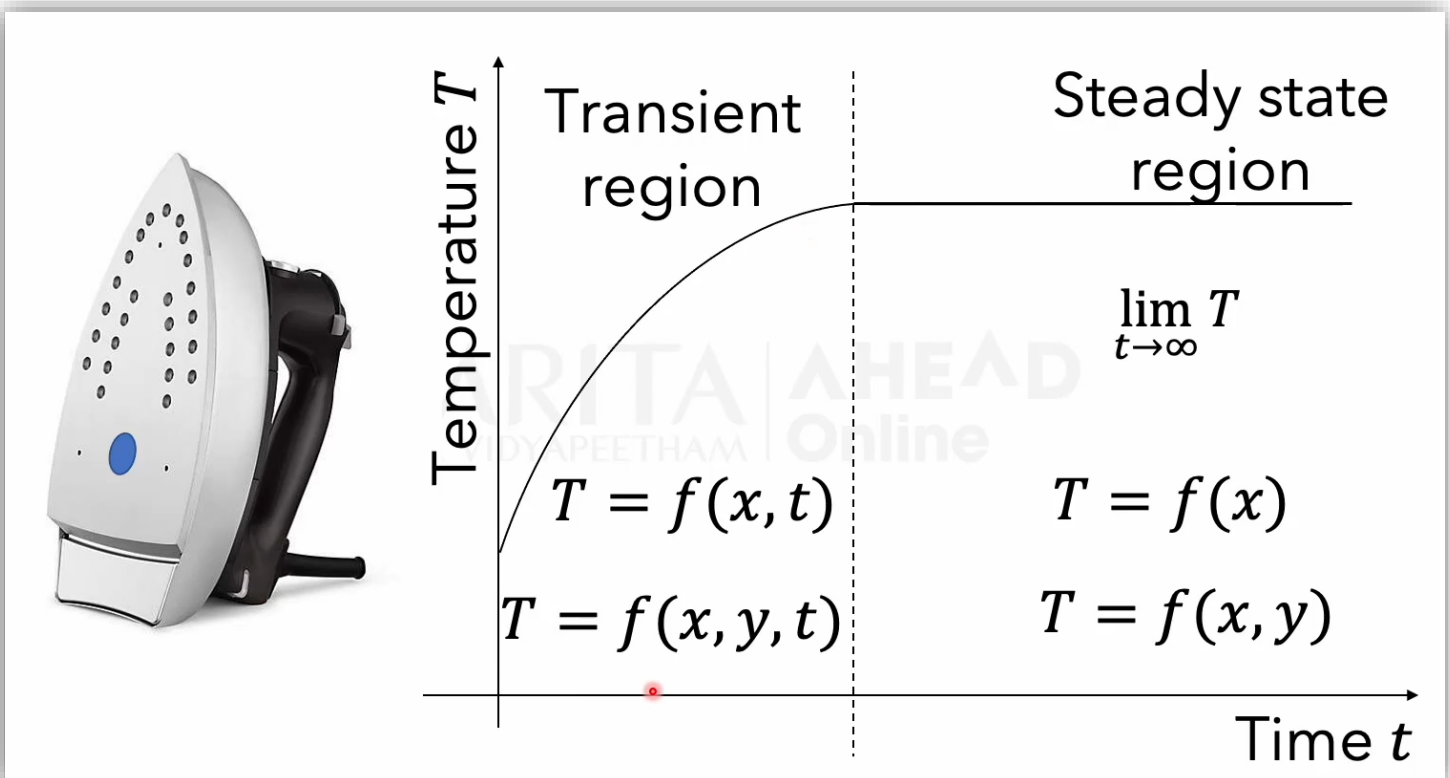
System on Chip (SOC)

- **IC - Integrated Circuits - made of billions of transistors that produce heat, raising the temperature of the devices.**
- **Temperature rise needs to be controlled**

➤ Rod vs Plate – Understanding dimensions



➤ Steady state Vs Transient problem

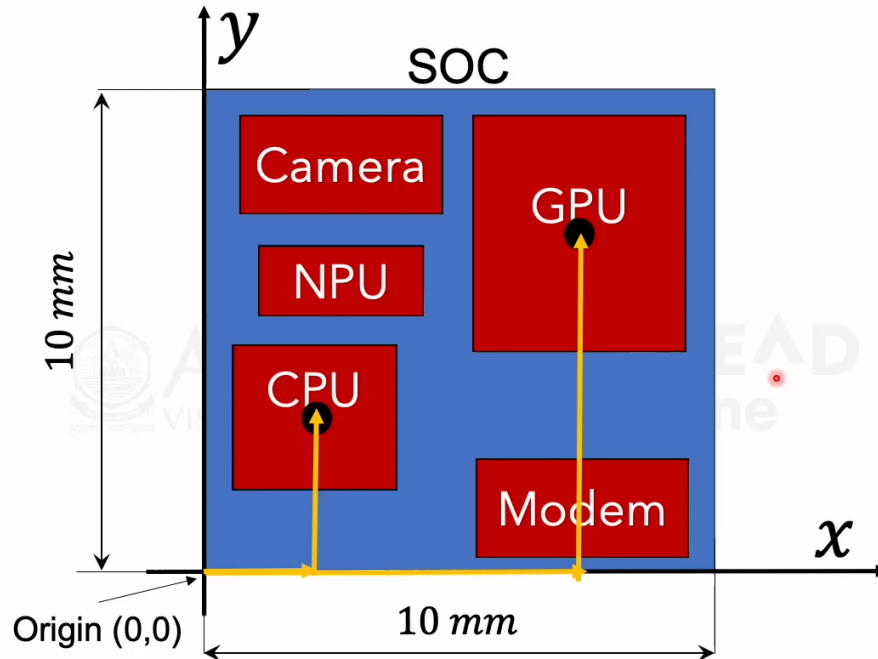


9.3 Data Description – part 2

➤ Temperature distribution on IC

- SOC – Contains all components like CPU, GPU, Modem, Camera etc. on a single chip

Temperature distribution on IC



CPU

$$x = 2$$

$$y = 4$$

$$(x, y) = (2, 4)$$

GPU

$$x = 7$$

$$y = 7$$

$$(x, y) = (7, 7)$$