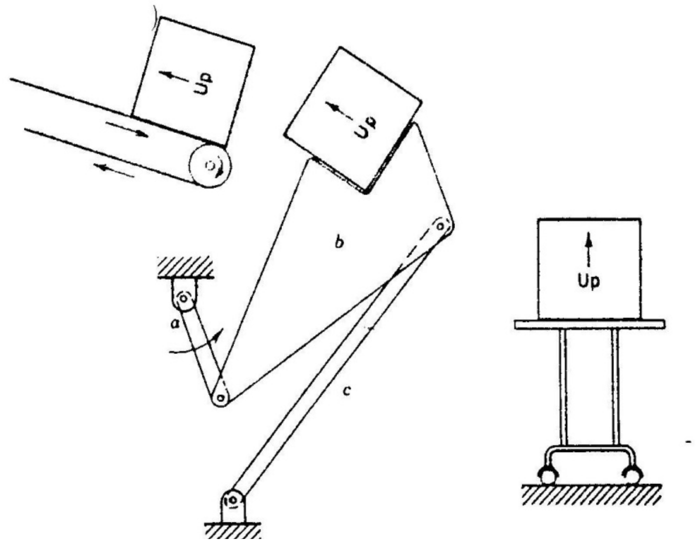


Mecanismos

Prof. Jorge Luiz Erthal

Síntese de mecanisos articulados

Orientação de objeto

Referência

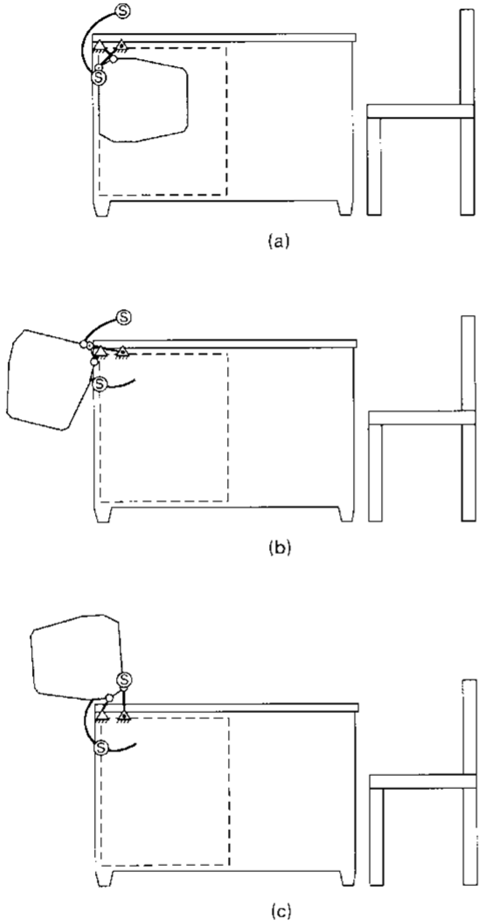
Mabie, H. H. e Reinholtz, C. F.. MECHANISMS AND DYNAMICS OF MACHINERY. New York:John Wiley, 1987

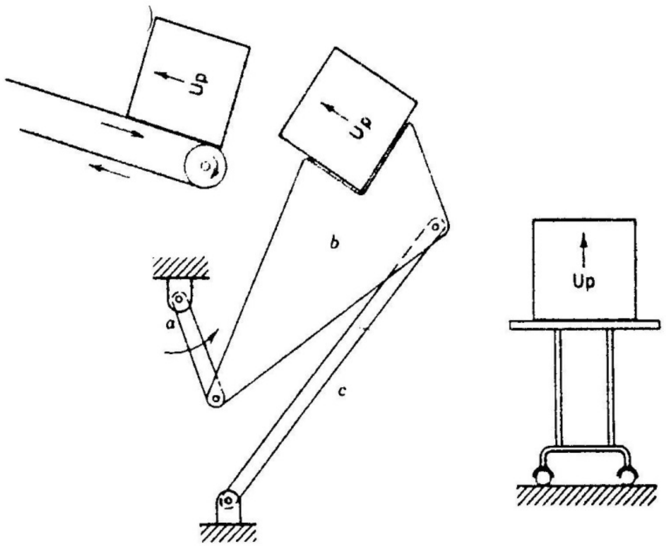
O Capítulo 11, referente à sintese encontra-se disponível no ftp.demec.ufpr.br/disciplinas/TM243.

Nesta aula

- Síntese para Orientação de Objeto
  - Cálculo dos centros fixos
  - Dimensões dos elos móveis
  - Exemplo

Orientação de objeto





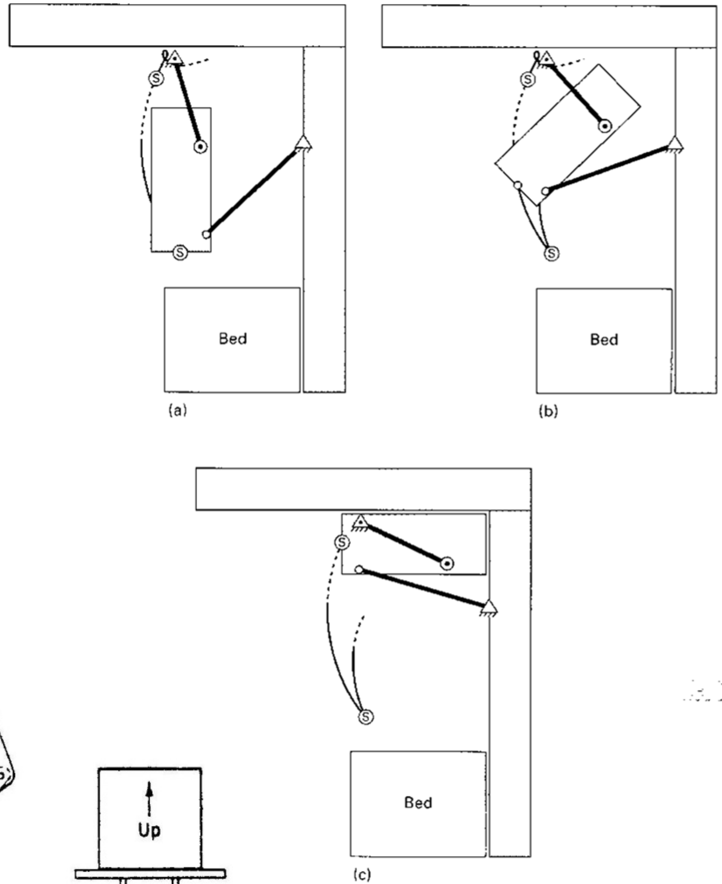
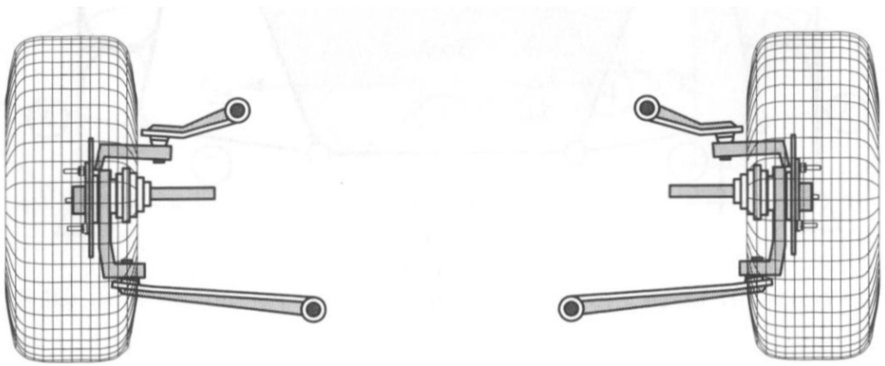
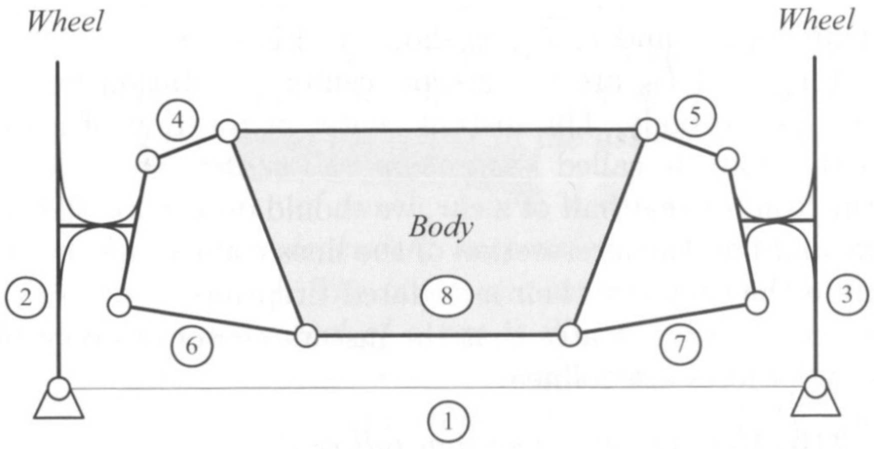


