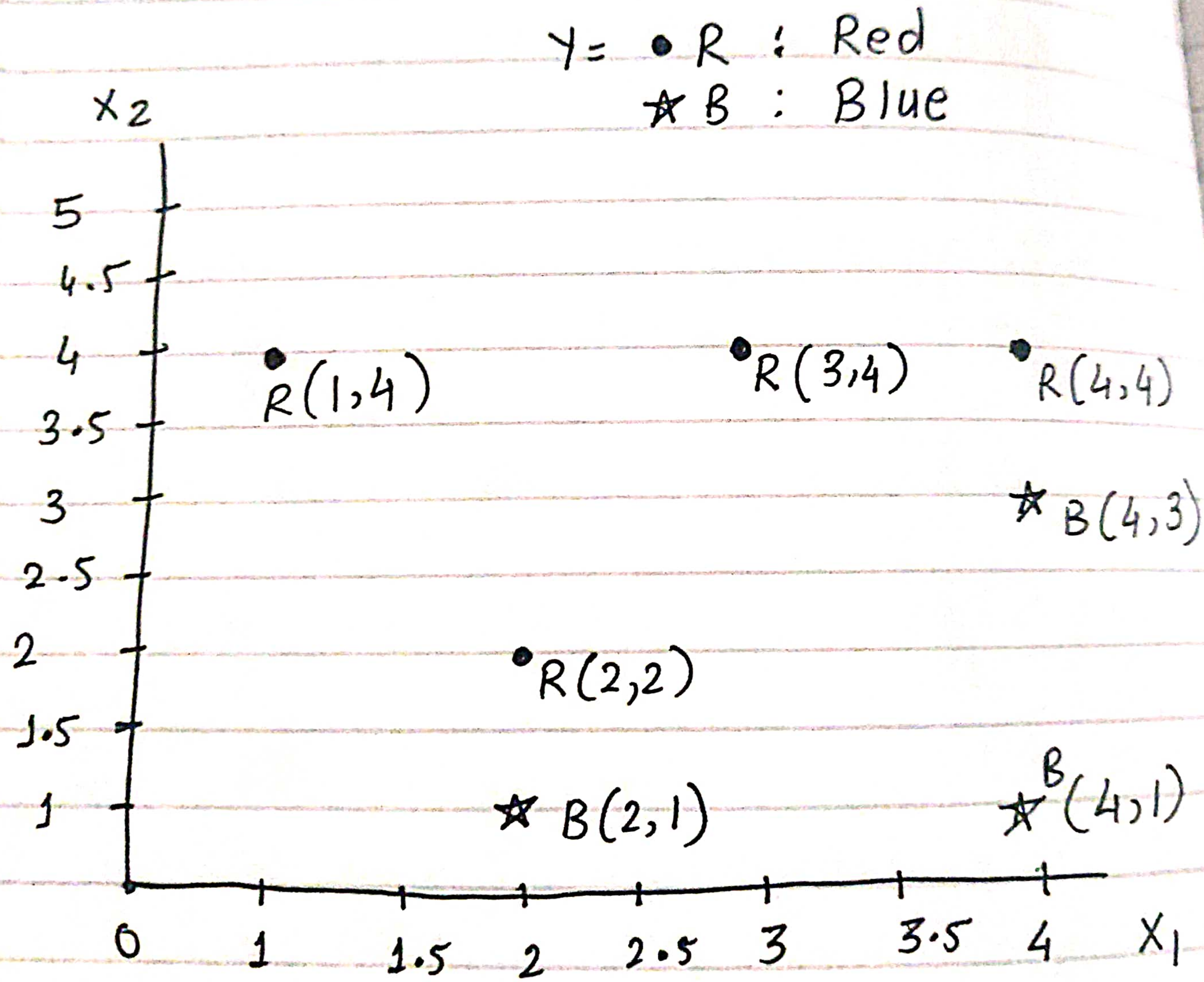
9.7.3.

a) $n = 7$

$p = 2$


Y = • R : Red
☆ B : Blue
X_2
5
4.5
4
3.5
3
2.5
2
1.5
1
0
1
1.5
2
2.5
3
3.5
4
X_1
R(1,4)
R(3,4)
R(4,4)
B(4,3)
R(2,2)
B(2,1)
B(4,1)

b)

As from above plot we can see that the optimal separating hyperplane has to be between the observations $B(2,1)$ & $R(2,2)$. And between the observations $^{B}(4,3)$ & $^{R}(4,4)$.

