Clipping

Course Code: CSC 3224 Course Title: Computer Graphics

Dept. of Computer Science
Faculty of Science and Technology

Lecturer No:	**14**	**Week No:**	**11**	**Semester:**	**Fall 2021-2022**
Lecturer:	**MAHFUJUR RAHMAN, *mahfuj@aiub.edu***				

Lecture Outline

1. Clipping
- Pont Clipping
- Line Clipping (Derivation)
- Line Clipping (Problem Solving)

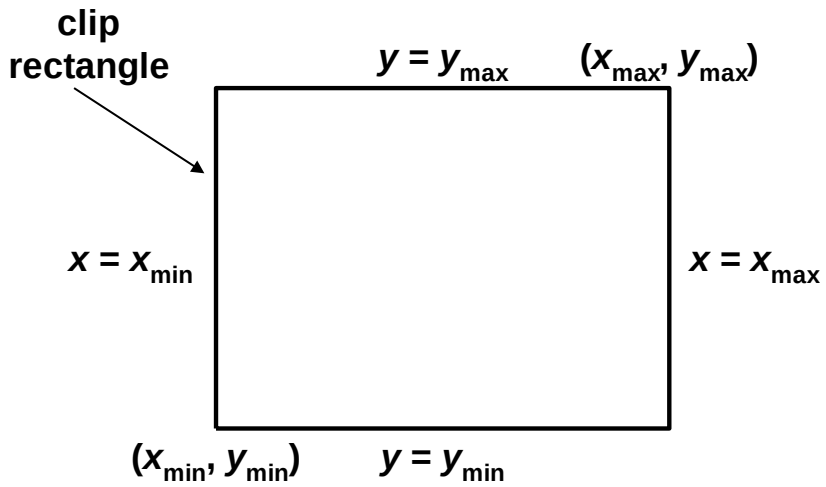
Clipping

- Clipping, in the context of computer graphics, is a method to selectively enable or disable rendering operations within a defined region of interest.
- A rendering algorithm only draws pixels in the intersection between the clip region and the scene model. Lines and surfaces outside the view volume are removed.

Clipping Type

- Types of clipping
  - Point clipping
  - Line clipping
  - Polygon clipping

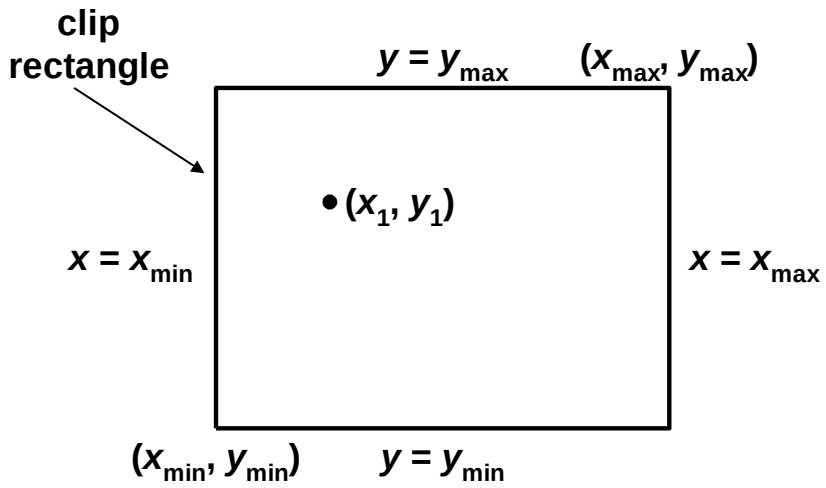
Point Clipping



For a point (x,y) to be inside the clip rectangle:

$$x_{min} \leq x \leq x_{max}$$
$$y_{min} \leq y \leq y_{max}$$

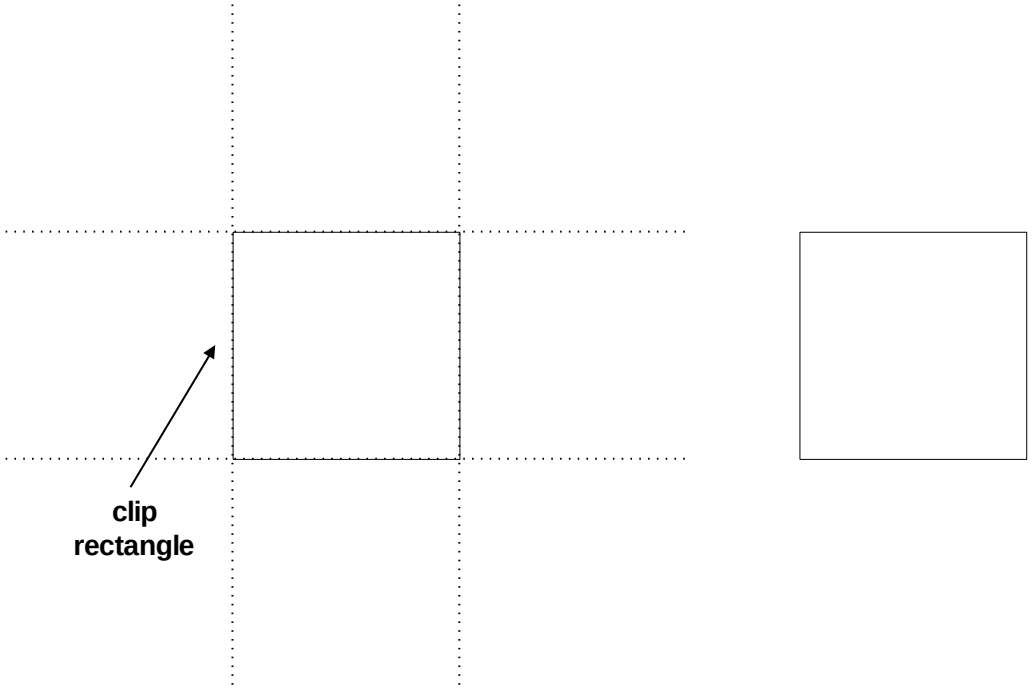
Point Clipping



For a point (x,y) to be inside the clip rectangle:

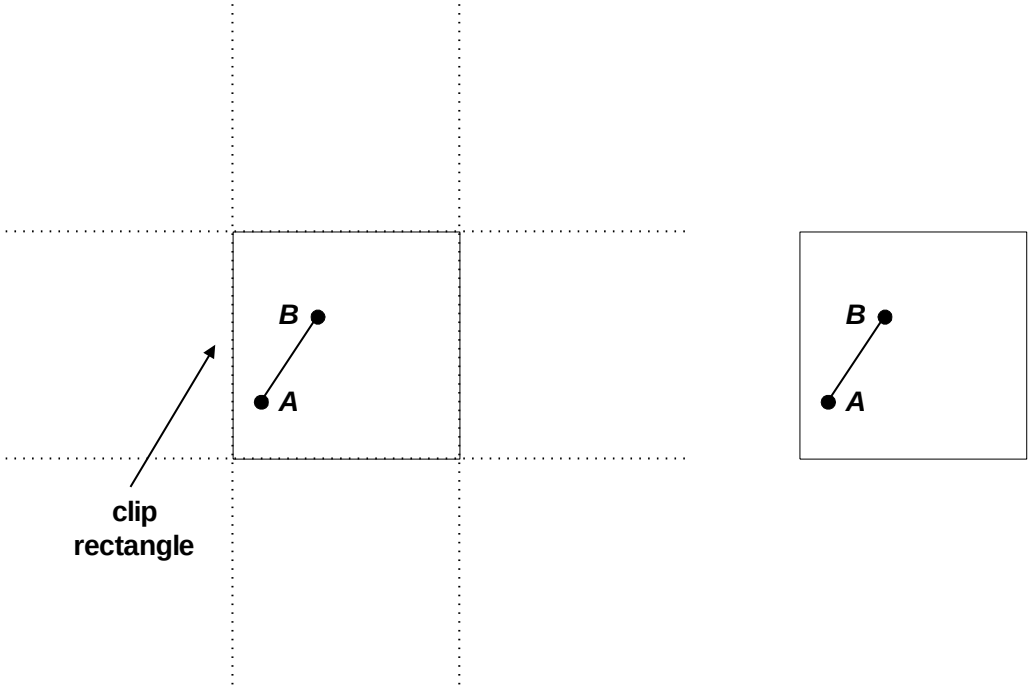
$$x_{min} \leq x \leq x_{max}$$
$$y_{min} \leq y \leq y_{max}$$