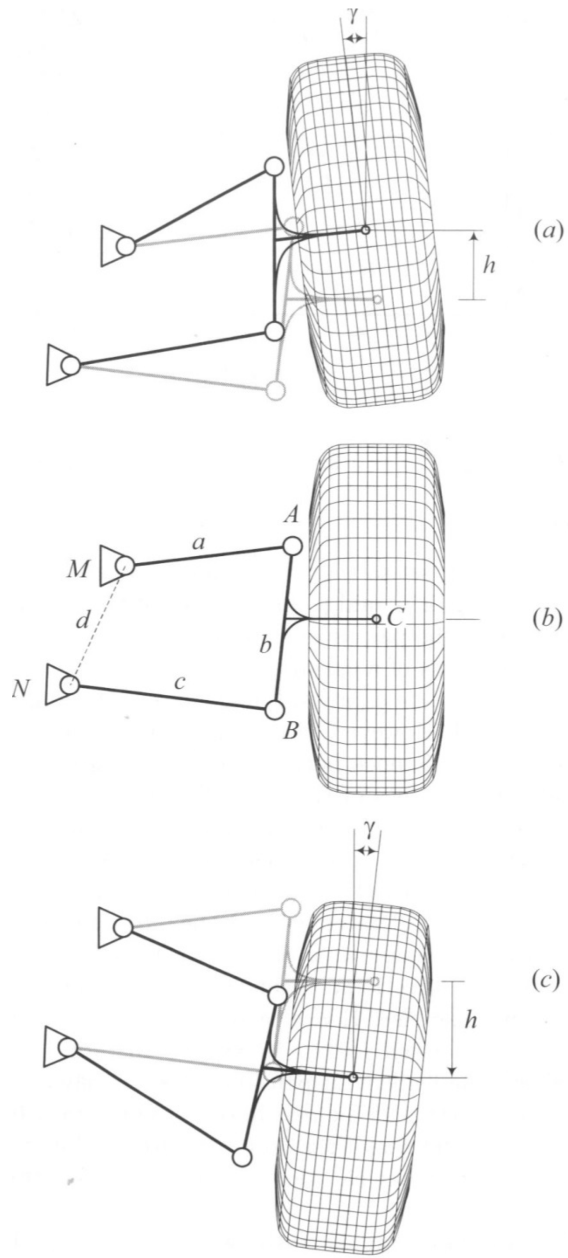
FIGURE 11.6

Orientação de objeto

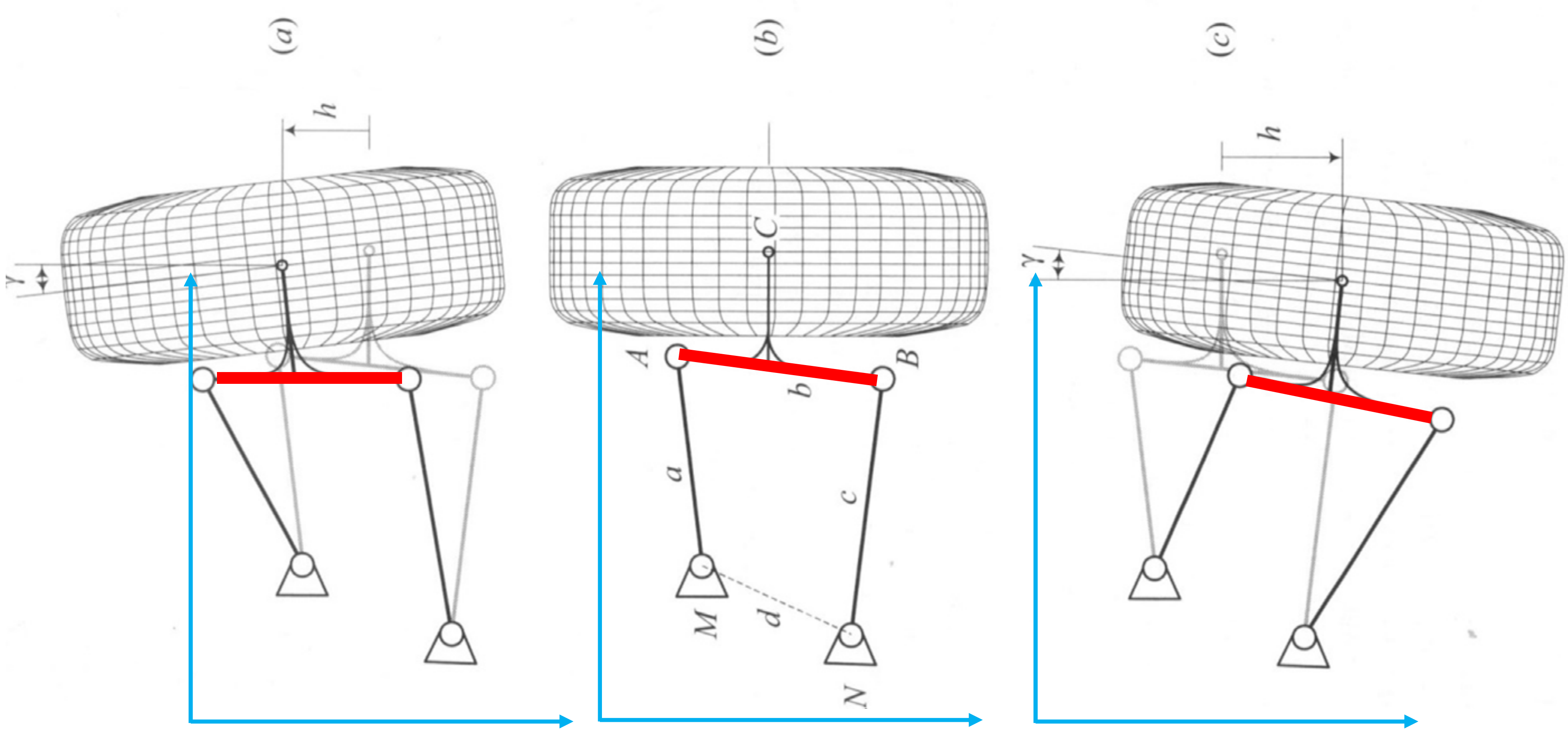
Suspensão automotiva
tipo Duplo A



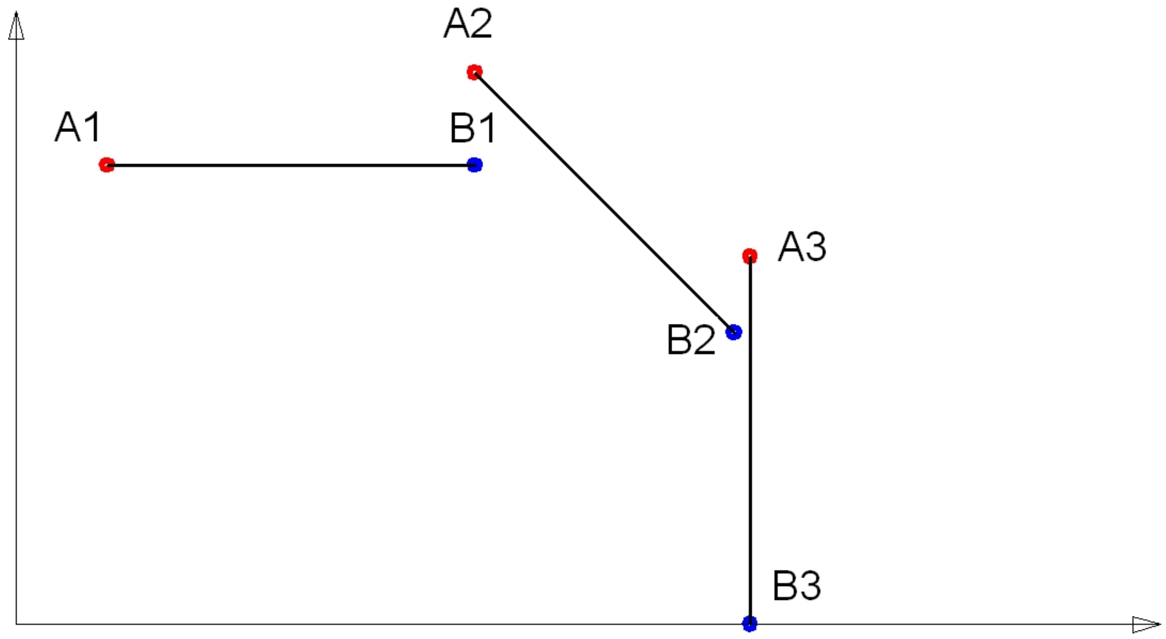




Orientação de objeto

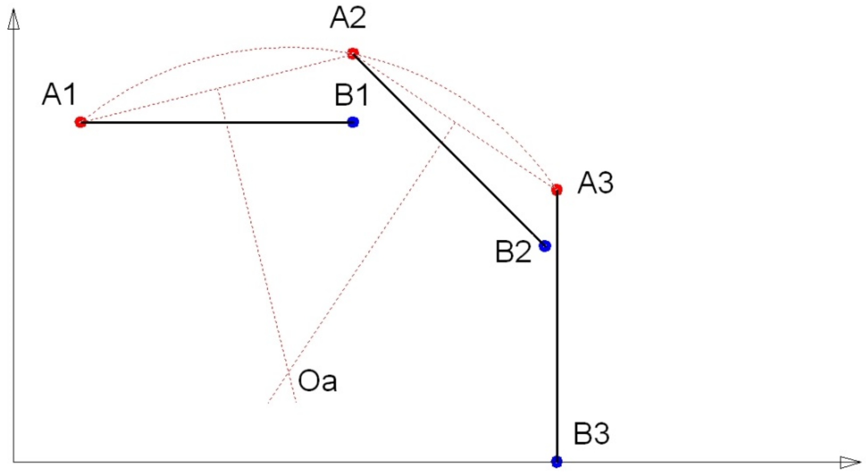


Coordenadas dos pontos



$ponto$	x	y
A_1	x_{A1}	y_{A1}
B_1	x_{B1}	y_{B1}
A_2	x_{A2}	y_{A2}
B_2	x_{B2}	y_{B2}
A_3	x_{A3}	y_{A3}
B_3	x_{B3}	y_{B3}

Equacionamento para o centro O_A



$$A_1O_A = \sqrt{\left(x_{A1} - x_{OA}\right)^2 + \left(y_{A1} - y_{OA}\right)^2}$$

$$A_2O_A = \sqrt{\left(x_{A2} - x_{OA}\right)^2 + \left(y_{A2} - y_{OA}\right)^2}$$

$$A_3O_A = \sqrt{\left(x_{A3} - x_{OA}\right)^2 + \left(y_{A3} - y_{OA}\right)^2}$$