So, Now,

mid point of $(2,2)$ & $(2,1)$

$$= \left(\frac{2+2}{2}, \frac{2+1}{2}\right)$$

$$= (2, 1.5)$$

mid point of $(4,3)$ & $(4,4)$

$$= (4+4/2, 3+4/2)$$

$$= (4, 3.5)$$

Now, according to eq^n 9.1, the 2D, a hyperplane is defined by :

$$\beta_0 + \beta_1 X_1 + \beta_2 X_2 = 0 \quad — ①$$

which is simply a equation of line
(∵ in 2D - hyperplane is a line).
① can be written as
i.e. $ax + by + c = 0 \quad — ②$

Now, line containing the 2 points (2, 1.5) & (4, 3.5), have slop :-

$$m = \text{slope} = \frac{3.5 - 1.5}{4-2} = 1$$

Now, $y = mx + c$

putting the point (2, 1.5) in above.

$$1.5 = 2 + c$$

$$\boxed{c = -0.5}$$

Now, here c is equivalent to β_0.

$\therefore$ $\boxed{\beta_0 = -0.5}$

Now, to get a & b intercepts.
putting $(2, 1.5)$ & $(4, 3.5)$ in ②

$$2a + 1.5b = 0.5$$
$$4a + 3.5b = 0.5$$

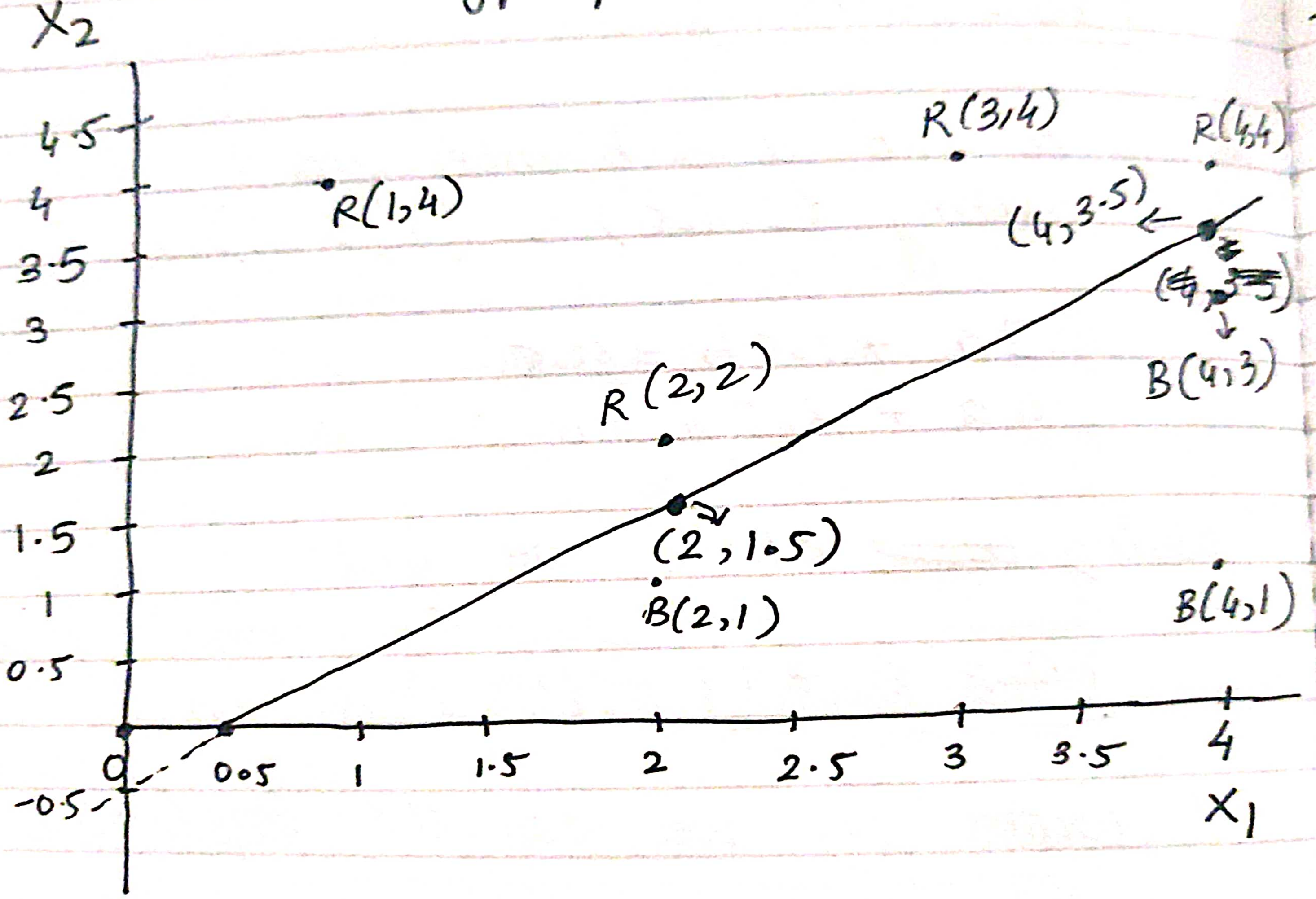
solving ~~these~~ above we get

$\boxed{a = \beta_1 = 1}$ & $\boxed{b = \beta_2 = -1}$

$\therefore$ from ① we get the final eq:-

$$\boxed{X_1 - X_2 - 0.5 = 0}$$

Black line representing hyperplane.



C.

As we calculated in part B,

$$\boxed{\beta_0 = 0.5}$$

$$\boxed{\beta_1 = 1}$$

$$\boxed{\beta_2 = -1}$$

and the equation : $\boxed{X_1 - X_2 - 0.5 = 0}$

As from the graph above we can see that:

The classification rule can be :