Line Clipping



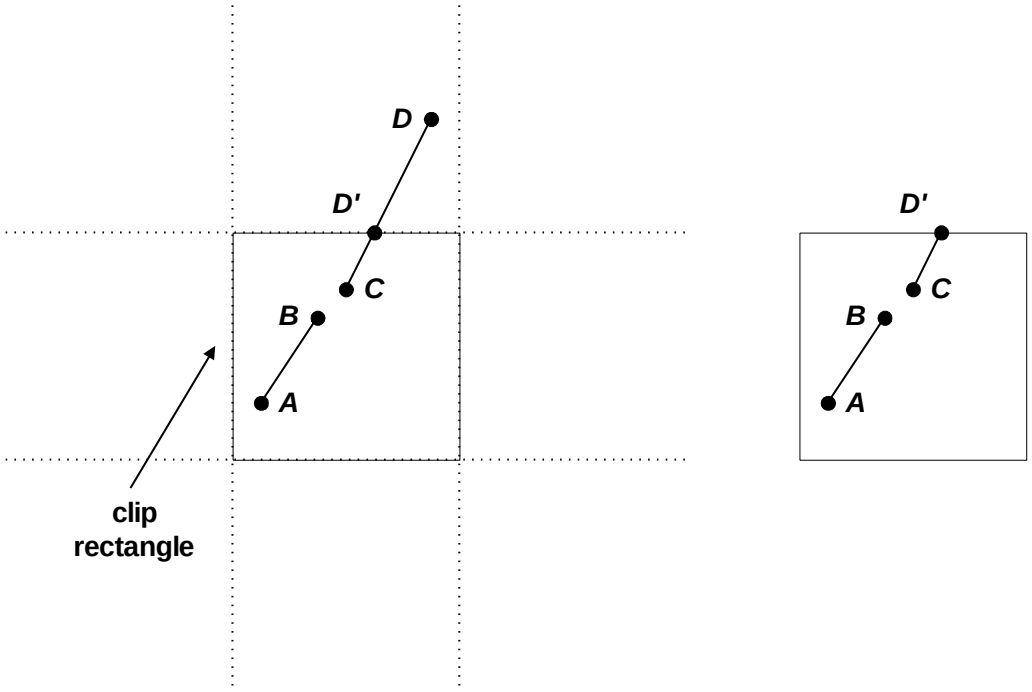
Cases for clipping lines

Line Clipping



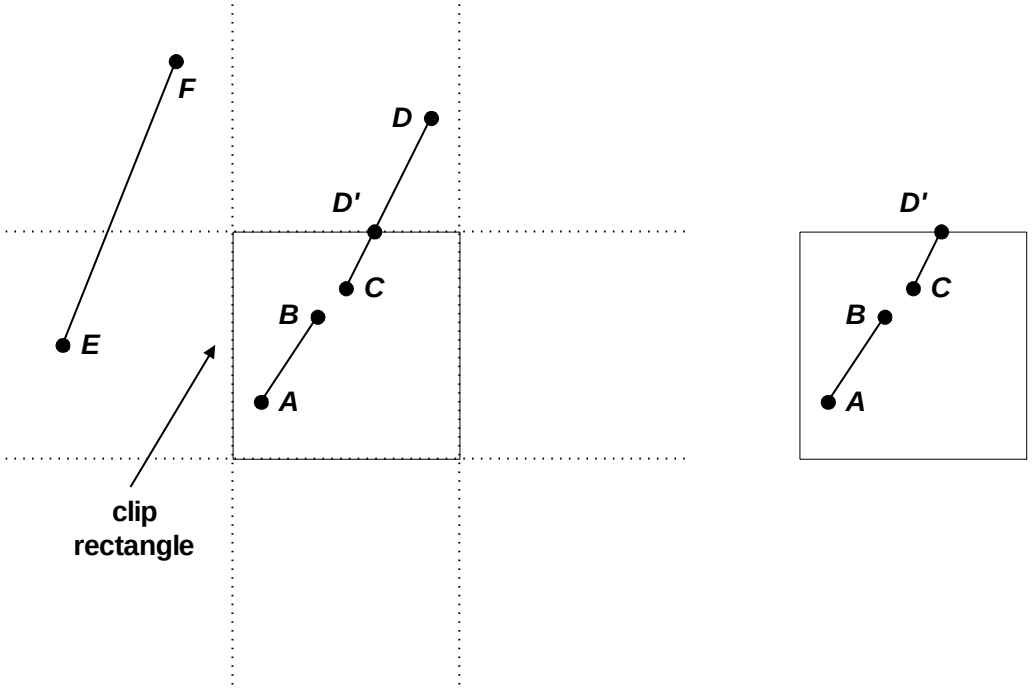
Cases for clipping lines

Line Clipping



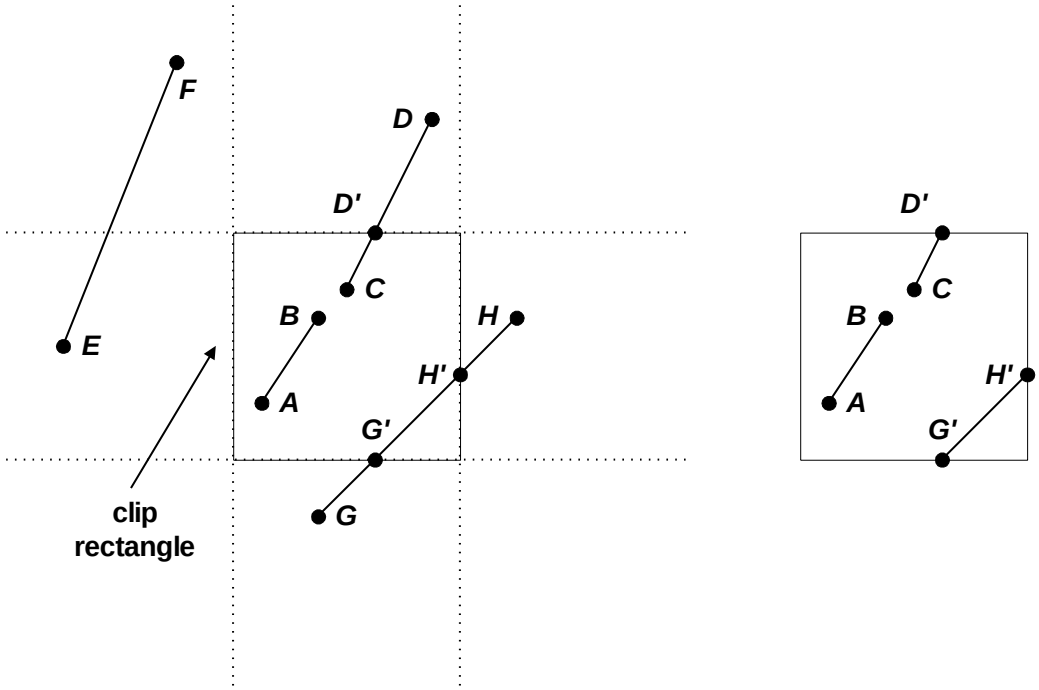
Cases for clipping lines

Line Clipping



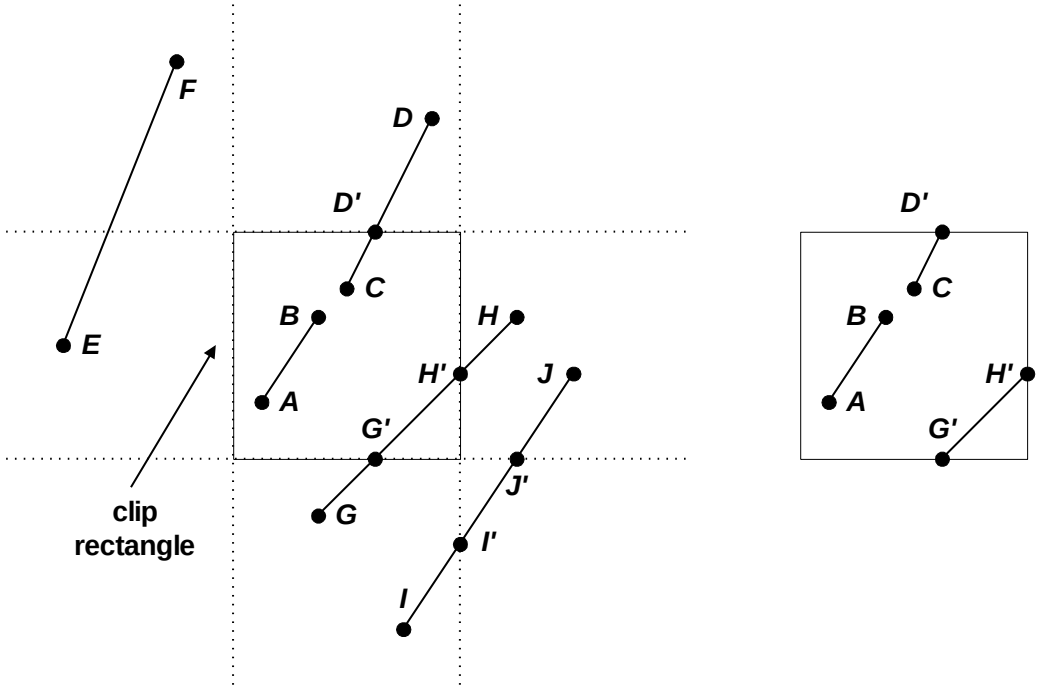
Cases for clipping lines

Line Clipping



Cases for clipping lines

Line Clipping

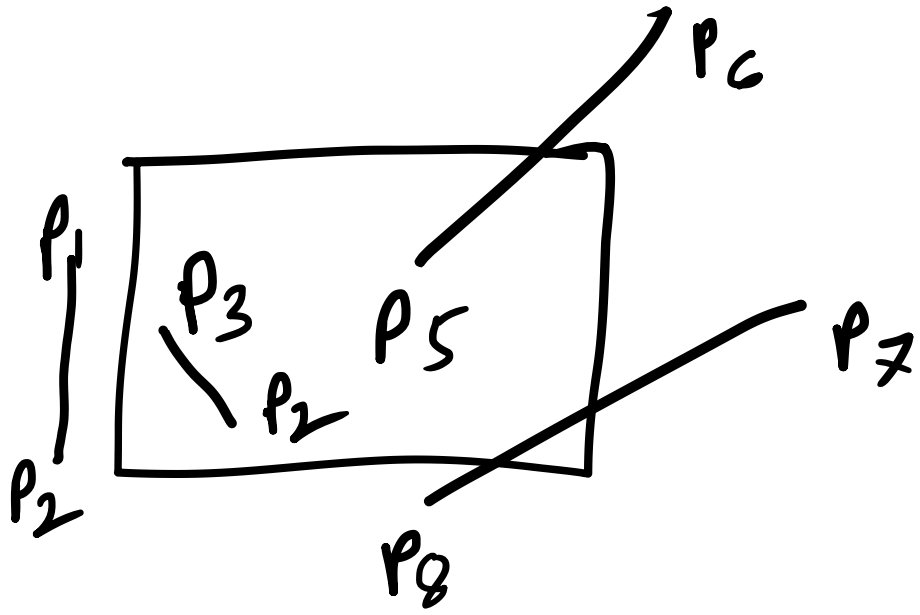


Cases for clipping lines

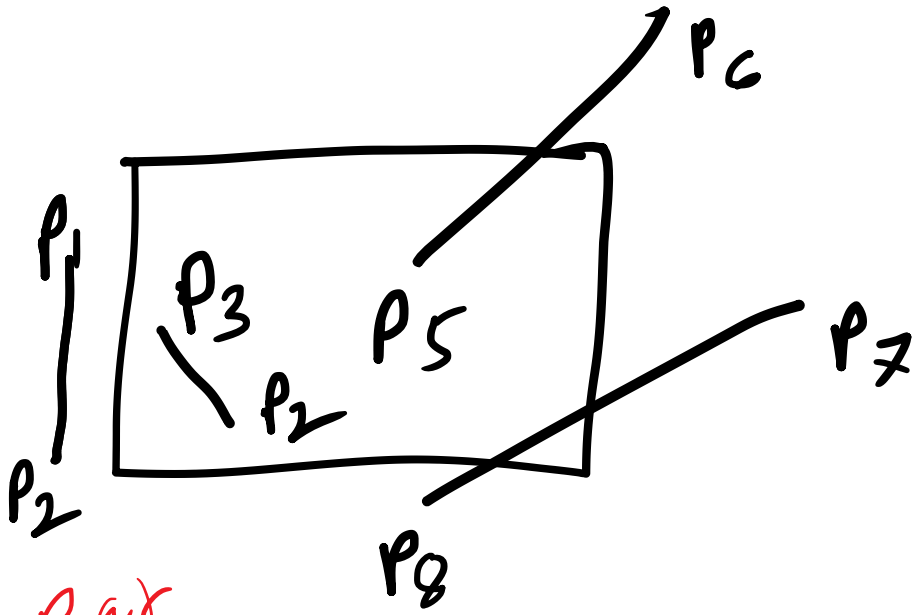