$$A_1O_A = A_2O_A$$

$$\sqrt{\left(x_{A1} - x_{OA}\right)^2 + \left(y_{A1} - y_{OA}\right)^2} = \sqrt{\left(x_{A2} - x_{OA}\right)^2 + \left(y_{A2} - y_{OA}\right)^2}$$

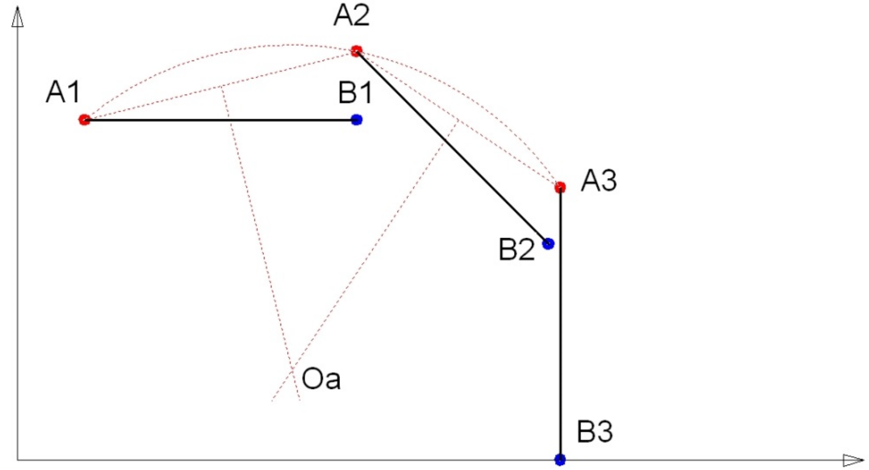
$$\boxed{2.x_{OA}\left(x_{A2} - x_{A1}\right) + x_{A1}^2 - x_{A2}^2 + 2.y_{OA}\left(y_{A2} - y_{A1}\right) + y_{A1}^2 - y_{A2}^2 = 0}$$

$$A_2O_A = A_3O_A$$

$$\sqrt{\left(x_{A2} - x_{OA}\right)^2 + \left(y_{A2} - y_{OA}\right)^2} = \sqrt{\left(x_{A3} - x_{OA}\right)^2 + \left(y_{A3} - y_{OA}\right)^2}$$

$$\boxed{2.x_{OA}\left(x_{A3} - x_{A2}\right) + x_{A2}^2 - x_{A3}^2 + 2.y_{OA}\left(y_{A3} - y_{A2}\right) + y_{A2}^2 - y_{A3}^2 = 0}$$