Classify to 'Red' if following is true

$$\boxed{X_1 - X_2 - 0.5 < 0}$$

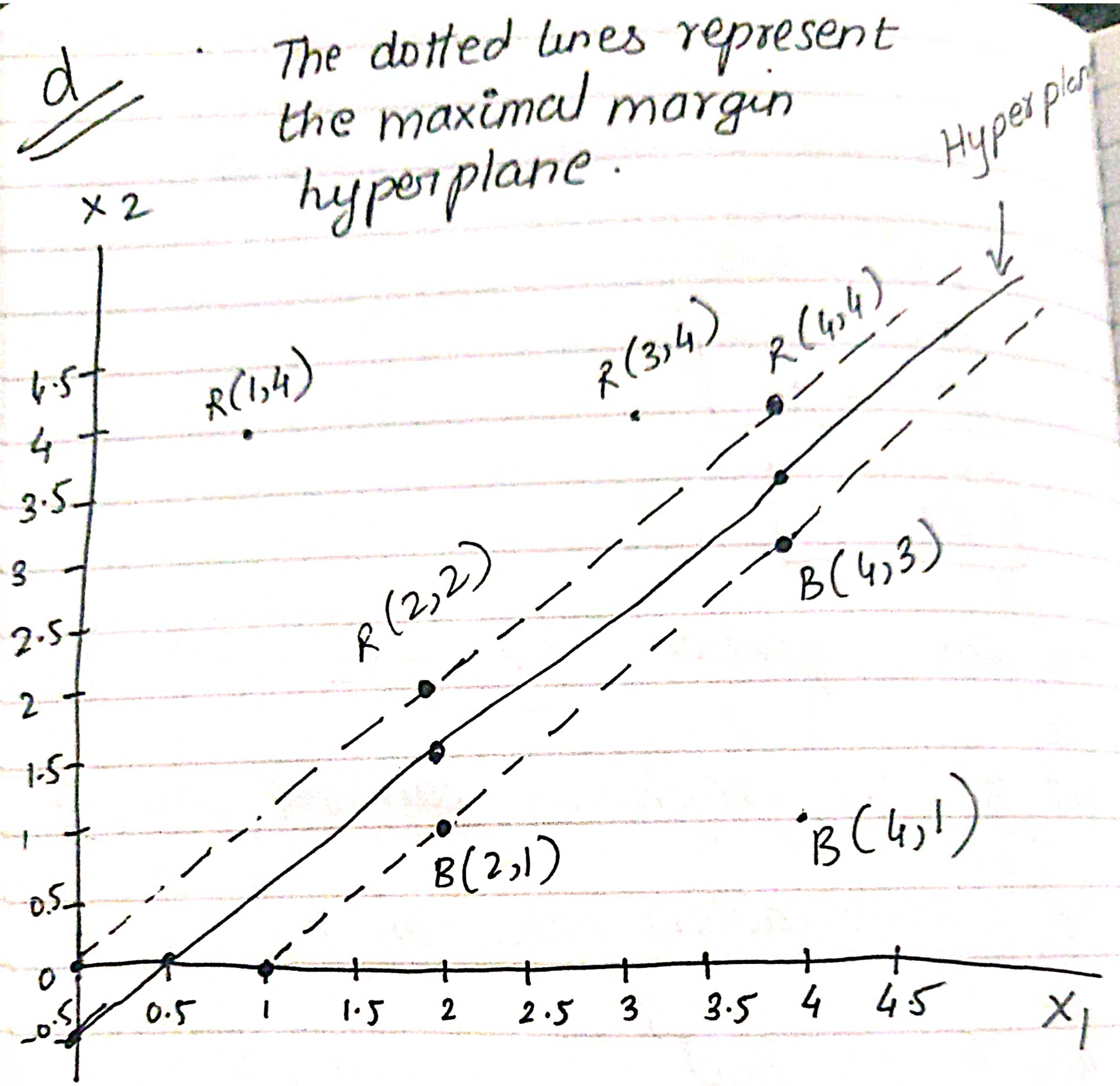
otherwise

Classify to 'Blue'

We can see that all points are properly classified according to the criteria.