The Cohen-Sutherland Line-Clipping

- The Cohen-Sutherland Line-Clipping Algorithm performs initial tests on a line to determine whether intersection calculations can be avoided.

Line Clipping (Example)



Line Clipping (Example)



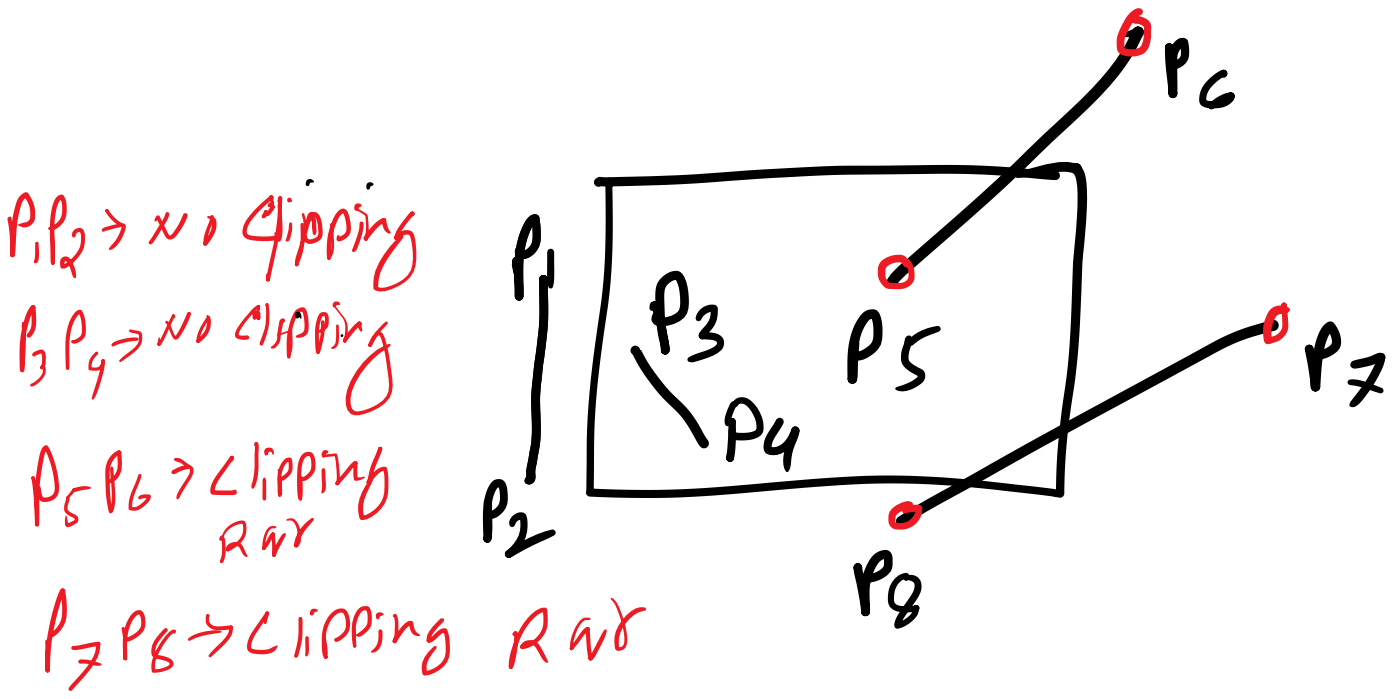
$P_1P_2 \rightarrow$ no clipping

$P_3P_4 \rightarrow$ no clipping

$P_5P_6 \rightarrow$ clipping Rgt

$P_7P_8 \rightarrow$ clipping Rgt

Line Clipping (Example)



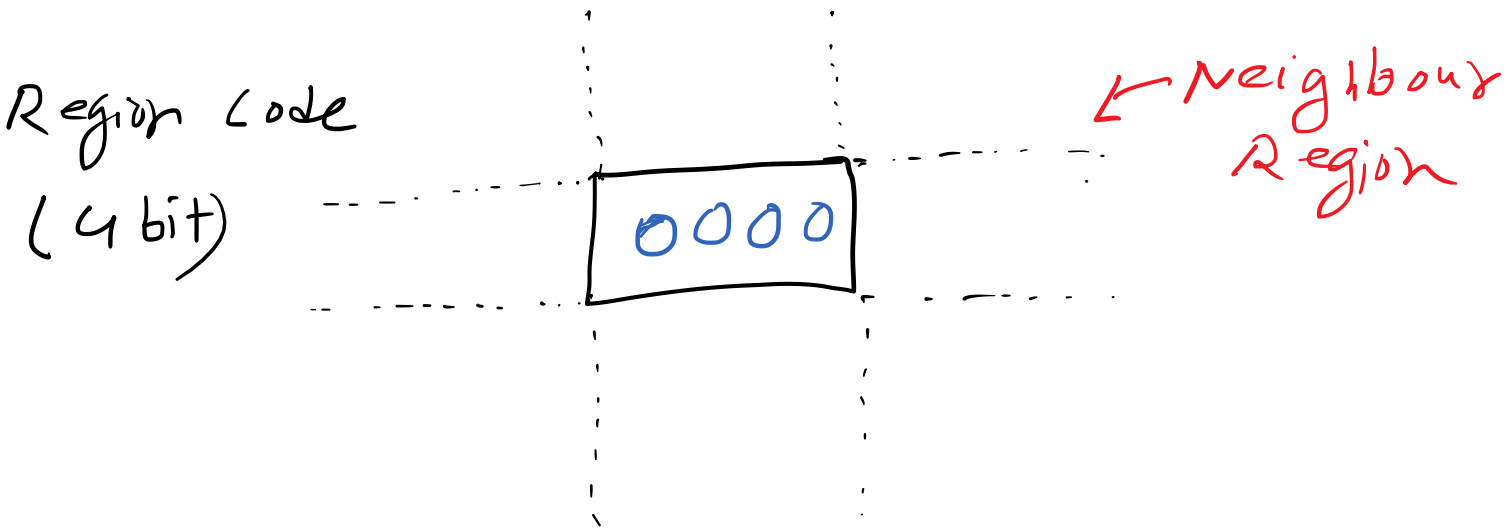
COHEN SUTHERLAND LINE CLIPPING (Derivation)

