

Mecanismos

Prof. Jorge Luiz Erthal

Síntese de mecanismos 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 síntese 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

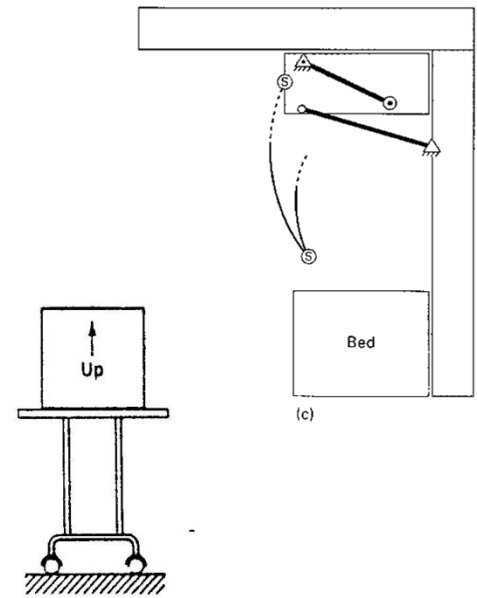
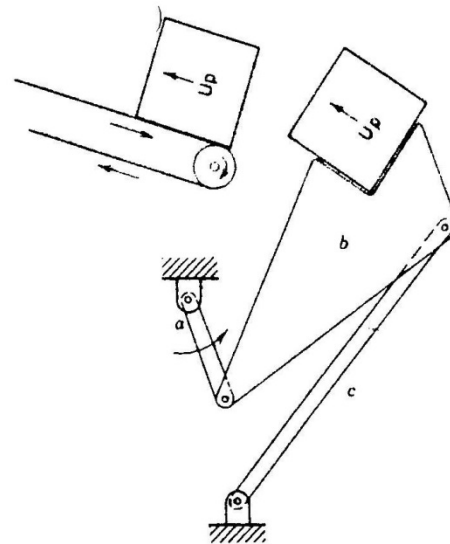
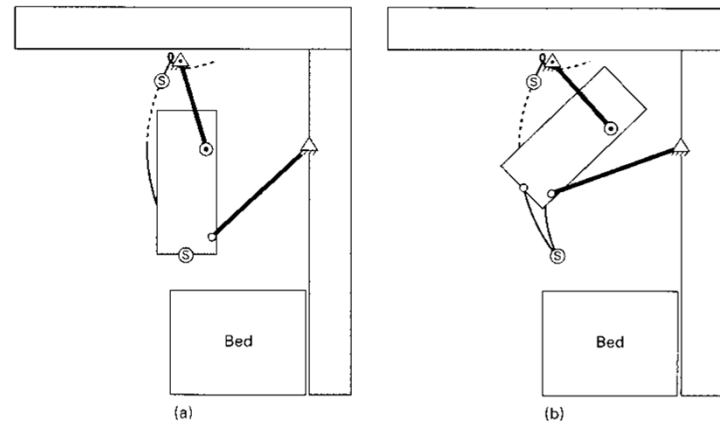
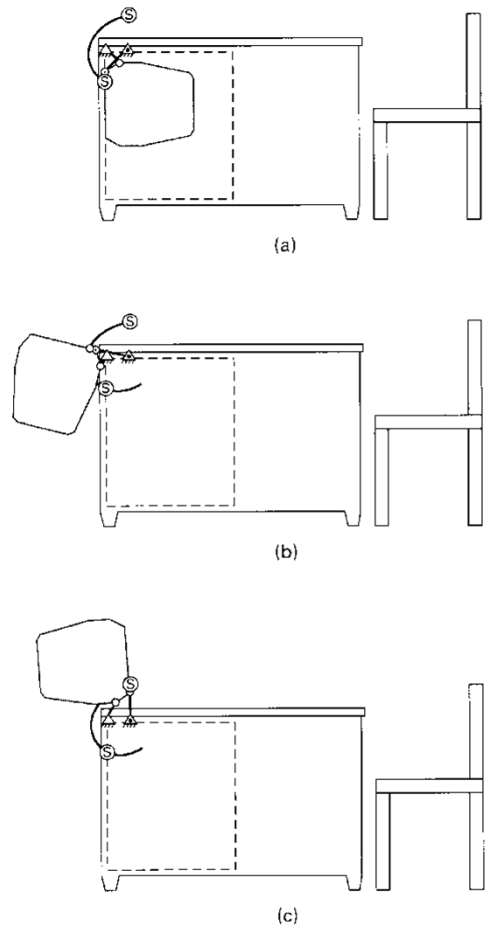
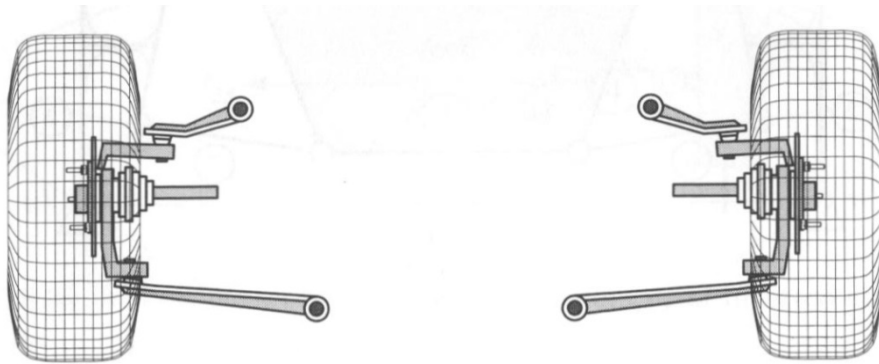