Solução do sistema



$$2.x_{OA}\left(x_{A2}-x_{A1}\right)+x_{A1}^{2}-x_{A2}^{2}+2.y_{OA}\left(y_{A2}-y_{A1}\right)+y_{A1}^{2}-y_{A2}^{2}=0$$

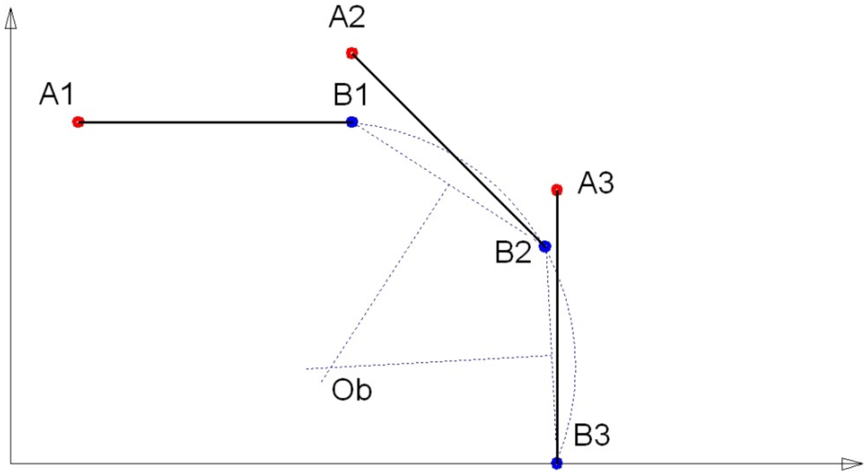
$$2.x_{OA}\left(x_{A3}-x_{A2}\right)+x_{A2}^{2}-x_{A3}^{2}+2.y_{OA}\left(y_{A3}-y_{A2}\right)+y_{A2}^{2}-y_{A3}^{2}=0$$

Solução na forma matricial:

$$\begin{bmatrix} 2.\left(x_{A2}-x_{A1}\right) & 2.\left(y_{A2}-y_{A1}\right) \\ 2.\left(x_{A3}-x_{A2}\right) & 2.\left(y_{A3}-y_{A2}\right) \end{bmatrix}.\begin{Bmatrix} x_{OA} \\ y_{OA} \end{Bmatrix}+\begin{Bmatrix} x_{A1}^{2}-x_{A2}^{2}+y_{A1}^{2}-y_{A2}^{2} \\ x_{A2}^{2}-x_{A3}^{2}+y_{A2}^{2}-y_{A3}^{2} \end{Bmatrix}=\begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$

$$\boxed{\begin{Bmatrix} x_{OA} \\ y_{OA} \end{Bmatrix}=-\begin{bmatrix} 2.\left(x_{A2}-x_{A1}\right) & 2.\left(y_{A2}-y_{A1}\right) \\ 2.\left(x_{A3}-x_{A2}\right) & 2.\left(y_{A3}-y_{A2}\right) \end{bmatrix}^{-1}.\begin{Bmatrix} x_{A1}^{2}-x_{A2}^{2}+y_{A1}^{2}-y_{A2}^{2} \\ x_{A2}^{2}-x_{A3}^{2}+y_{A2}^{2}-y_{A3}^{2} \end{Bmatrix}}$$

Equacionamento para o centro O$_B$



$$B_1O_B = \sqrt{\left(x_{B1} - x_{OB}\right)^2 + \left(y_{B1} - y_{OB}\right)^2}$$

$$B_2O_B = \sqrt{\left(x_{B2} - x_{OB}\right)^2 + \left(y_{B2} - y_{OB}\right)^2}$$

$$B_3O_B = \sqrt{\left(x_{B3} - x_{OB}\right)^2 + \left(y_{B3} - y_{OB}\right)^2}$$

$$B_1O_B = B_2O_B$$

$$\sqrt{\left(x_{B1} - x_{OB}\right)^2 + \left(y_{B1} - y_{OB}\right)^2} = \sqrt{\left(x_{B2} - x_{OB}\right)^2 + \left(y_{B2} - y_{OB}\right)^2}$$

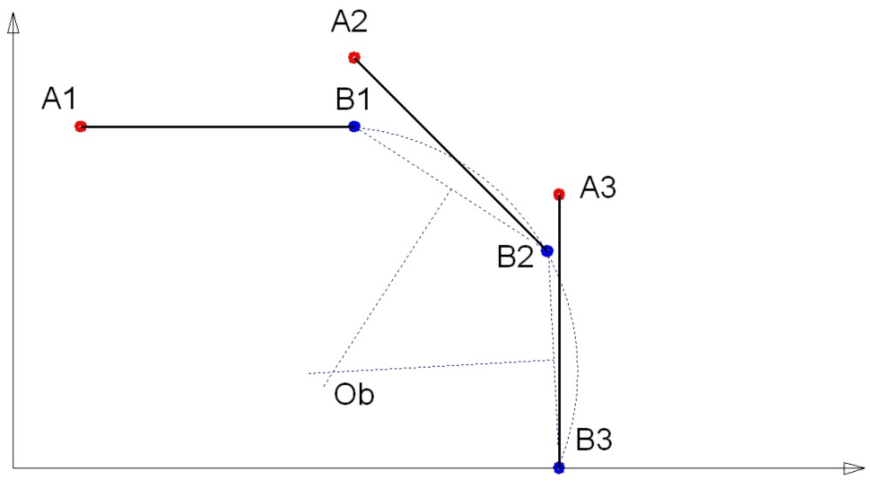
$$\boxed{2.x_{OB}\left(x_{B2} - x_{B1}\right) + x_{B1}^2 - x_{B2}^2 + 2.y_{OB}\left(y_{B2} - y_{B1}\right) + y_{B1}^2 - y_{B2}^2 = 0}$$

$$B_2O_B = B_3O_B$$

$$\sqrt{\left(x_{B2} - x_{OB}\right)^2 + \left(y_{B2} - y_{OB}\right)^2} = \sqrt{\left(x_{B3} - x_{OB}\right)^2 + \left(y_{B3} - y_{OB}\right)^2}$$

$$\boxed{2.x_{OB}\left(x_{B3} - x_{B2}\right) + x_{B2}^2 - x_{B3}^2 + 2.y_{OB}\left(y_{B3} - y_{B2}\right) + y_{B2}^2 - y_{B3}^2 = 0}$$

Solução do sistema



$$2.x_{OB}\left(x_{B2}-x_{B1}\right)+x_{B1}^2-x_{B2}^2+2.y_{OB}\left(y_{B2}-y_{B1}\right)+y_{B1}^2-y_{B2}^2=0$$