* Algorithm run based on Region Code
  → Region Code is 4 bit code

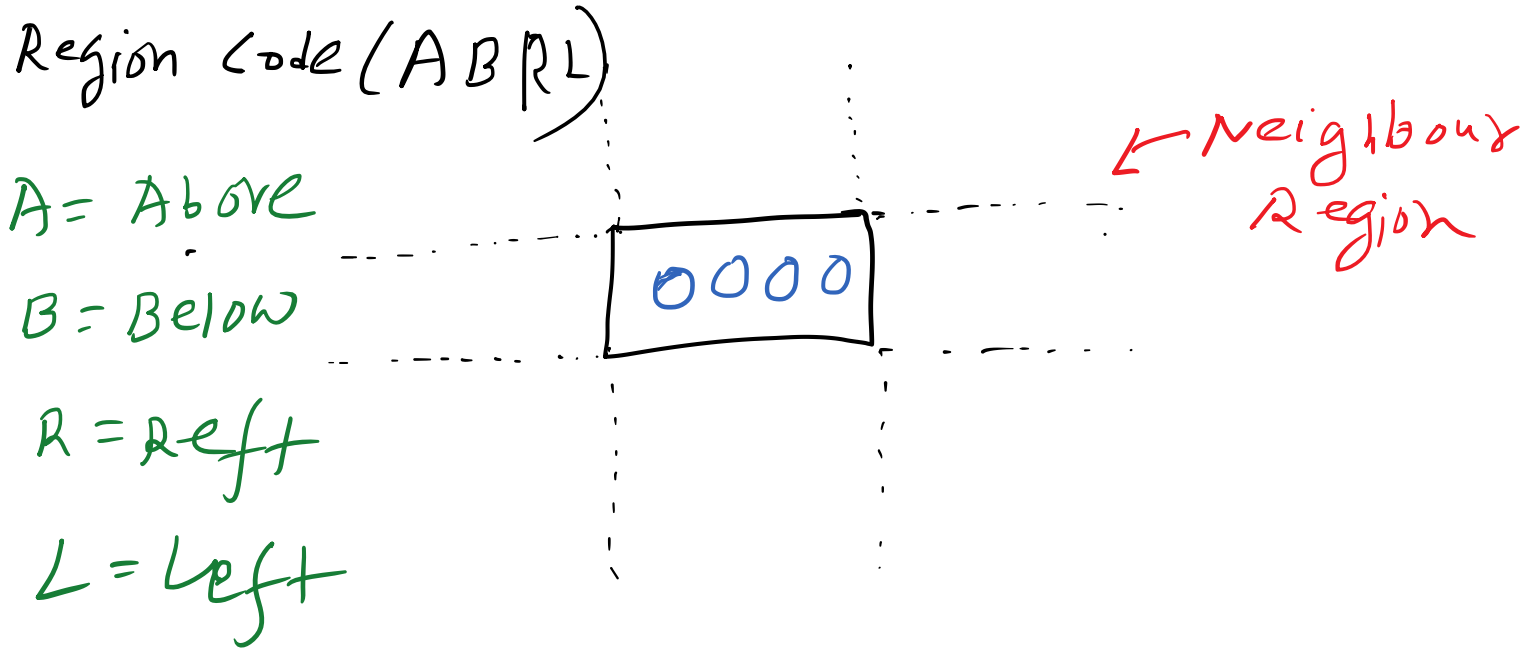
(*) Region Code

(4) 4 bit Code

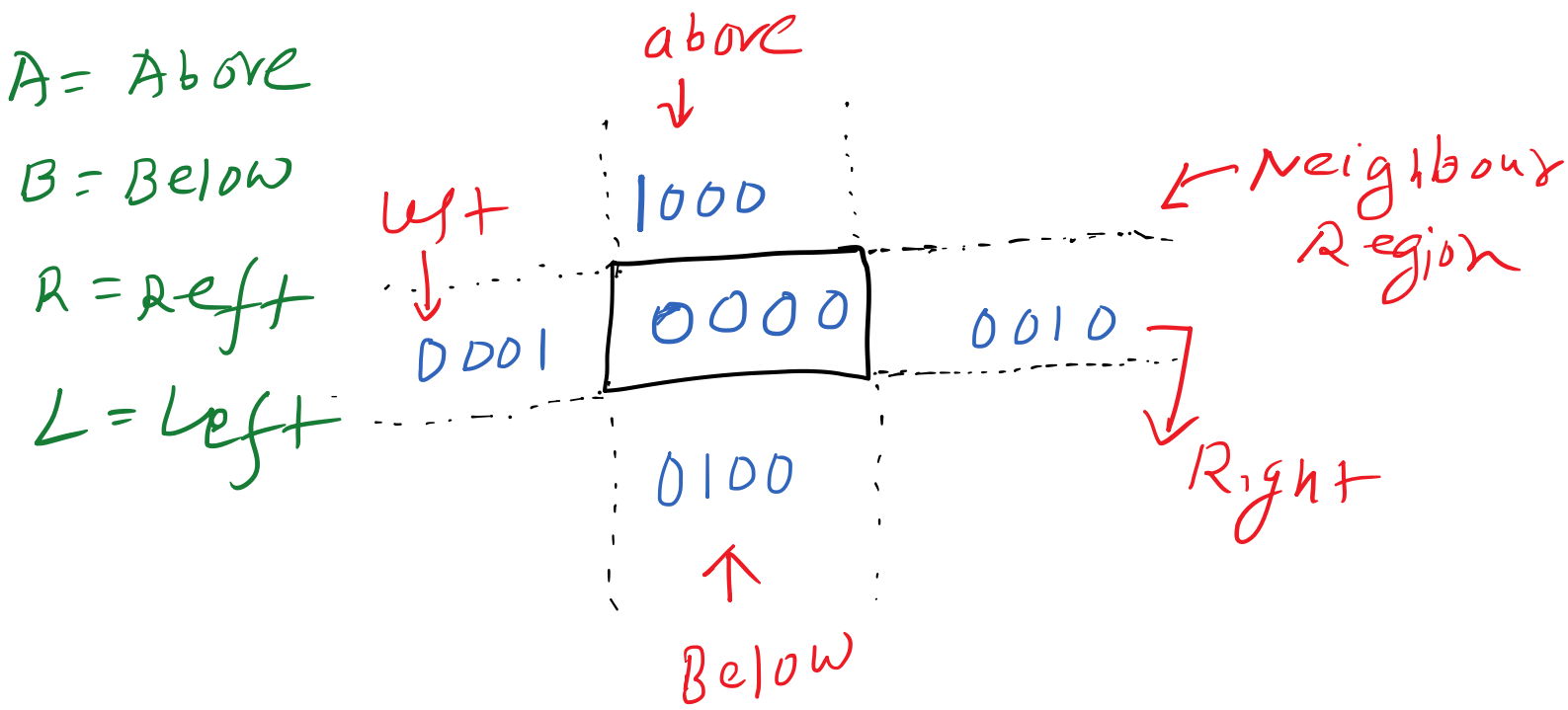
Line Clipping (Derivation)



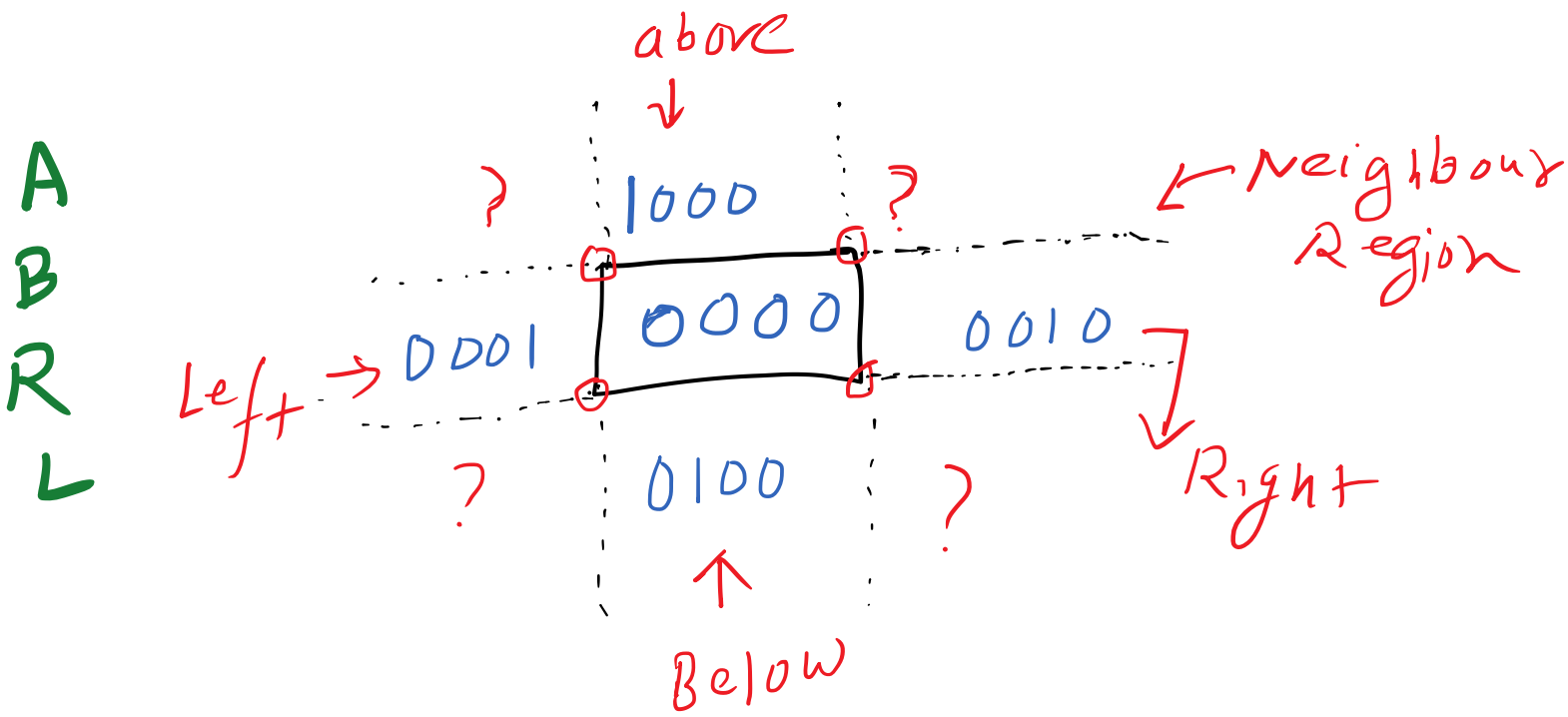
Line Clipping (Derivation)