FIGURE 11.6

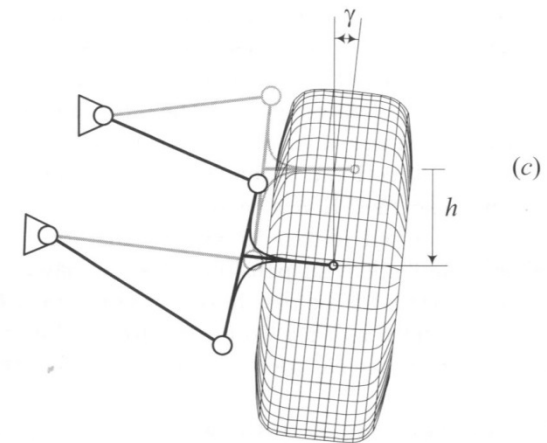
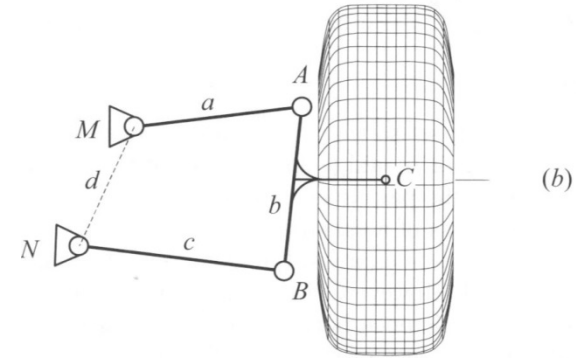
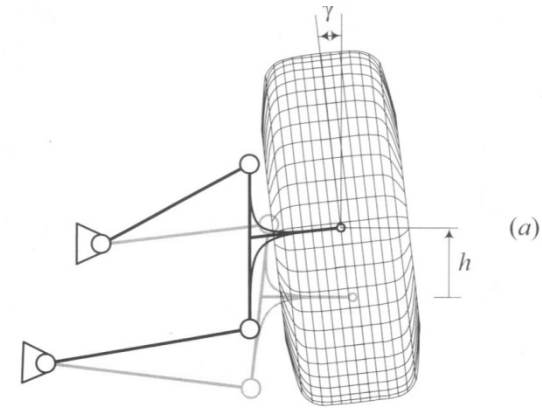
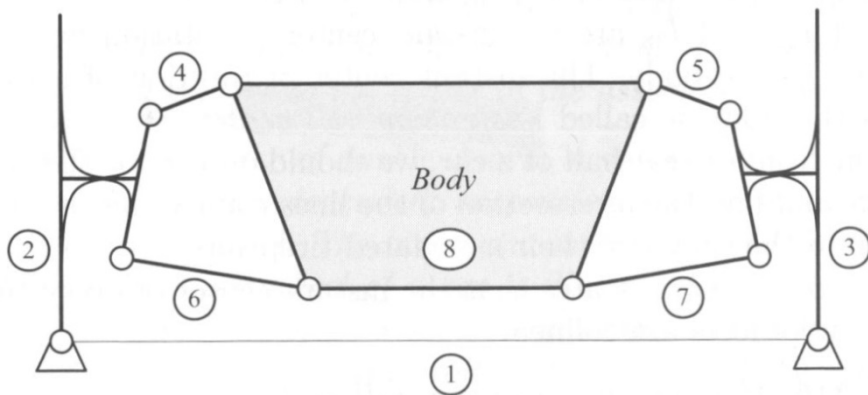
Orientação de objeto