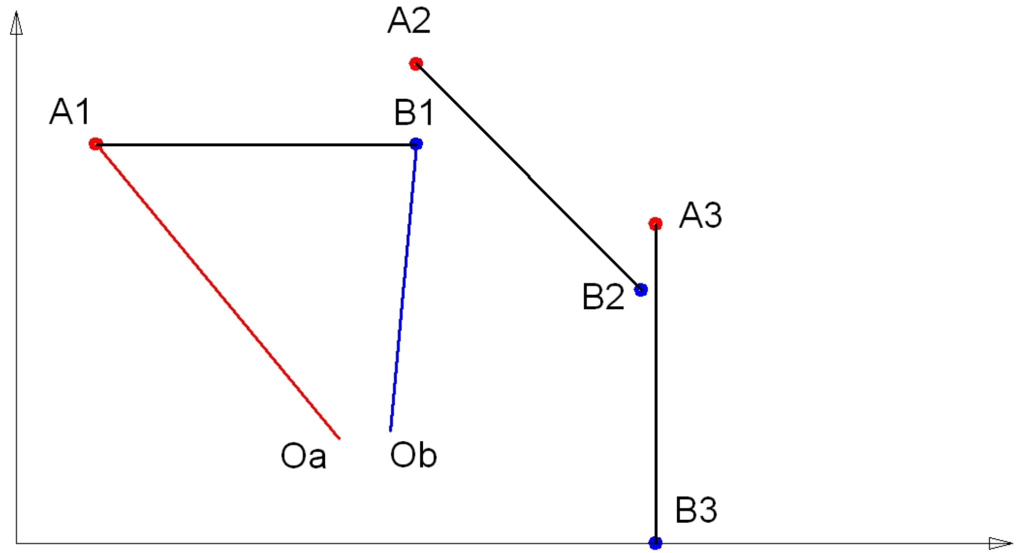
$$2.x_{OB}\left(x_{B3}-x_{B2}\right)+x_{B2}^2-x_{B3}^2+2.y_{OB}\left(y_{B3}-y_{B2}\right)+y_{B2}^2-y_{B3}^2=0$$

Solução na forma matricial:

$$\begin{bmatrix} 2.\left(x_{B2}-x_{B1}\right) & 2.\left(y_{B2}-y_{B1}\right) \\ 2.\left(x_{B3}-x_{B2}\right) & 2.\left(y_{B3}-y_{B2}\right) \end{bmatrix} . \begin{Bmatrix} x_{OB} \\ y_{OB} \end{Bmatrix} + \begin{Bmatrix} x_{B1}^2-x_{B2}^2+y_{B1}^2-y_{B2}^2 \\ x_{B2}^2-x_{B3}^2+y_{B2}^2-y_{B3}^2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$

$$\boxed{\begin{Bmatrix} x_{OB} \\ y_{OB} \end{Bmatrix} = -\begin{bmatrix} 2.\left(x_{B2}-x_{B1}\right) & 2.\left(y_{B2}-y_{B1}\right) \\ 2.\left(x_{B3}-x_{B2}\right) & 2.\left(y_{B3}-y_{B2}\right) \end{bmatrix}^{-1} . \begin{Bmatrix} x_{B1}^2-x_{B2}^2+y_{B1}^2-y_{B2}^2 \\ x_{B2}^2-x_{B3}^2+y_{B2}^2-y_{B3}^2 \end{Bmatrix}}$$

Cálculo dos comprimentos dos elos



$$a = \sqrt{\left(x_{A1} - x_{OA}\right)^2 + \left(y_{A1} - y_{OA}\right)^2}$$

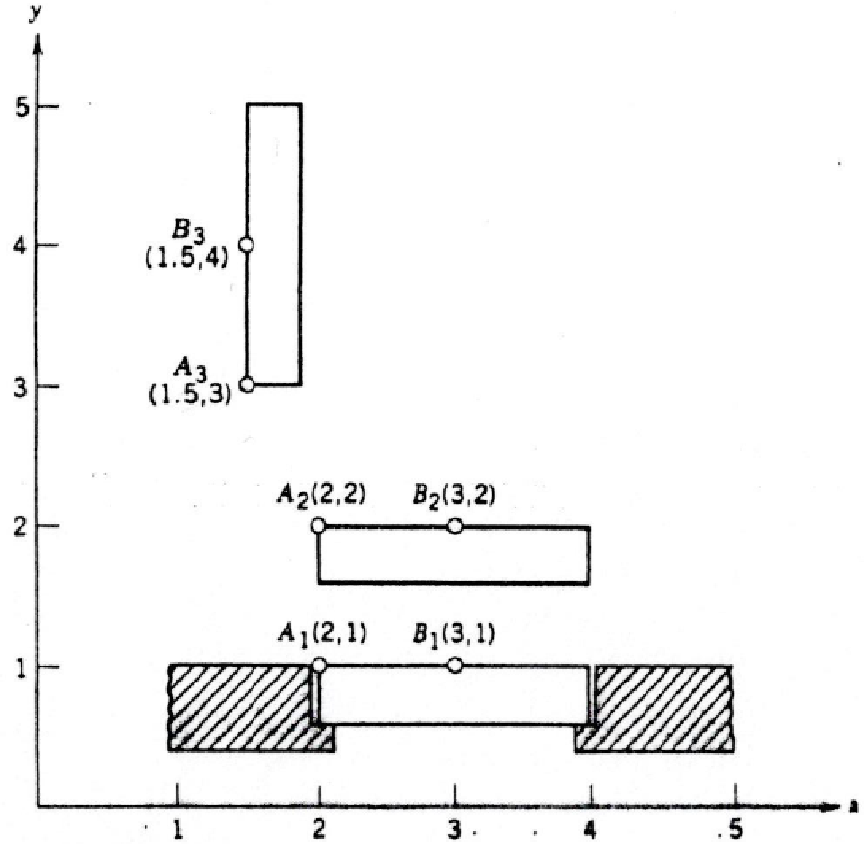
$$b = \sqrt{\left(x_{A1} - x_{B1}\right)^2 + \left(y_{A1} - y_{B1}\right)^2}$$

$$c = \sqrt{\left(x_{B1} - x_{OB}\right)^2 + \left(y_{B1} - y_{OB}\right)^2}$$

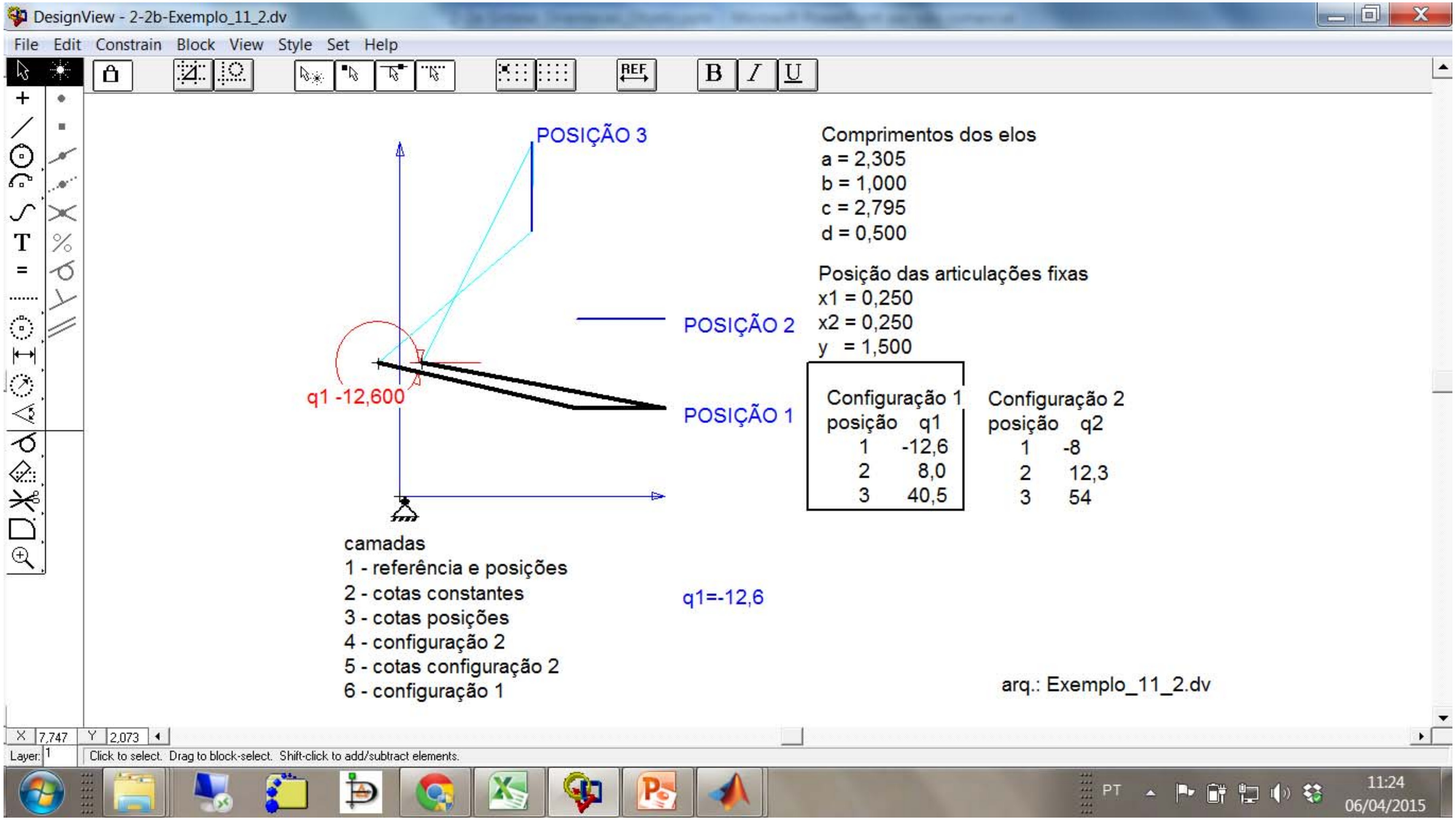
$$d = \sqrt{\left(x_{OA} - x_{OB}\right)^2 + \left(y_{OA} - y_{OB}\right)^2}$$