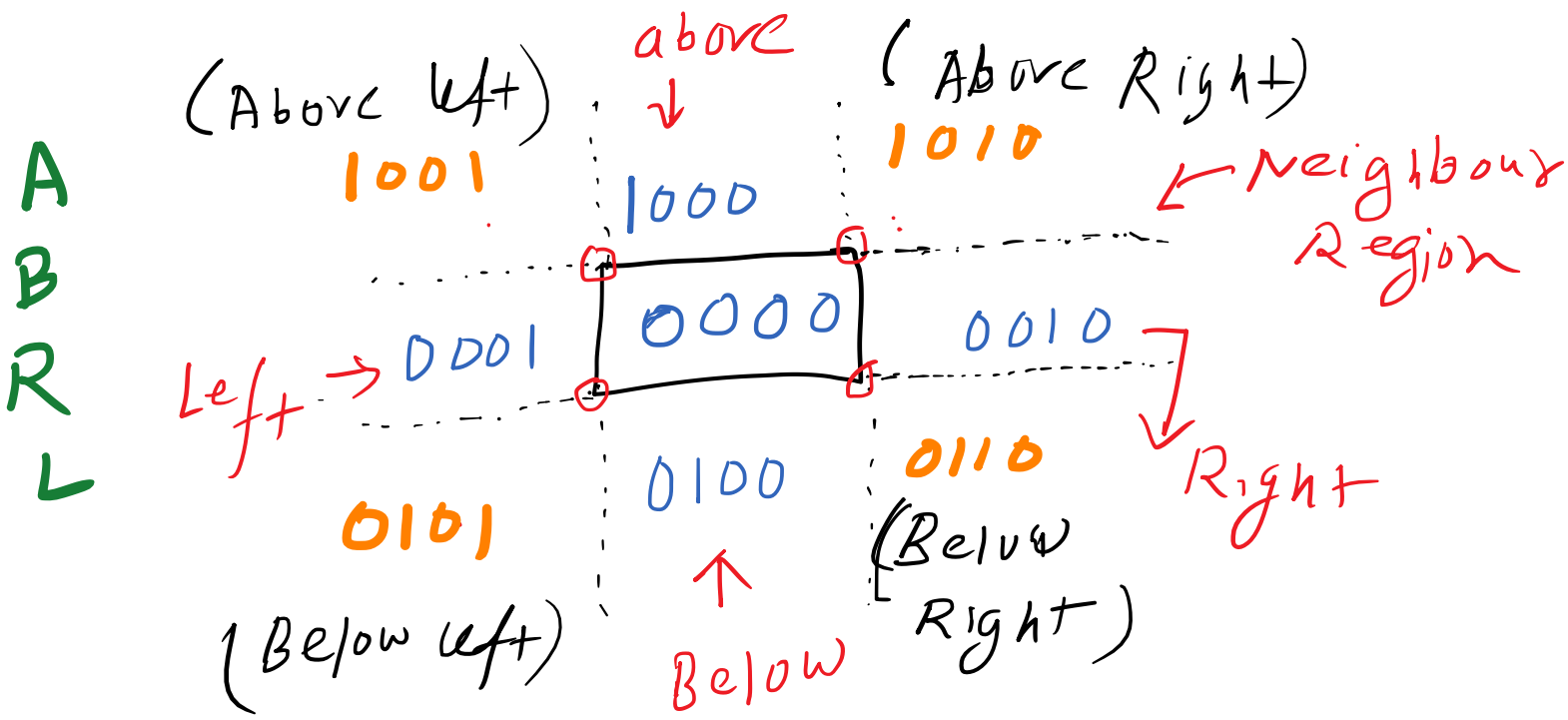
Line Clipping (Derivation)



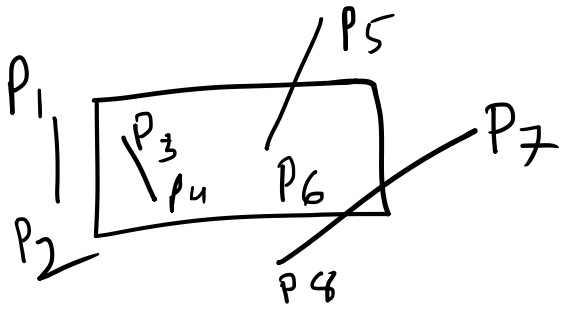
Line Clipping (Derivation)

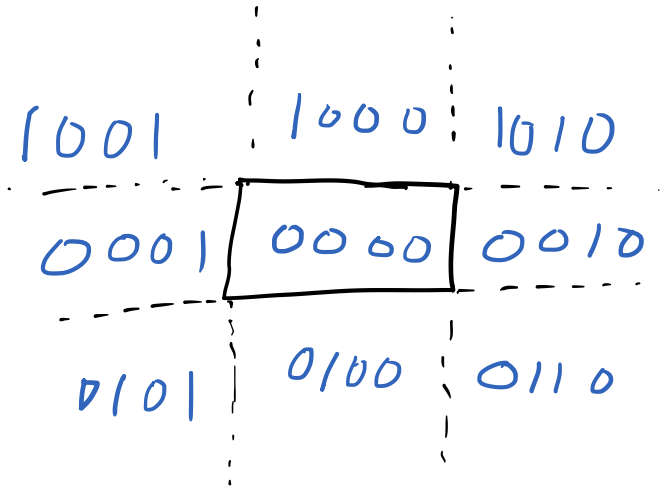


Line Clipping (Derivation)



Line Clipping (Derivation)





P1P2

$P_1 \rightarrow 0001 \Rightarrow$ Non zero

$P_2 \rightarrow 0001 \rightarrow$ non zero

AND $\rightarrow 0001 \rightarrow$ No zero (No Clipping Regt)

Line Clipping (Derivation)

P_3P_4

$P_3 \rightarrow 0000 \rightarrow$ zero

$P_4 \rightarrow 0000 \rightarrow$ zero

AND $\rightarrow 0000 \rightarrow$ zero

Line is inside

No Clipping

Required

Line Clipping (Derivation)

$P_5 P_6$

$P_5 \rightarrow 1000 \rightarrow$ Non zero

$P_6 \rightarrow 0000 \rightarrow$ zero

AND $\rightarrow 0000 \rightarrow$ zero

(Clipping is rear)

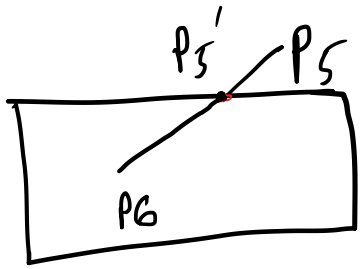
* AND $\rightarrow$ Zero

$\rightarrow$ some portion Line is inside
some portion Line is outside

* Intersection point on window

Line Clipping (Derivation)

P_5P_6 → Intersection point on window



P_5' → 0000 → Zero

P_6 → 0000 → Zero

AND → 0000 → Zero

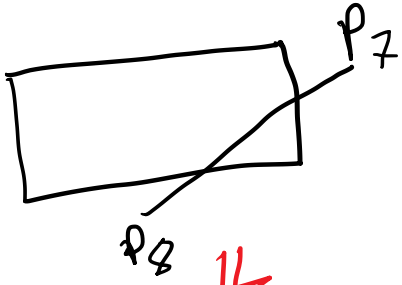
So, P_5P_5' Clipped

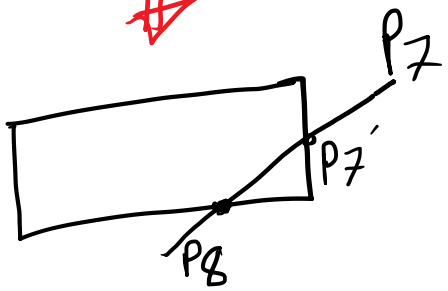
Line Clipping (Derivation)

P_7P_8 → P_8 → 0100 → NON ZERO

P_7 → 0010 → NON ZERO

AND → 0000 → ZERO





Clipping Req → means some outside some inside

Line Clipping (Derivation)

Intersection point on window

$P_7 P_8 \Rightarrow P_7' P_7 \rightarrow$ outside the window (clipped)

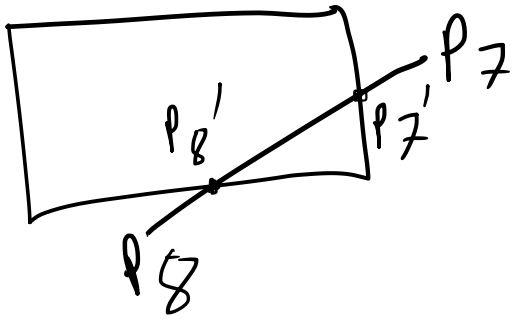
$P_7' P_8$

$P_7' \rightarrow 0000 \rightarrow$ zero

$P_8 \rightarrow 0010 \Rightarrow$ non zero

AND $\Rightarrow 0000 \Rightarrow$ zero (need Cliping)

Line Clipping (Derivation)



$P_8P_8' \Rightarrow$ Clipped (outside window)