Suspensão automotiva tipo Duplo A

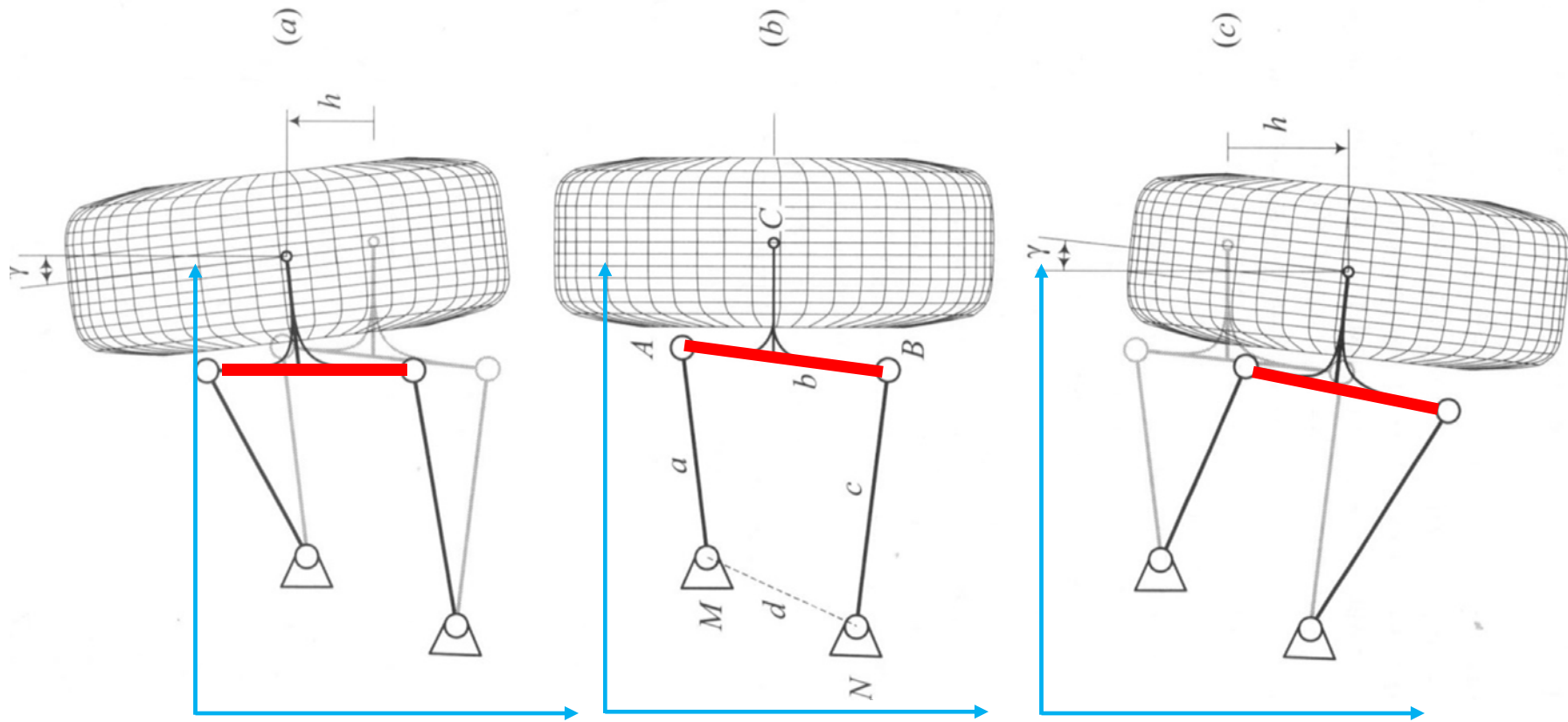


Wheel

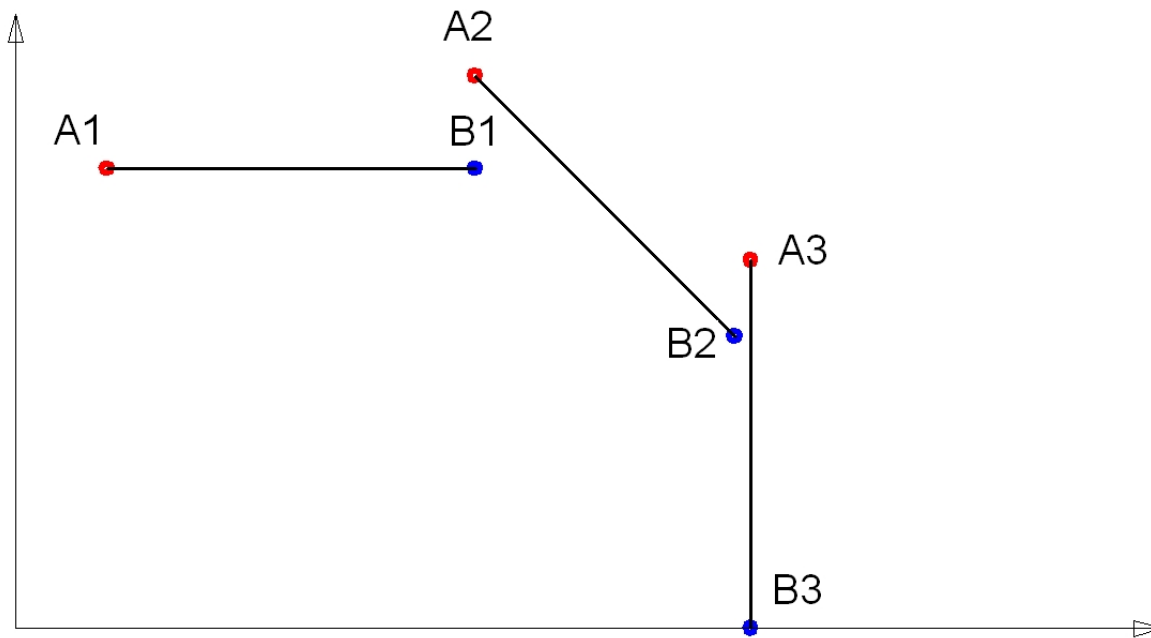
Wheel



Orientação de objeto

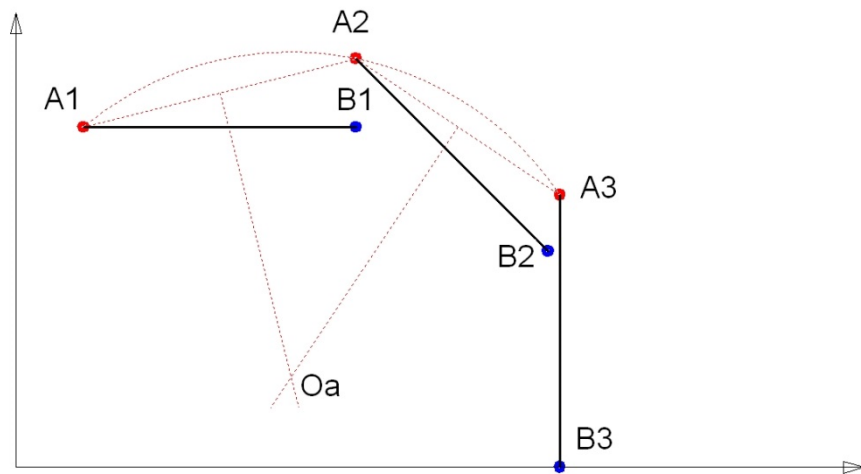


Coordenadas dos pontos



<i>ponto</i>	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



