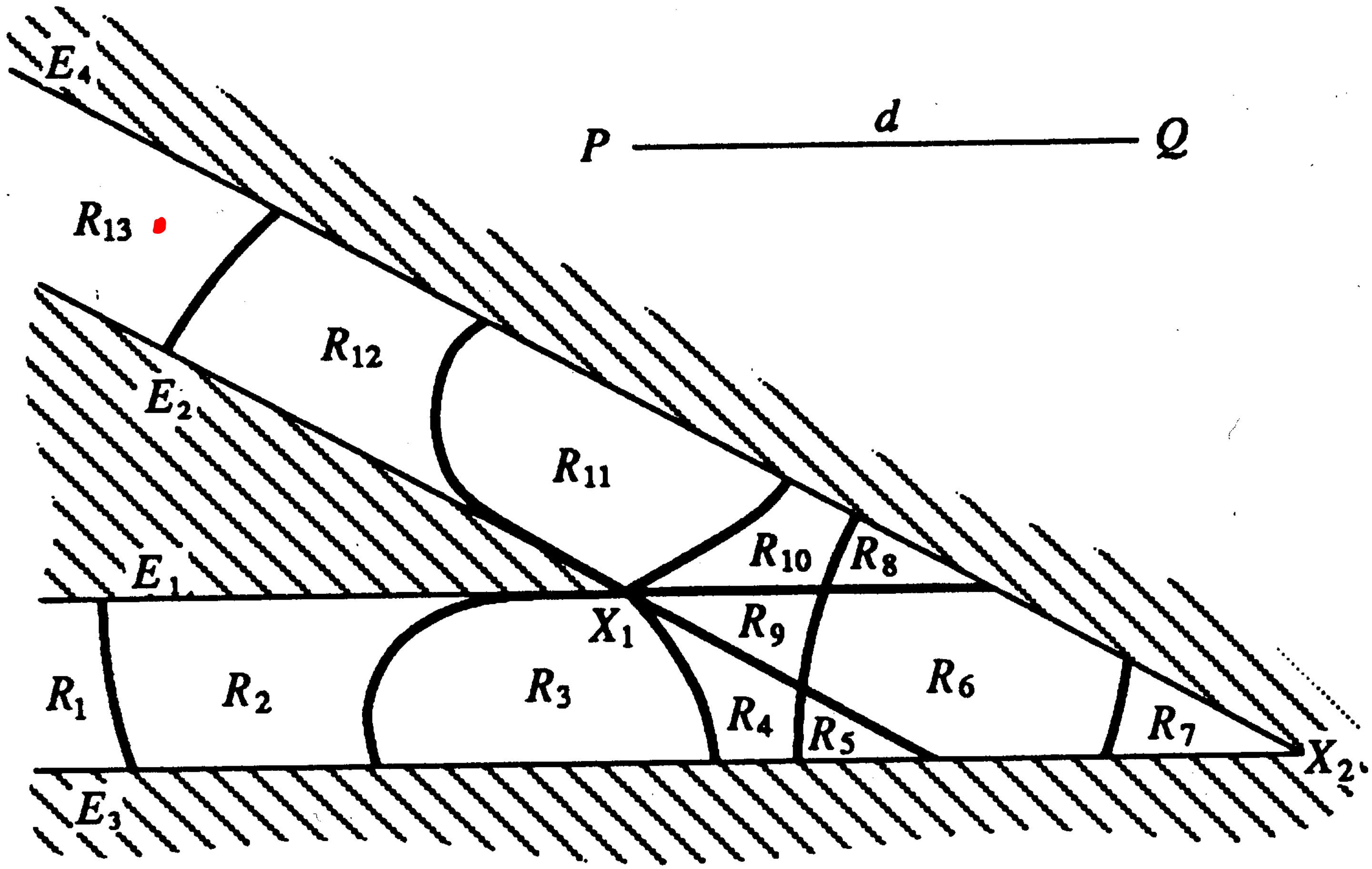


Figure 12. This figure shows the decomposition of a polygonal workspace into 13 noncritical regions. The robot can move from one end of the "corner" to the other but it cannot make a full rotation in the corner. Thus, when

KEY IDEA: project the "faces" of C-obstacles onto x-y plane.