Exemplo 11.2

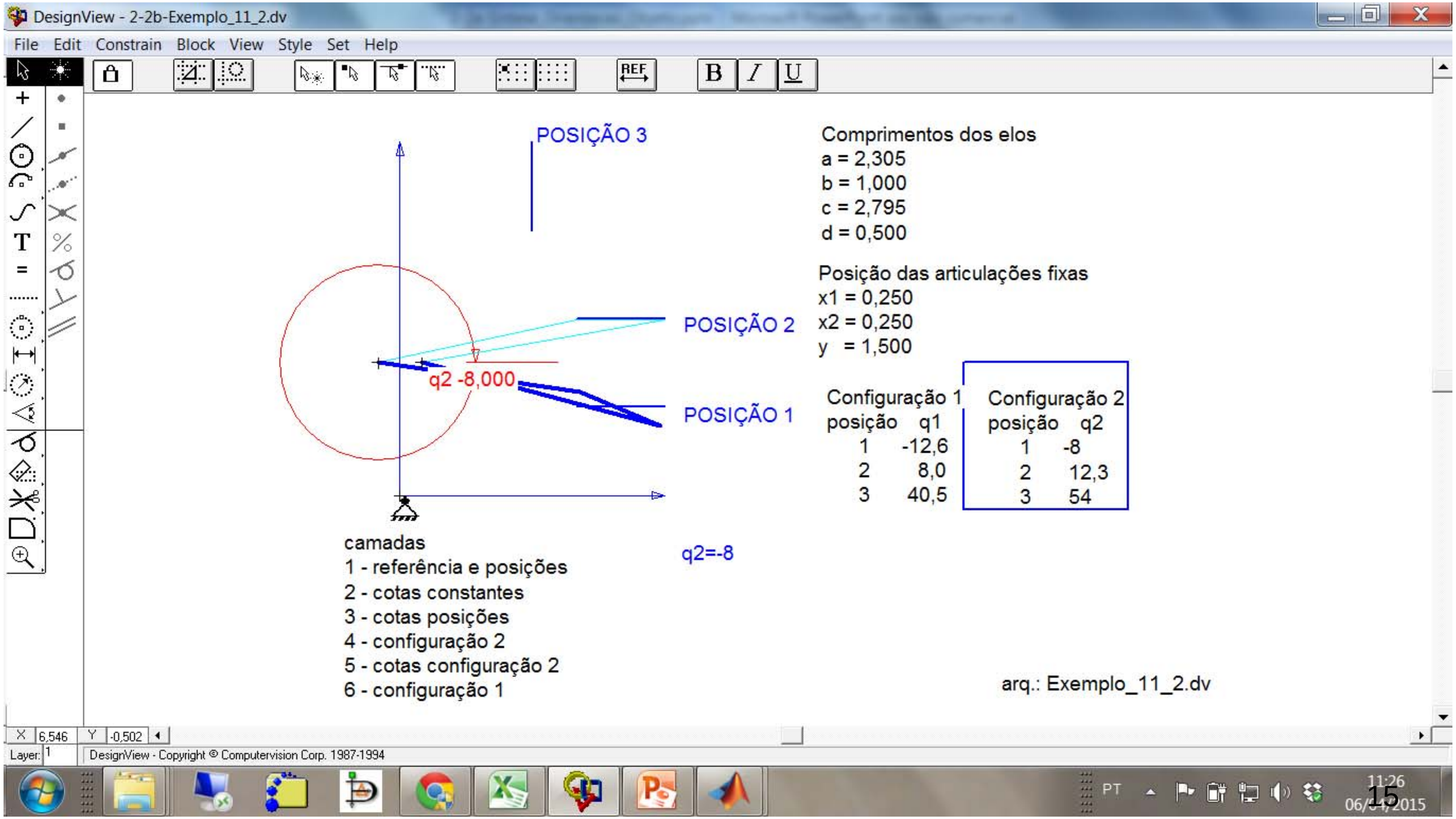
Example 11.2. In designing pressure-sealing or thermal-sealing doors, it is sometimes necessary to reduce the clearance surrounding the door to less than that which could be obtained using a conventional hinge. One possible solution is to design a four-bar linkage that guides the door in and out with little rotation until it clears the surrounding structure, after which it swings fully open to one side. Figure 11.23 shows three positions of such a door undergoing this type of motion. Use both graphical and analytical techniques to find a four-bar linkage with moving pivots at points A and B that guides the body through these three positions.