$P_8'P_7' \Rightarrow$

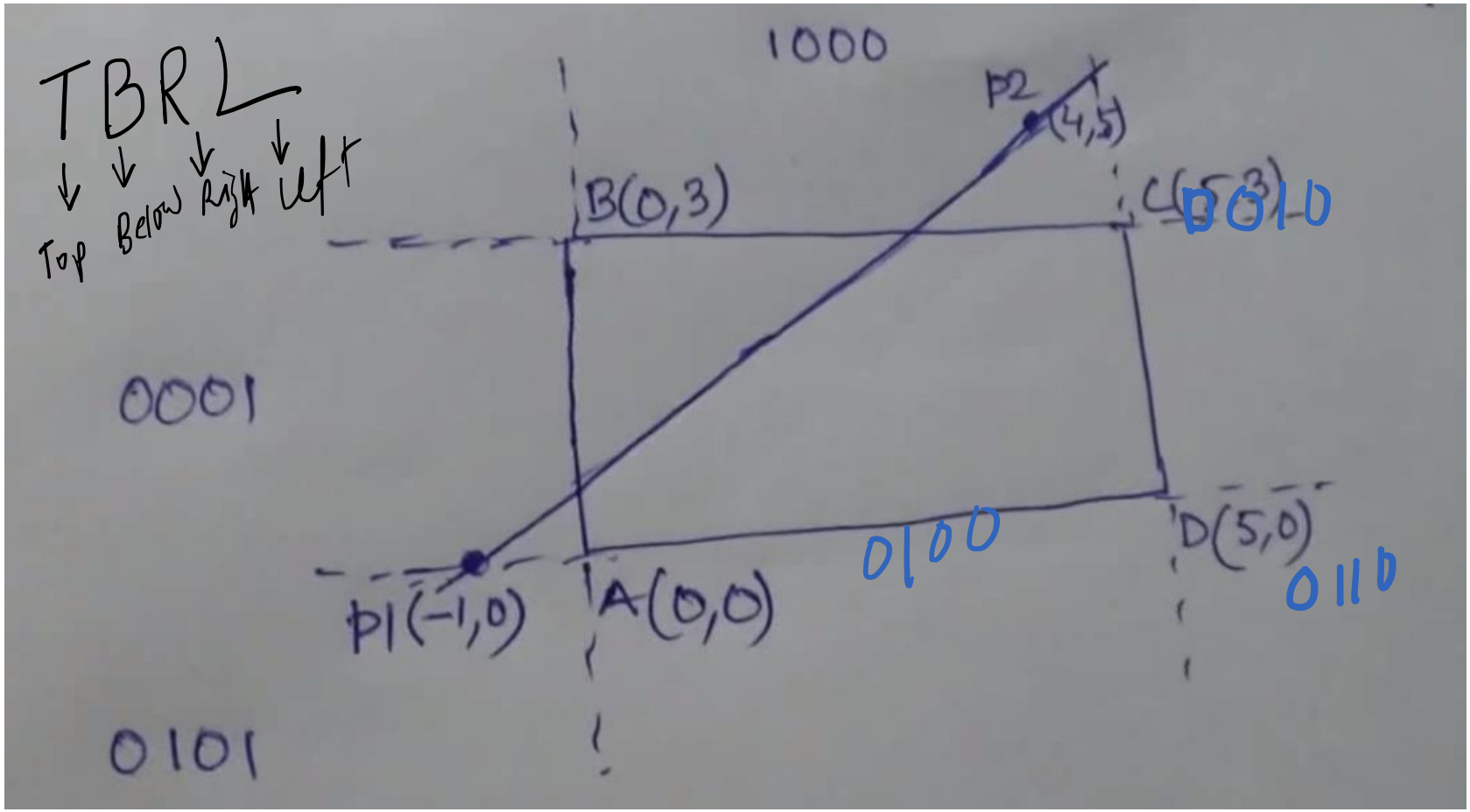
$P_8' \rightarrow 0000 \rightarrow$ zero

$P_7' \rightarrow 0000 \rightarrow$ zero

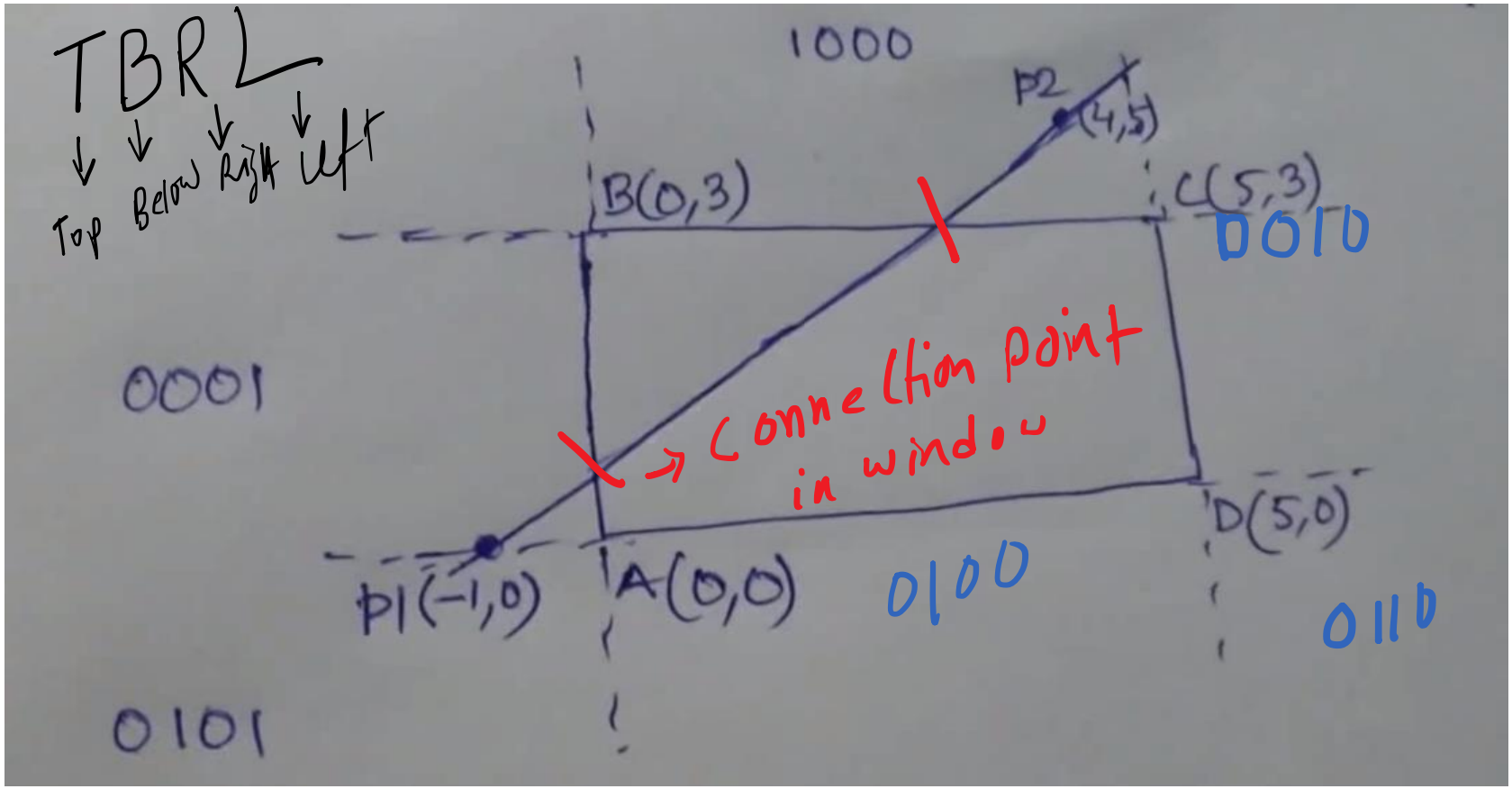
AND $\rightarrow 0000 \rightarrow$ zero

So, $P_8'P_7' \rightarrow$ inside the window

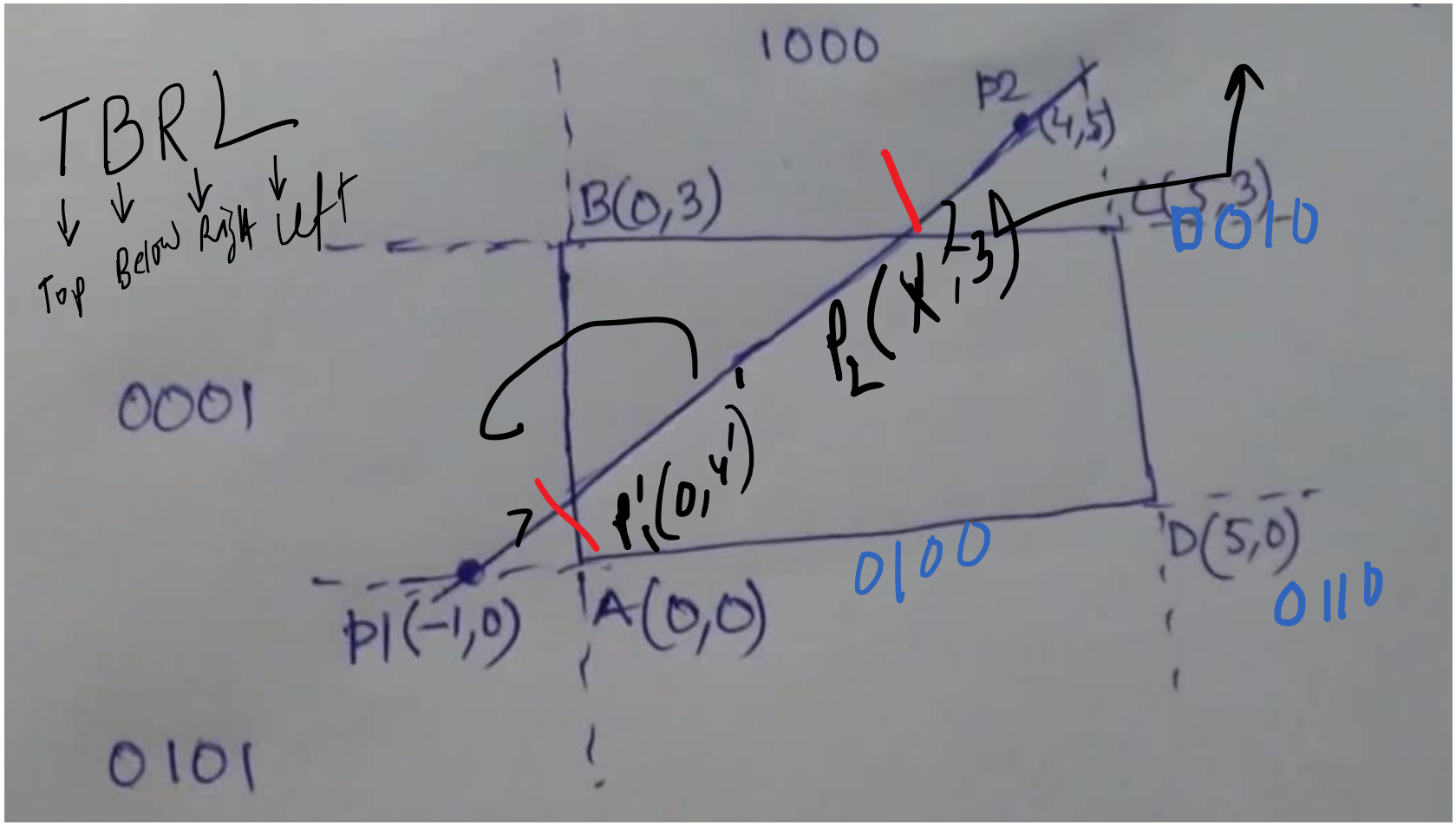
Problem Solving (Line Clipping)