$\Rightarrow$ Critical curves in x-y plane

Critical curves:

1) Boundaries of faces of C_{obs}

2) curves in C_{obs}'s faces where tangent plane to the face is $\perp$ x-y plane

"low deg. polynomials in x-y" ≤ 4

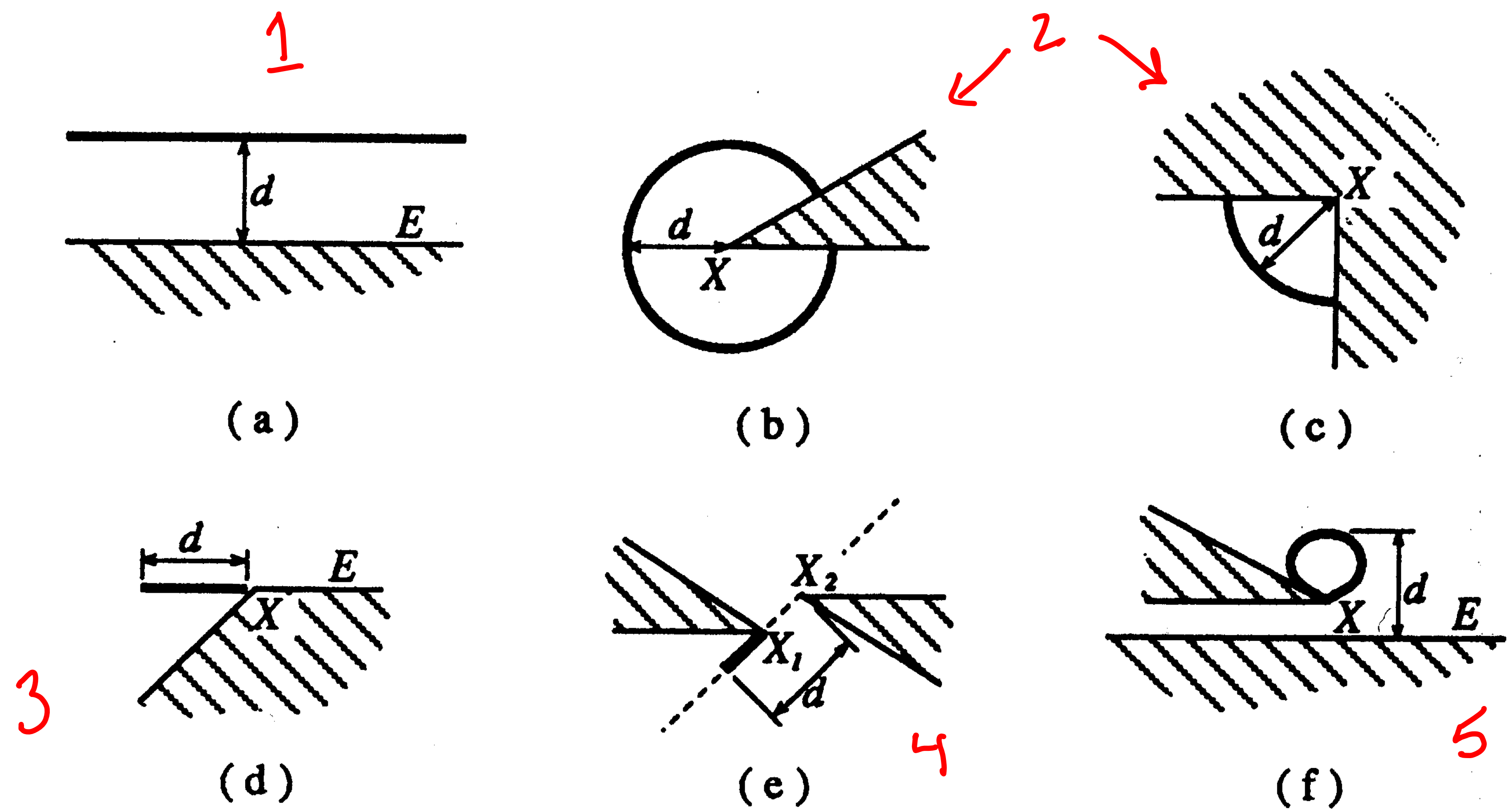


Figure 5. This figure illustrates the various types of critical curves other than the obstacle edges. The critical curves (shown in bold lines) are the set of positions of $\mathcal{A}$ where the structure of the C-obstacle region along the θ direction undergoes a qualitative change.