$$A_1 O_A = \sqrt{(x_{A1} - x_{O_A})^2 + (y_{A1} - y_{O_A})^2}$$

$$A_2 O_A = \sqrt{(x_{A2} - x_{O_A})^2 + (y_{A2} - y_{O_A})^2}$$

$$A_3 O_A = \sqrt{(x_{A3} - x_{O_A})^2 + (y_{A3} - y_{O_A})^2}$$

$$A_1 O_A = A_2 O_A$$

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

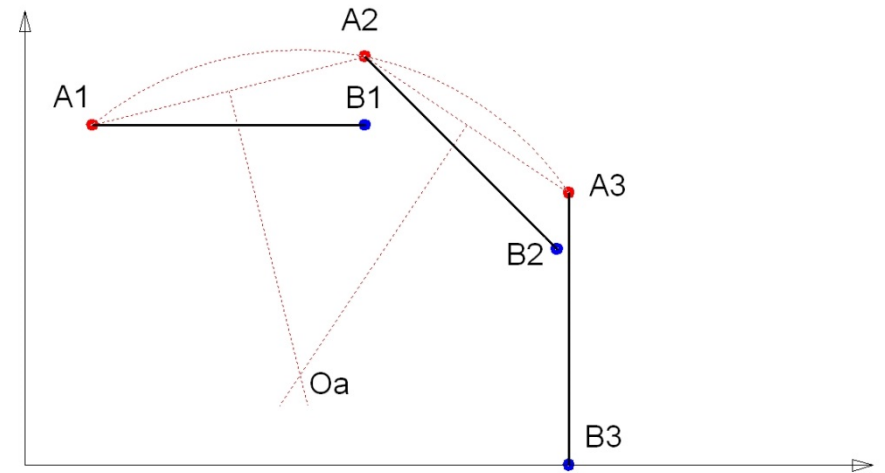
$$2 \cdot x_{O_A} (x_{A2} - x_{A1}) + x_{A1}^2 - x_{A2}^2 + 2 \cdot y_{O_A} (y_{A2} - y_{A1}) + y_{A1}^2 - y_{A2}^2 = 0$$

$$A_2 O_A = A_3 O_A$$

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

$$2 \cdot x_{O_A} (x_{A3} - x_{A2}) + x_{A2}^2 - x_{A3}^2 + 2 \cdot y_{O_A} (y_{A3} - y_{A2}) + y_{A2}^2 - y_{A3}^2 = 0$$