Problem Solving (Line Clipping)



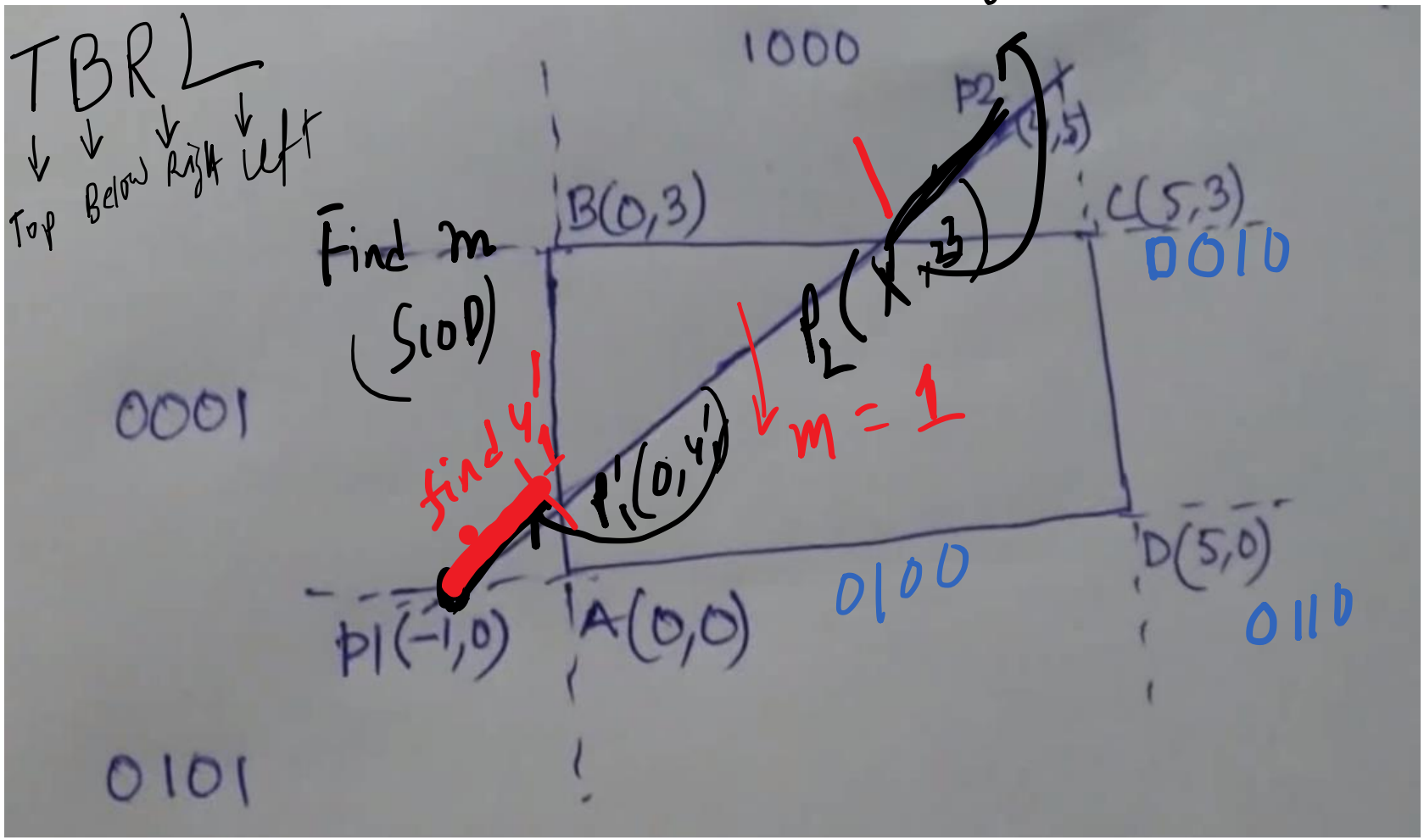
Problem Solving (Line Clipping)



Find Slope, m

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5 - 0}{4 + 1} = \underline{1}$$

Problem Solving (Line Clipping)



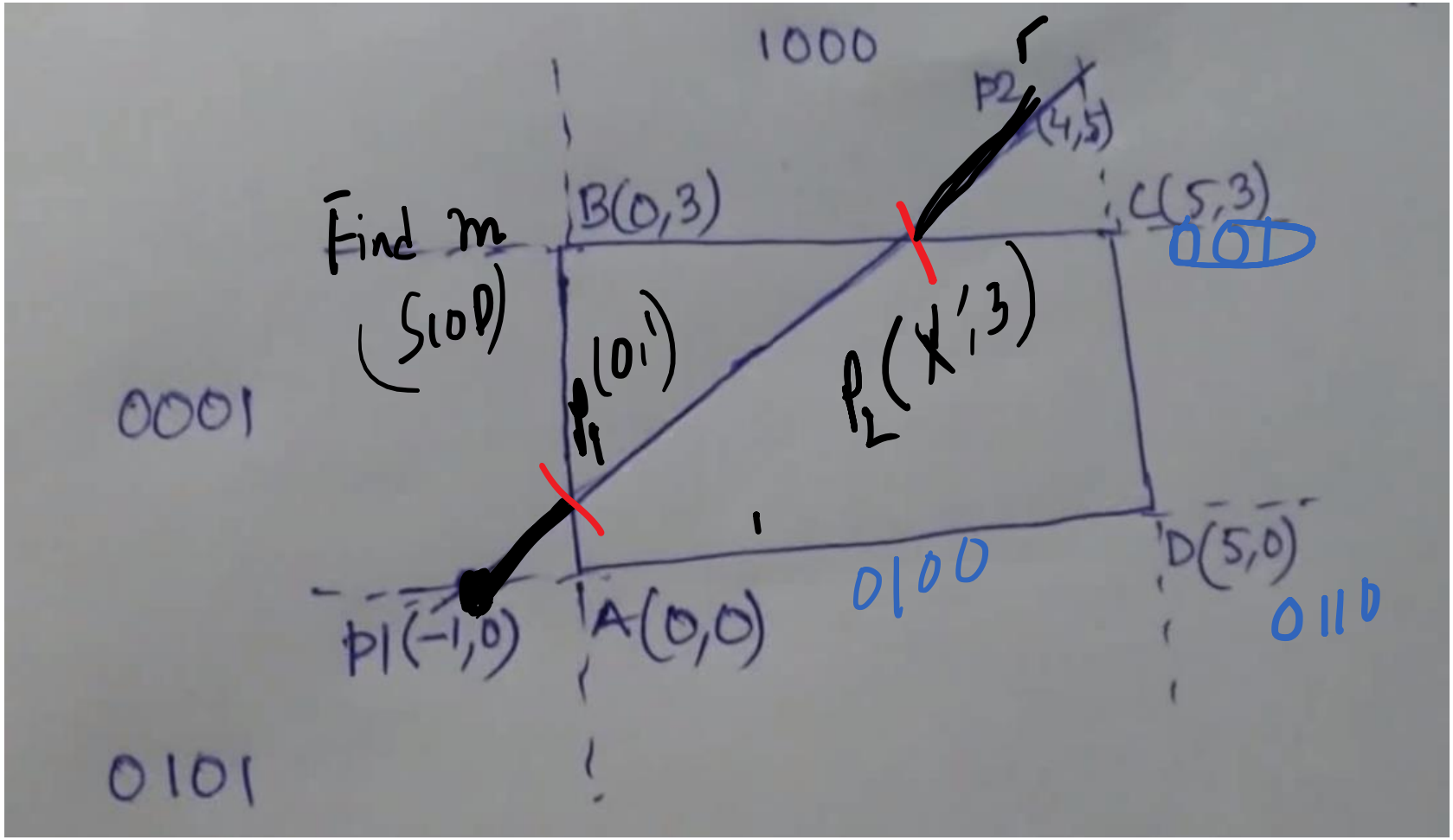
Find Y_1'