d

The dotted lines represent the maximal margin hyperplane.



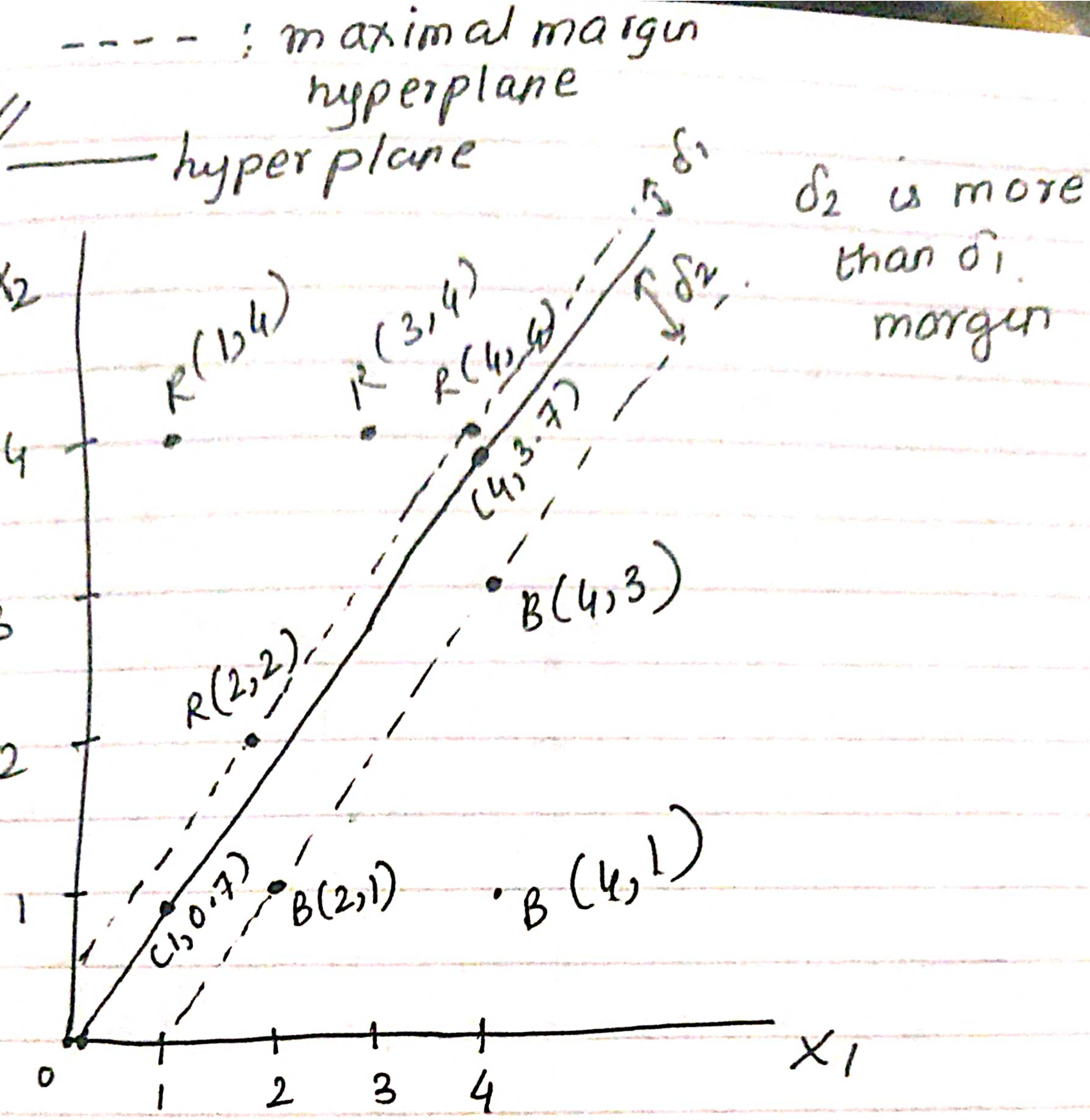
(Please consider all lines drawn above are parallel., as not drawn using a ruler).