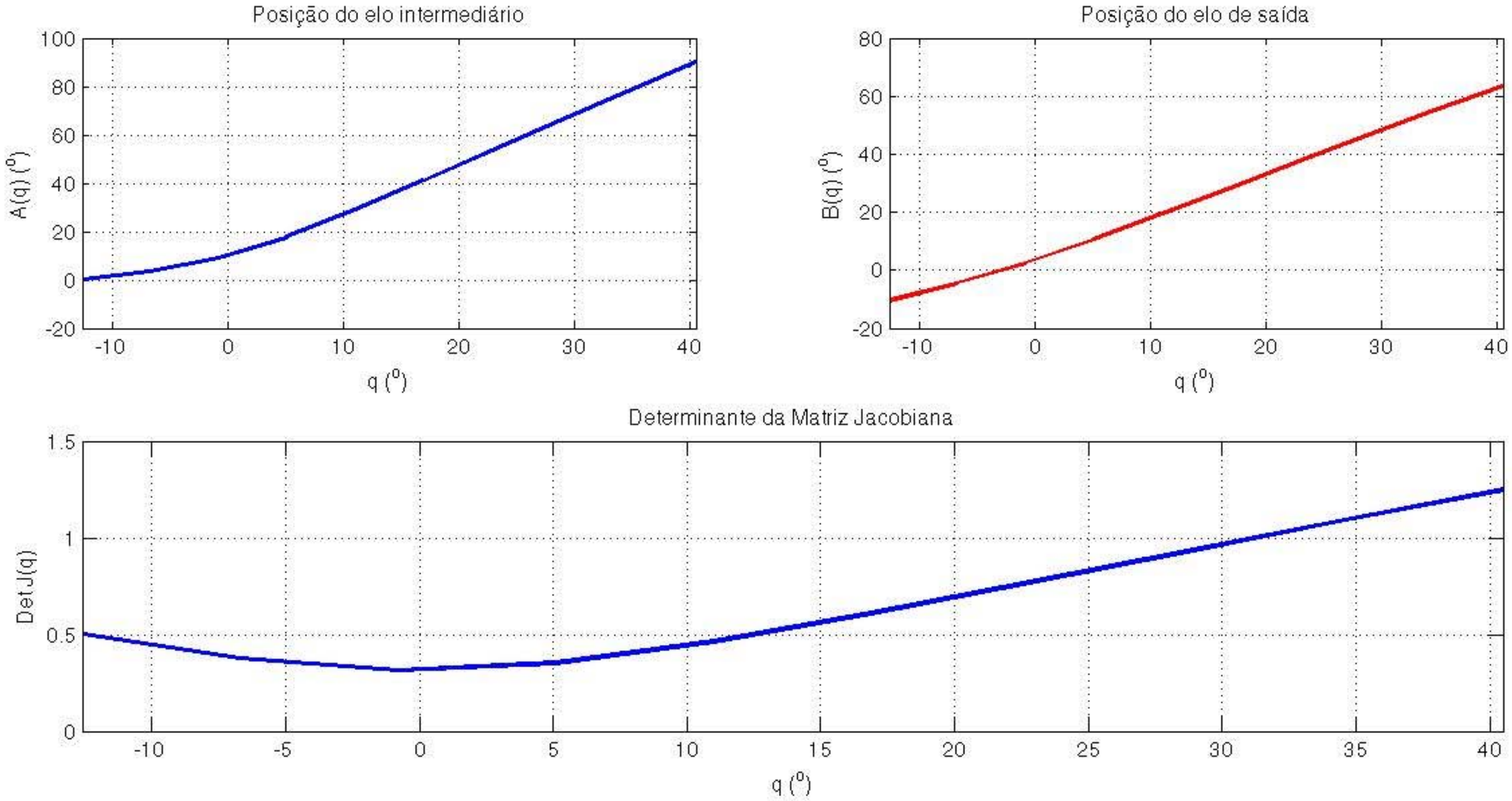
configuração 1



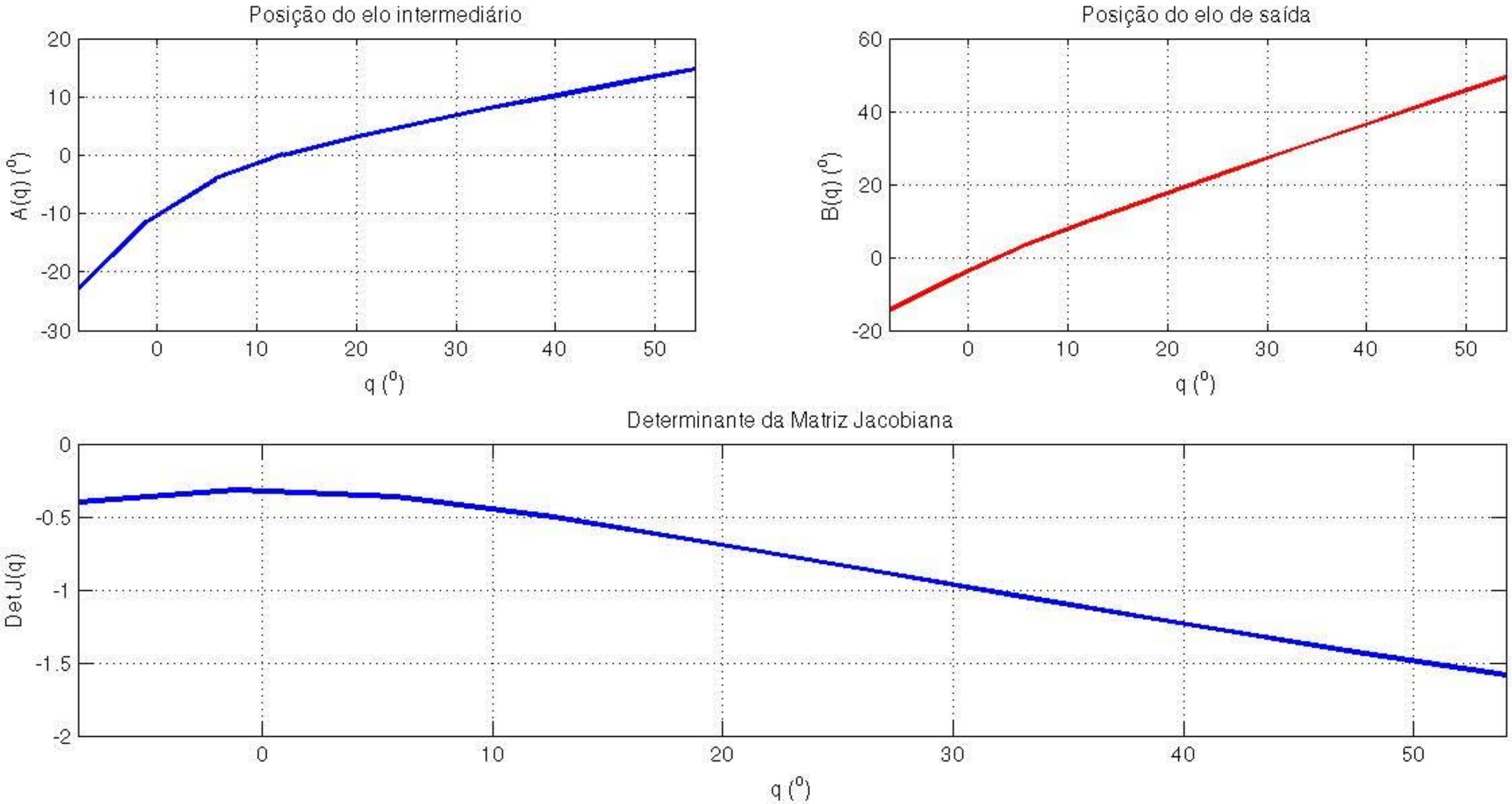
configuração 2



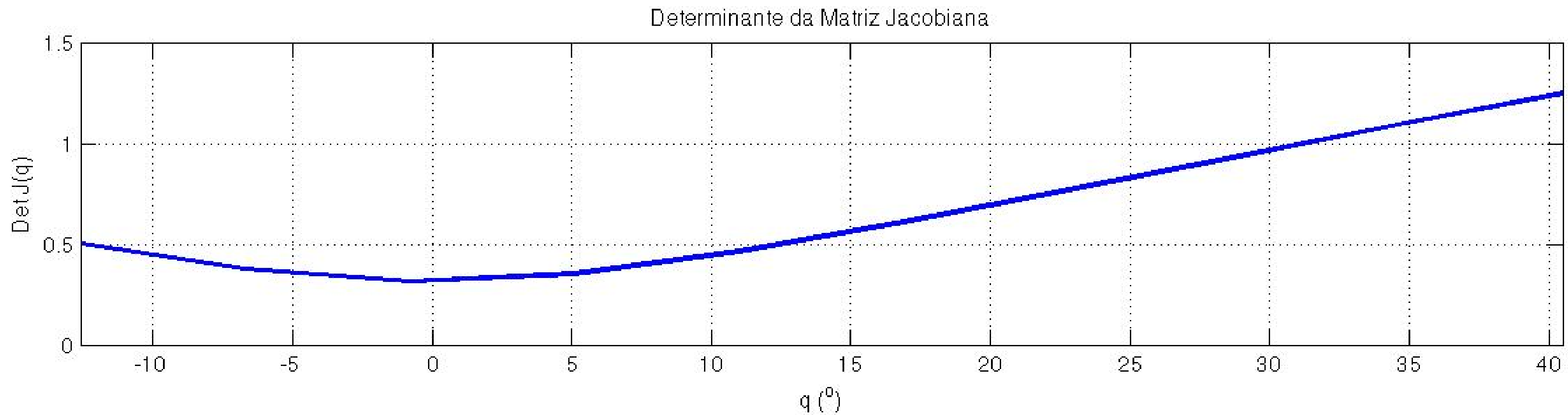
configuração 1

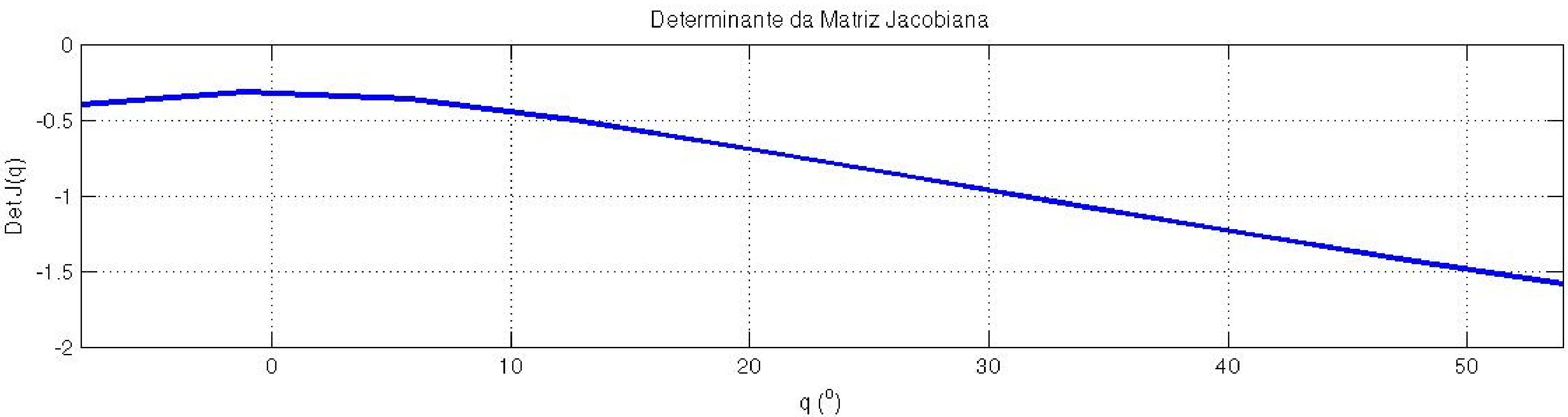


configuração 2



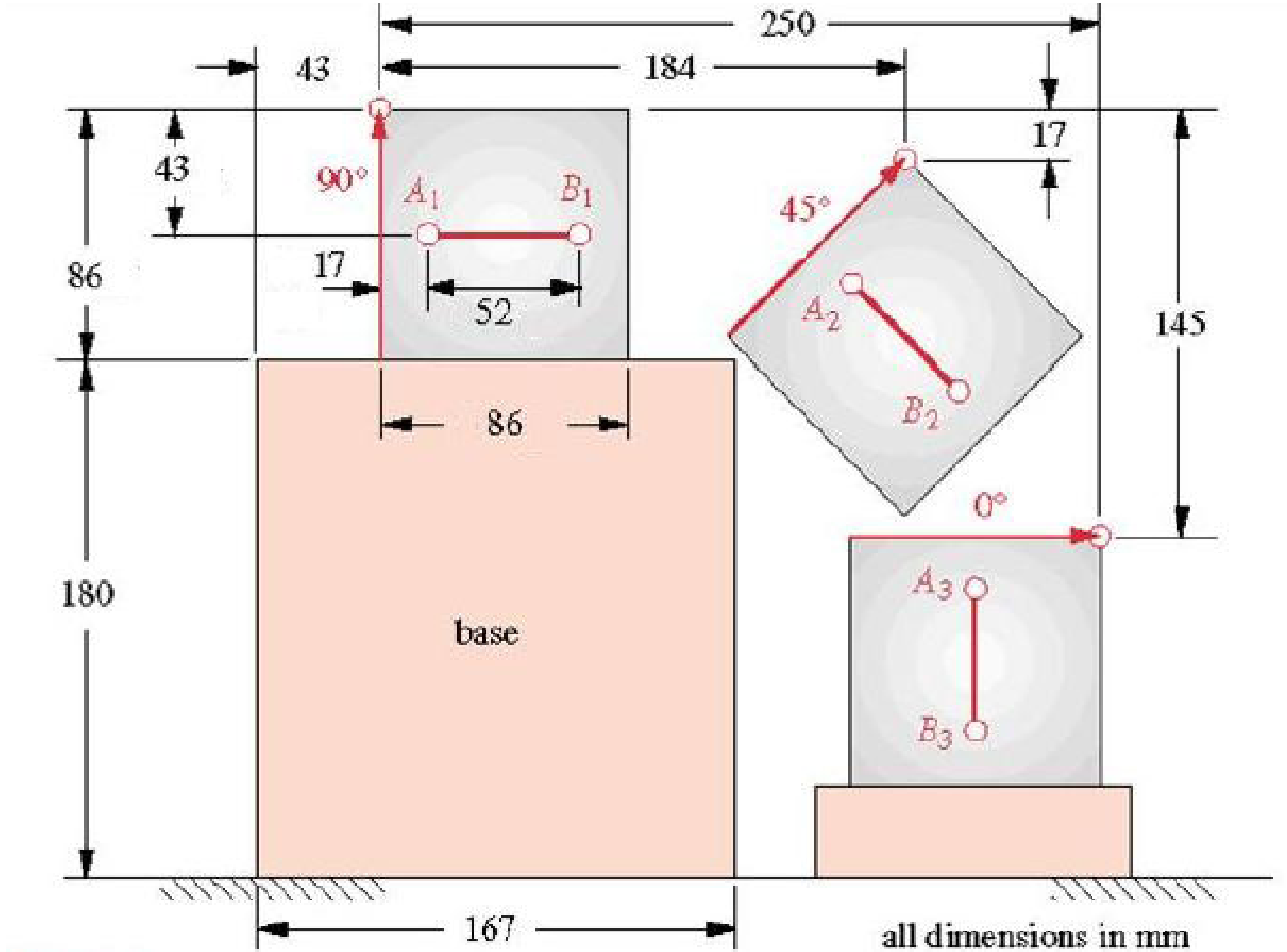
configurações 1 e 2





Exercício

2-Projetar um mecanismo de quatro barras para mover o objeto pelas três posições mostradas na figura. Utilizar os pontos A e B como articulações.



2- $a = 127,29$; $b = 52$; $c = 120,25$; $d = 20,74$