$$m = \frac{y_1' - 0}{0 + 1} = \frac{y_1'}{1}$$

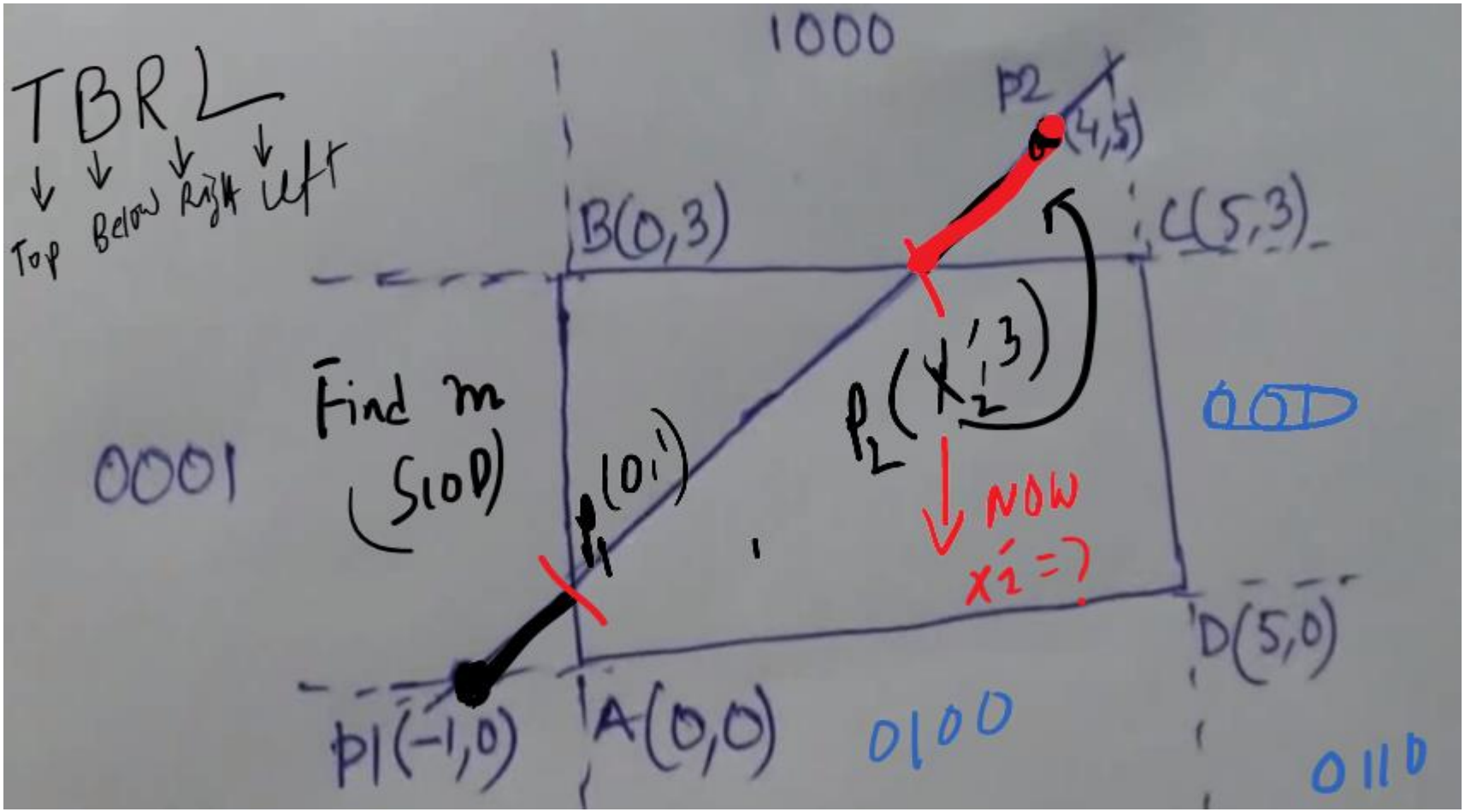
$$\Rightarrow y_1' = m * 1 = 1 * 1 = 1$$

$$\Rightarrow \text{So, } P_1(x_1', y_1') = (0, 1)$$

Problem Solving (Line Clipping)



Find X2’


TBRL
Top
Below
Right
Left
1000
P2
(4,5)
B(0,3)
C(5,3)
Find m
(SLOP)
0001
P1(-1,0)
A(0,0)
0100
D(5,0)
0110
0010
NOW
x2 = ?

Find X_2'

$$m = \frac{5-3}{4-x_2'}$$

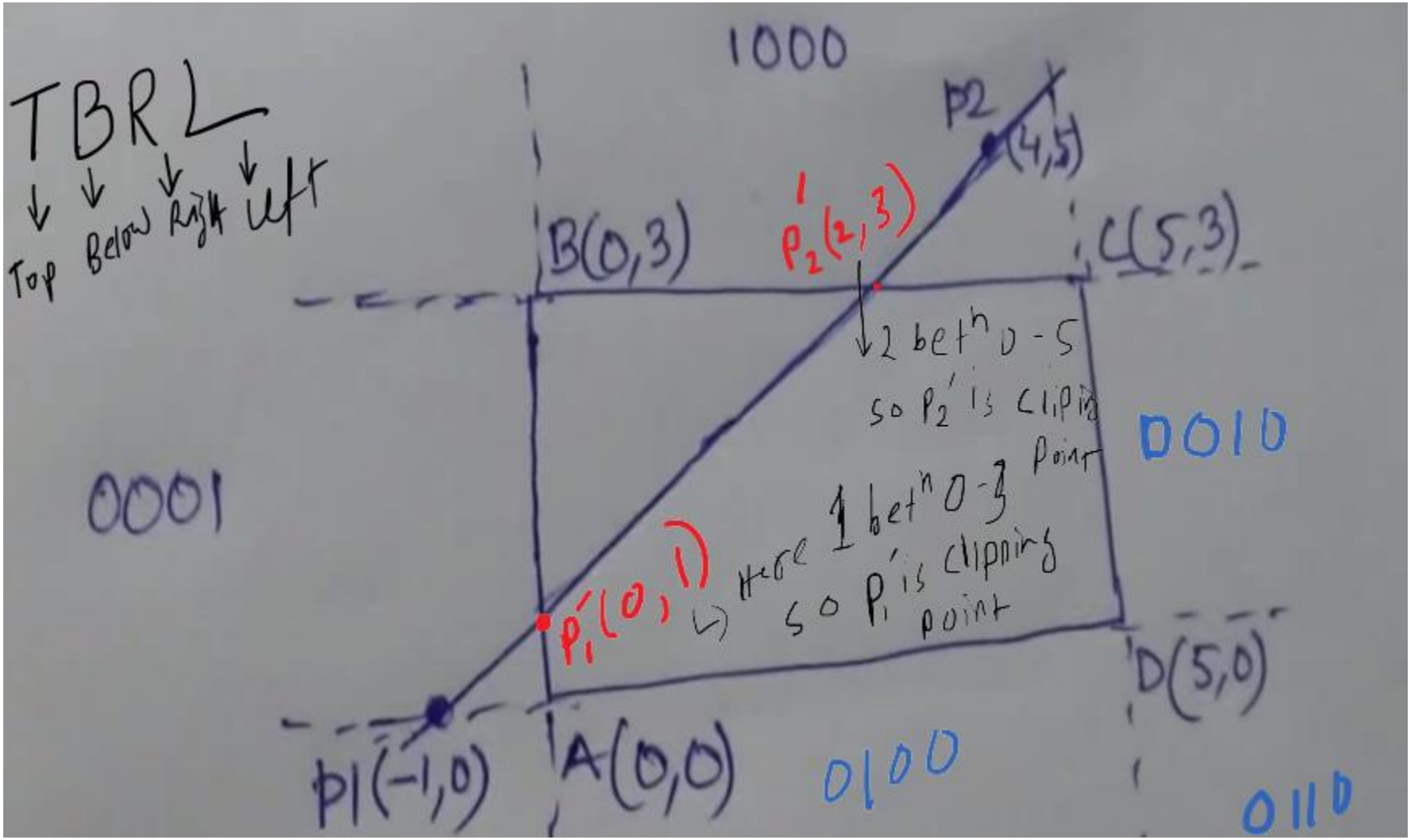
$$\Rightarrow 1 = \frac{2}{4-x_2'}$$

$$\Rightarrow 4 - x_2' = 2$$

$$\Rightarrow x_2' = 2$$

So, $P_2'(x_2', y_2') = P_2''(2, 3)$

Finally


TBRL
Top
Below
Right
Left
1000
P2
(4,5)
B(0,3)
P2'(2,3)
C(5,3)
2 bet^n 0 - 5
so P2' is clipping point
0001
0010
P1'(0,1)
Here 1 bet^n 0 - 3
so P1' is clipping point
D(5,0)
P1(-1,0)
A(0,0)
0100
0110

Books

- Foley, van Dam, Feiner, Hughes, Computer Graphics: principles and practice, Addison Wesley, Second Edition.
- Schaum's Outline of Theory & Problems of Computer Graphics.
- Peter Shirley Steve Marschner , “Fundamental of computer graphics”, Third Edition.

References

Chapter 3: Foley, van Dam, Feiner, Hughes, Computer Graphics: principles and practice, Addison Wesley, Second Edition.

https://en.wikipedia.org/wiki/Clipping_(computer_graphics)

https://www.onlinestudy.xyz/2019/06/clipping-in-computer-graphics.html