The margin here equal to 1/4.

e

∴ The support vectors for maximal margin classifier are points B(2,1), B(4,3) & R(2,2), R(4,4) f). By examining the plot in (d), we can see that if we moved the observation B (4,1), we would not change the maximal margin hyperplane as it is not a support vector.

g)



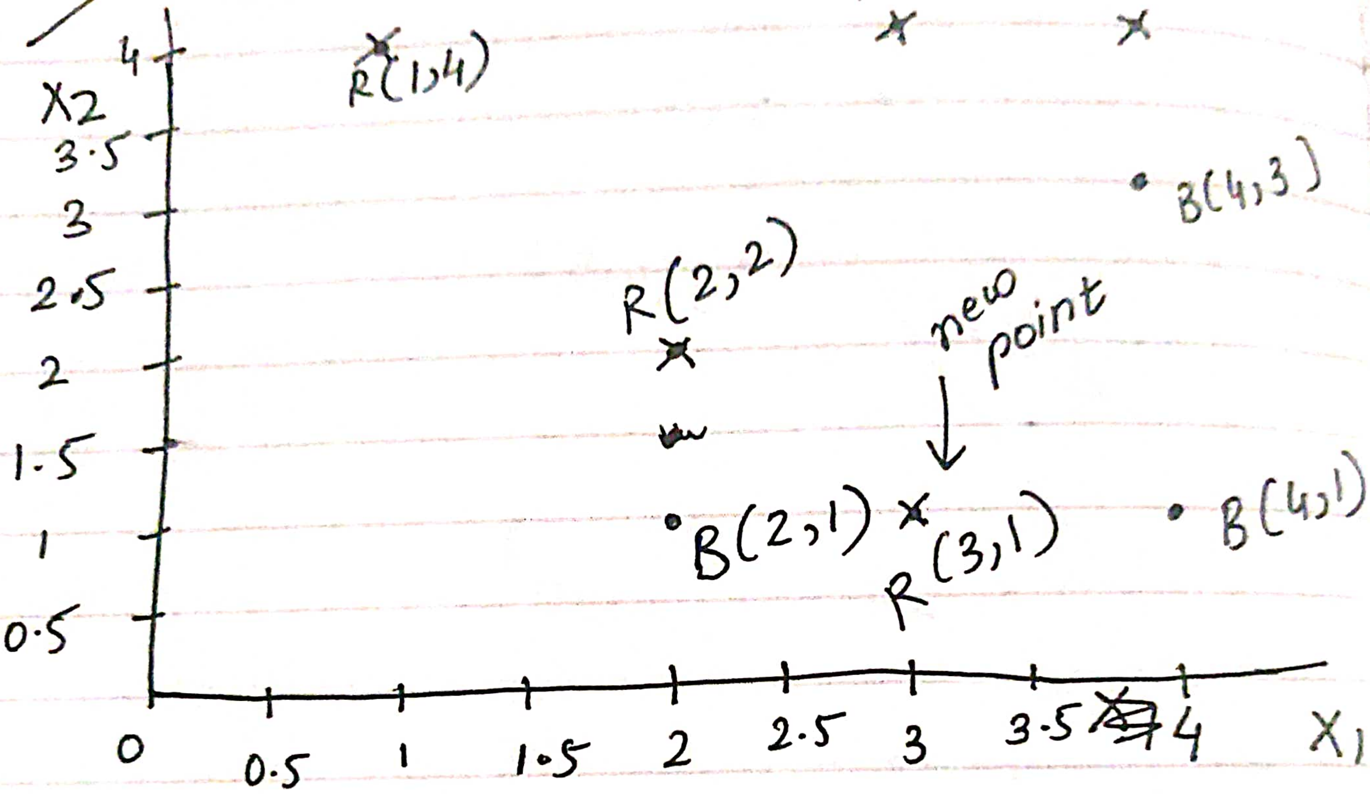
let the hyperplane eq^n be

$$X_1 - X_2 - 0.3 = 0$$

⇒ As we can see in the plot it is not optimal seperating hyperplane.

⇒ Any parallel line except for the center line between the margins is non optimal hyperplane.

h)



when we add red point (3,1), the 2 classes are not seperable by a hyperplane anymore.