$d^2 = (y+h)^2 + (x+k)^2$

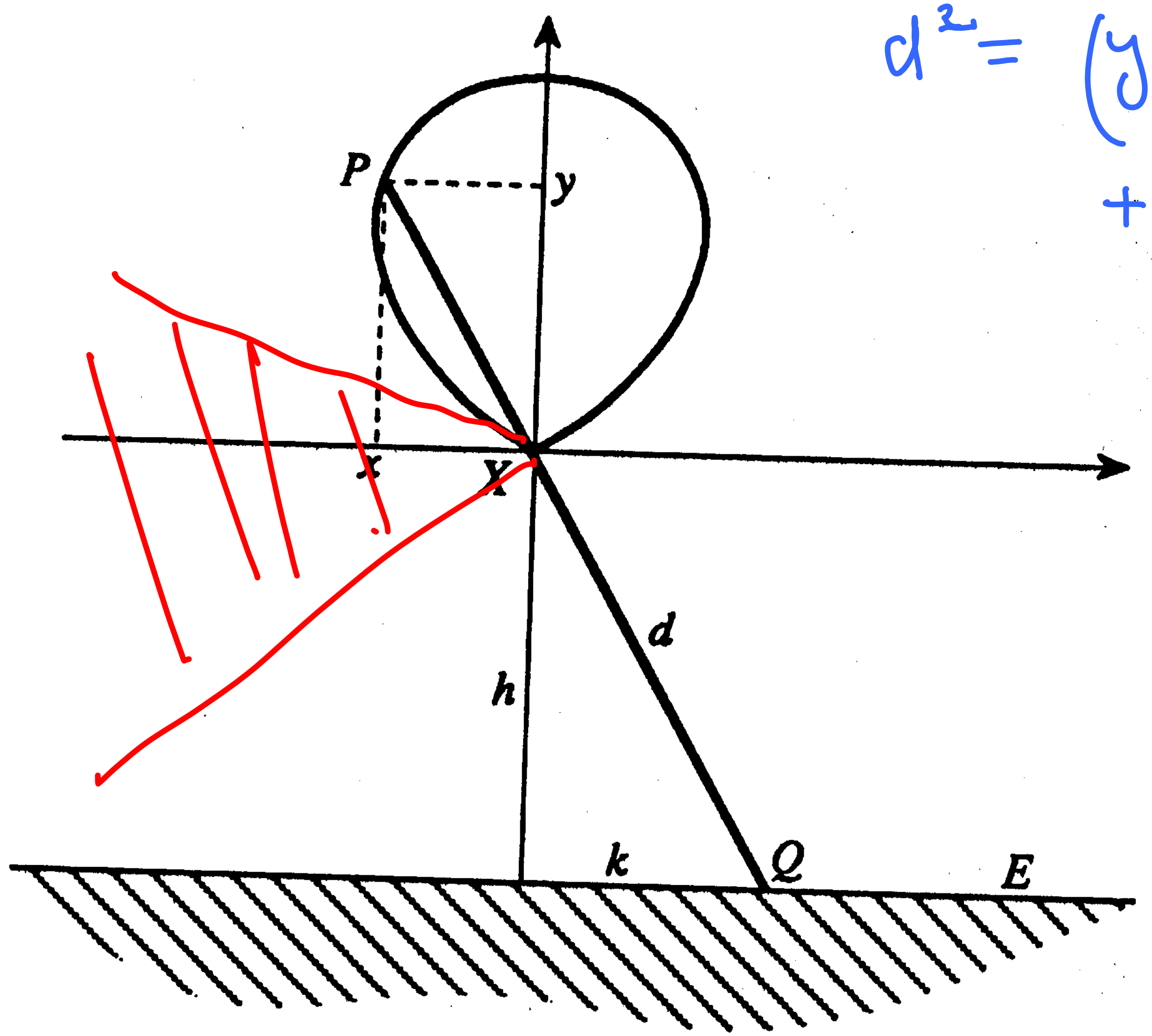


Figure 6. A conchoid of Nicomedes (see text) is an algebraic curve of degree 4. We have: $d^2 =$

$\beta_1 - \beta_6 \to$ Type 1 $\beta_7 - \beta_{10}$: type 2
$\beta_{11} - \beta_{16} \to$ Type 3 $\beta_{17} - \beta_{18} \to$ type 4
$\beta_{19} - \beta_{21} \to$ Type 5