Solução do sistema



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

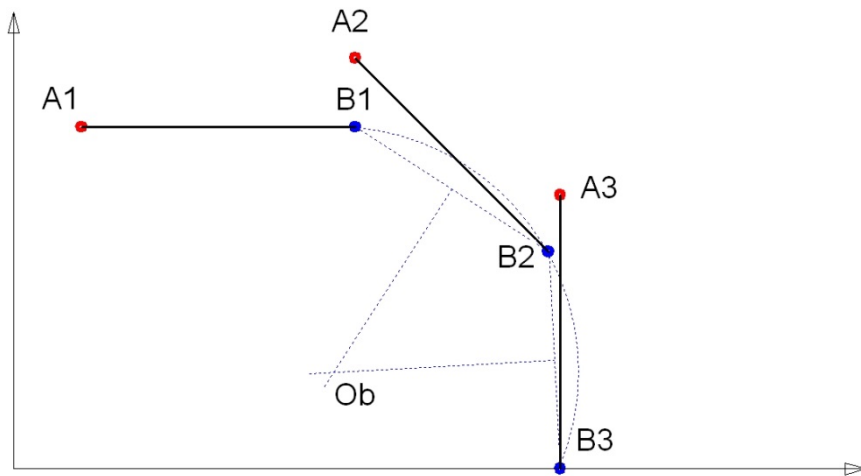
$$2 \cdot x_{OA} (x_{A3} - x_{A2}) + x_{A2}^2 - x_{A3}^2 + 2 \cdot y_{OA} (y_{A3} - y_{A2}) + y_{A2}^2 - y_{A3}^2 = 0$$

Solução na forma matricial:

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

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

Equacionamento para o centro O_B



$$B_1 O_B = \sqrt{(x_{B1} - x_{OB})^2 + (y_{B1} - y_{OB})^2}$$

$$B_2 O_B = \sqrt{(x_{B2} - x_{OB})^2 + (y_{B2} - y_{OB})^2}$$

$$B_3 O_B = \sqrt{(x_{B3} - x_{OB})^2 + (y_{B3} - y_{OB})^2}$$

$$B_1 O_B = B_2 O_B$$

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

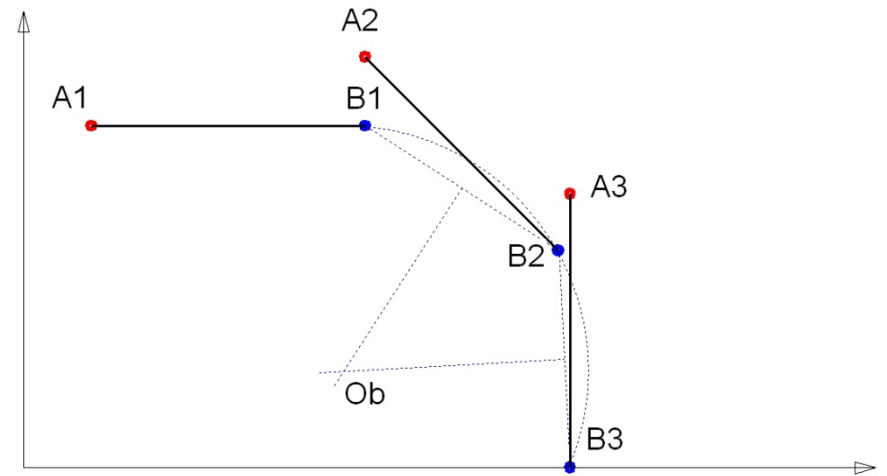
$$2 \cdot x_{OB} (x_{B2} - x_{B1}) + x_{B1}^2 - x_{B2}^2 + 2 \cdot y_{OB} (y_{B2} - y_{B1}) + y_{B1}^2 - y_{B2}^2 = 0$$