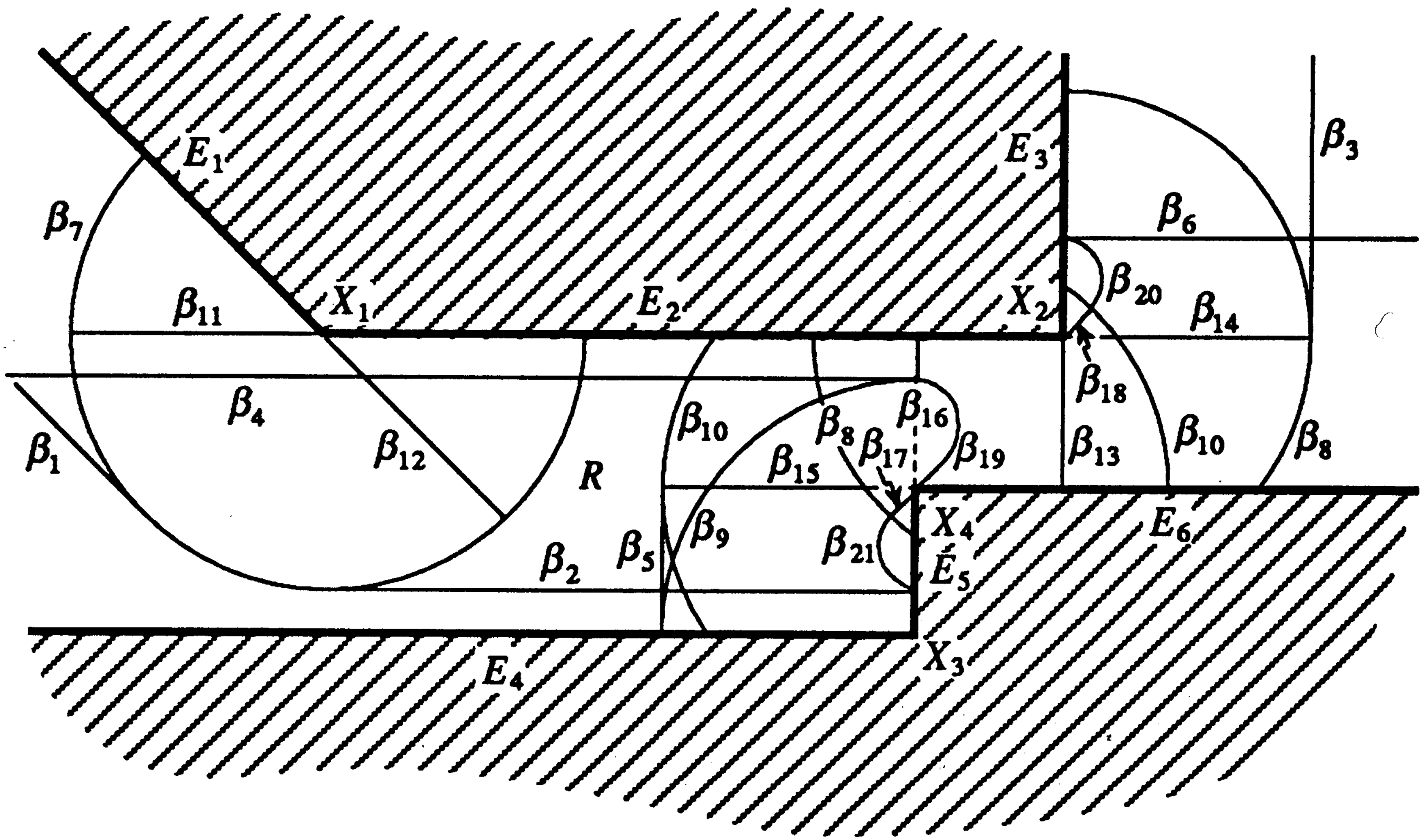
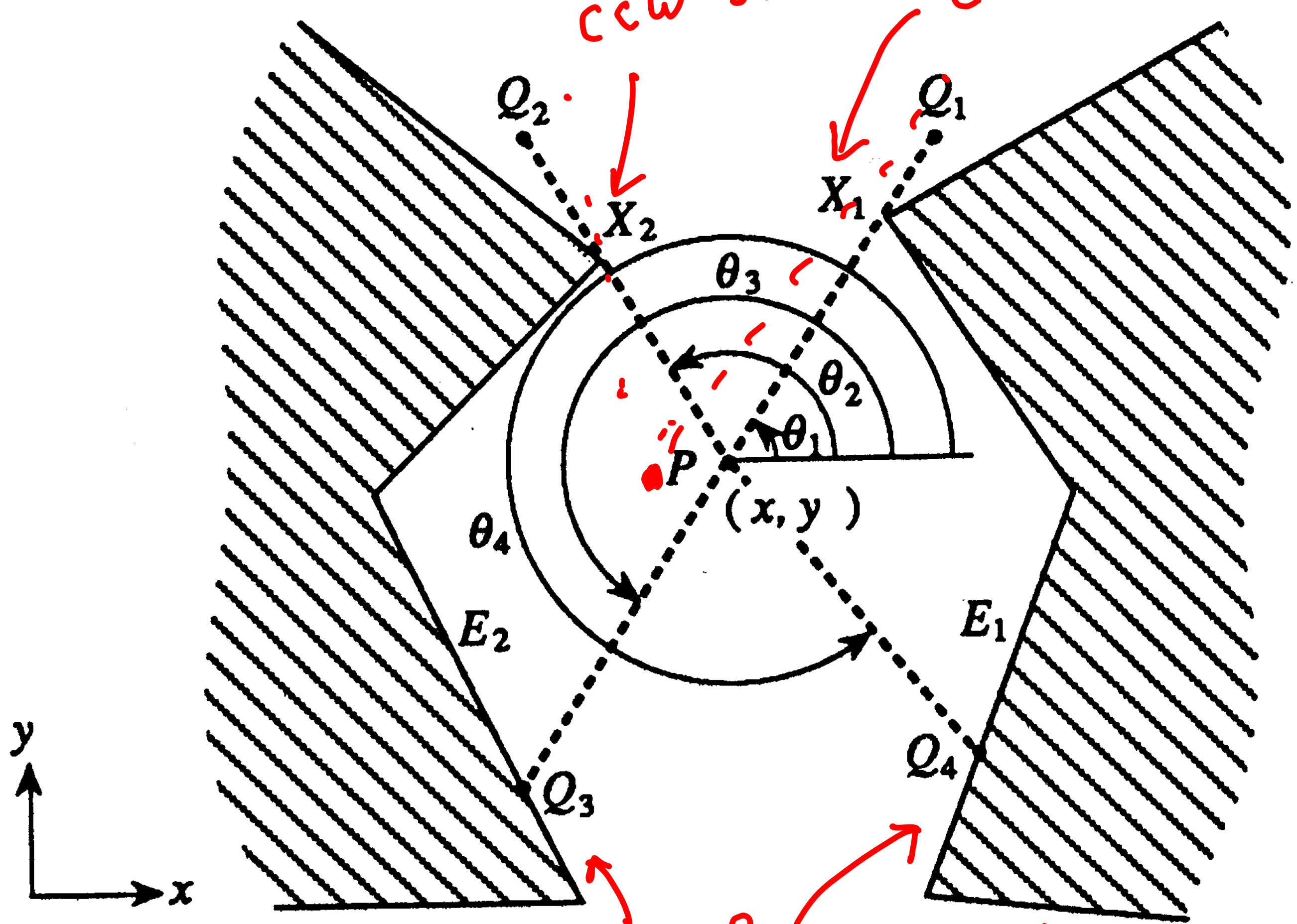


Figure 7. This figure illustrates the concepts of a critical curve and a non-

Decomposition of free-space



$F(x,y)$

$= \{\theta : (x,y,\theta) \in C_{free}\}$

$=$ set of intervals

$\sigma(x,y)$ corr. to a.

$= \{[X_1, X_2], [E_1, E_2]\}$ cw/ccw stop

re 10. $\mathcal{A}$ is at a noncritical position (x, y). The obstacle edges and ver- t can touch without intersecting the interior of $\mathcal{B}$ when it rotates about called stops. A stop is (counter)clockwise if it can be reached from a

$\lambda_1(x, y, x_1) = \theta_1 \rightarrow$ orient. at x, y where A touches x_1

$\lambda_2(x, y, x_2) = \theta_2$

$$\text{Cell} = \left\{ (x, y, \theta) : (x,y) \text{ have same stops } s_1, s_2 \ \wedge\ \theta \in \left[\lambda_1(x,y,s_1),\ \lambda_2(x,y,s_2)\right] \right\}$$

<u>adjacency:</u> "Crossing rule" $\Rightarrow$

$\Downarrow$ "interiors" of two cells must share all pts in overlapping angle intervals at boundary β

Example $\qquad$ Type 1 $\to$ boundary : β

line seg $\parallel$ edge E

cell $[R, (s_1, s_2)]$ is adjacent to cell $[R', (s_1', s_2')]$

iff $\quad [s_1', s_2'] = [s_1, s_2]$

or

$$[s_1', s_2'] = [s_1, E]$$

or

$$[s_1', s_2'] = [E, s_2] \quad \ldots$$

see precise rules in Latombe

- One element in one pair in $\sigma(x, y)$ changes.

If β is a redundant section of a critical curve, then $\sigma(x, y)$ is unchang
when β is crossed.

Thus, the crossing rules for the different types of critical curves can
generalized in the single following rule, which is valid for any critic
curve section β, if no two critical curves coincide along β:

Connect cell(R, s_1, s_2) *to cell*(R', s_1, s_2) *for each* $[s_1, s_2] \in \sigma(R) \cap \sigma(R$
and connect each cell(R, s_1, s_2), $[s_1, s_2] \in \sigma(R) \setminus \sigma(R')$, *if any, to ea*
cell(R', s'_1, s'_2), $[s'_1, s'_2] \in \sigma(R') \setminus \sigma(R)$, *if any.*

Now, we can define and build the connectivity graph:

DEFINITION 5: *The* **connectivity graph** G *is the non-direct*
graph whose nodes are all the cells cell(R, s_1, s_2), *where* R *is a no*

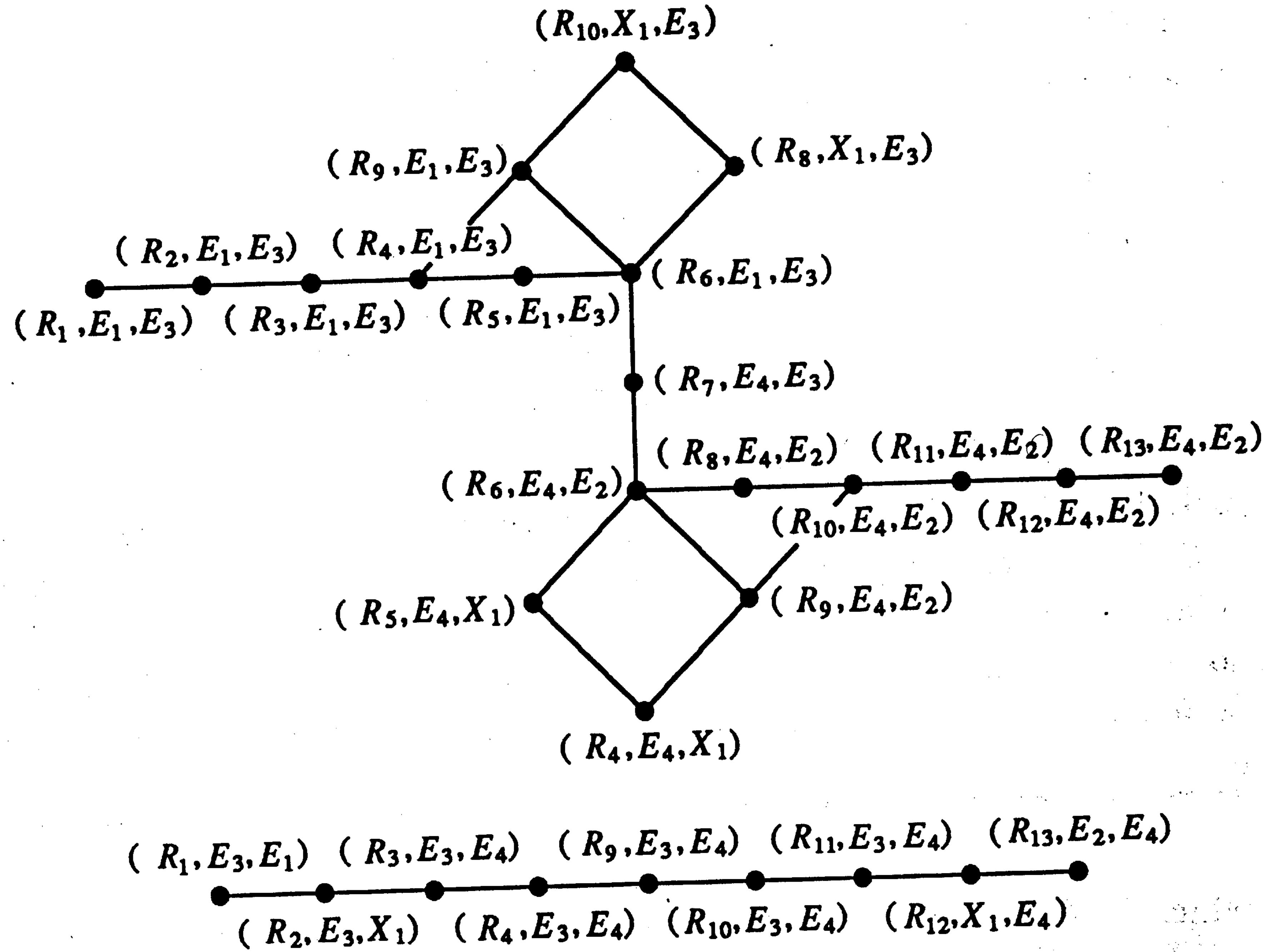


Figure 13. This figure shows the connectivity graph for the example
Figure 12. It consists of two connected components, hence verifying the lege