$$B_2 O_B = B_3 O_B$$

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

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

Solução do sistema



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

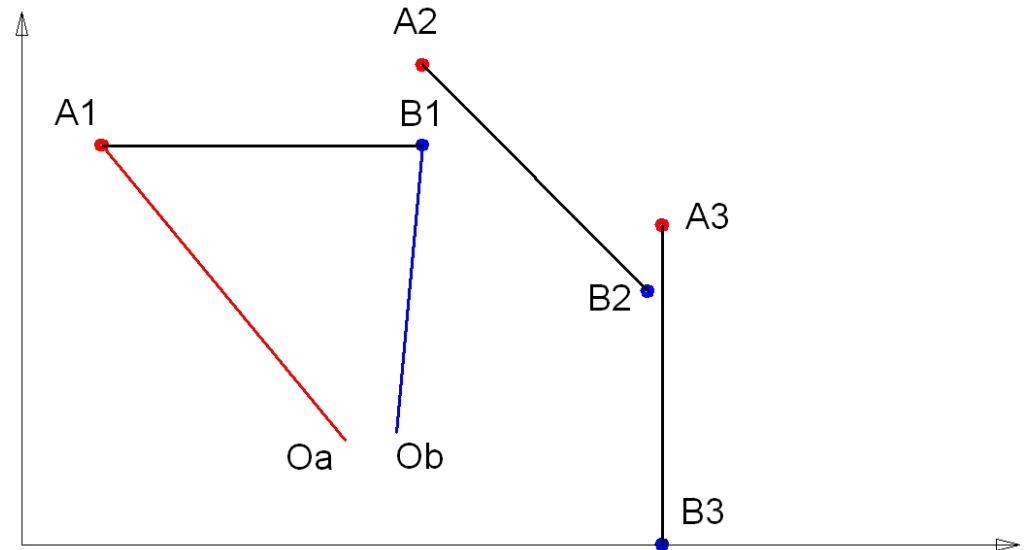
$$2 \cdot x_{OB} (x_{B3} - x_{B2}) + x_{B2}^2 - x_{B3}^2 + 2 \cdot y_{OB} (y_{B3} - y_{B2}) + y_{B2}^2 - y_{B3}^2 = 0$$

Solução na forma matricial:

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

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

Cálculo dos comprimentos dos elos



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

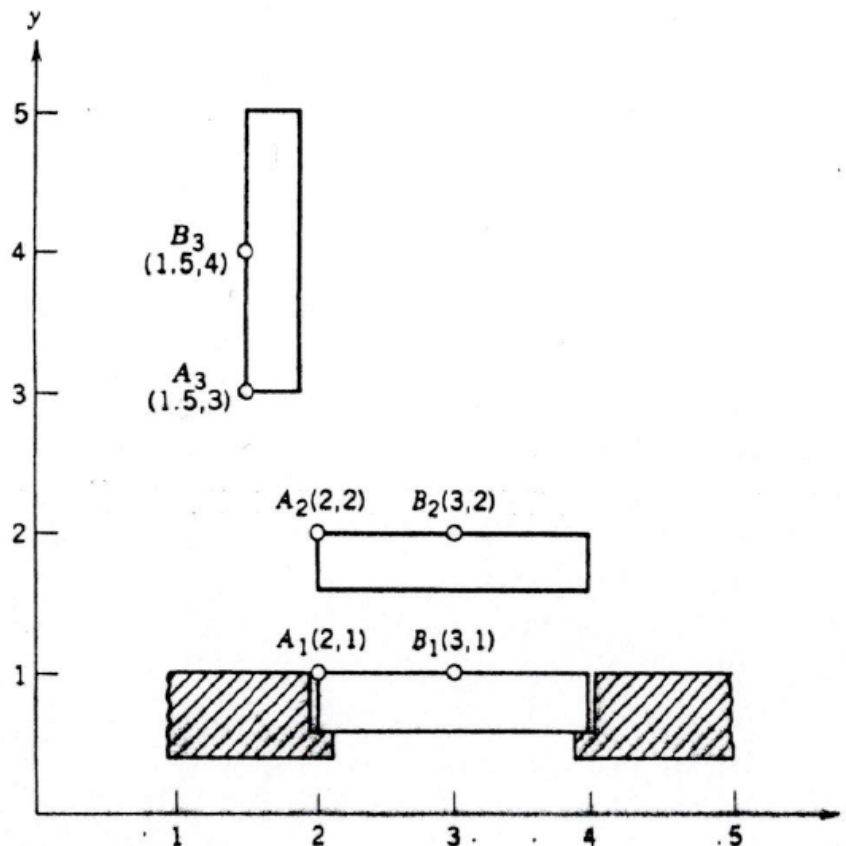
$$b = \sqrt{(x_{A1} - x_{B1})^2 + (y_{A1} - y_{B1})^2}$$

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

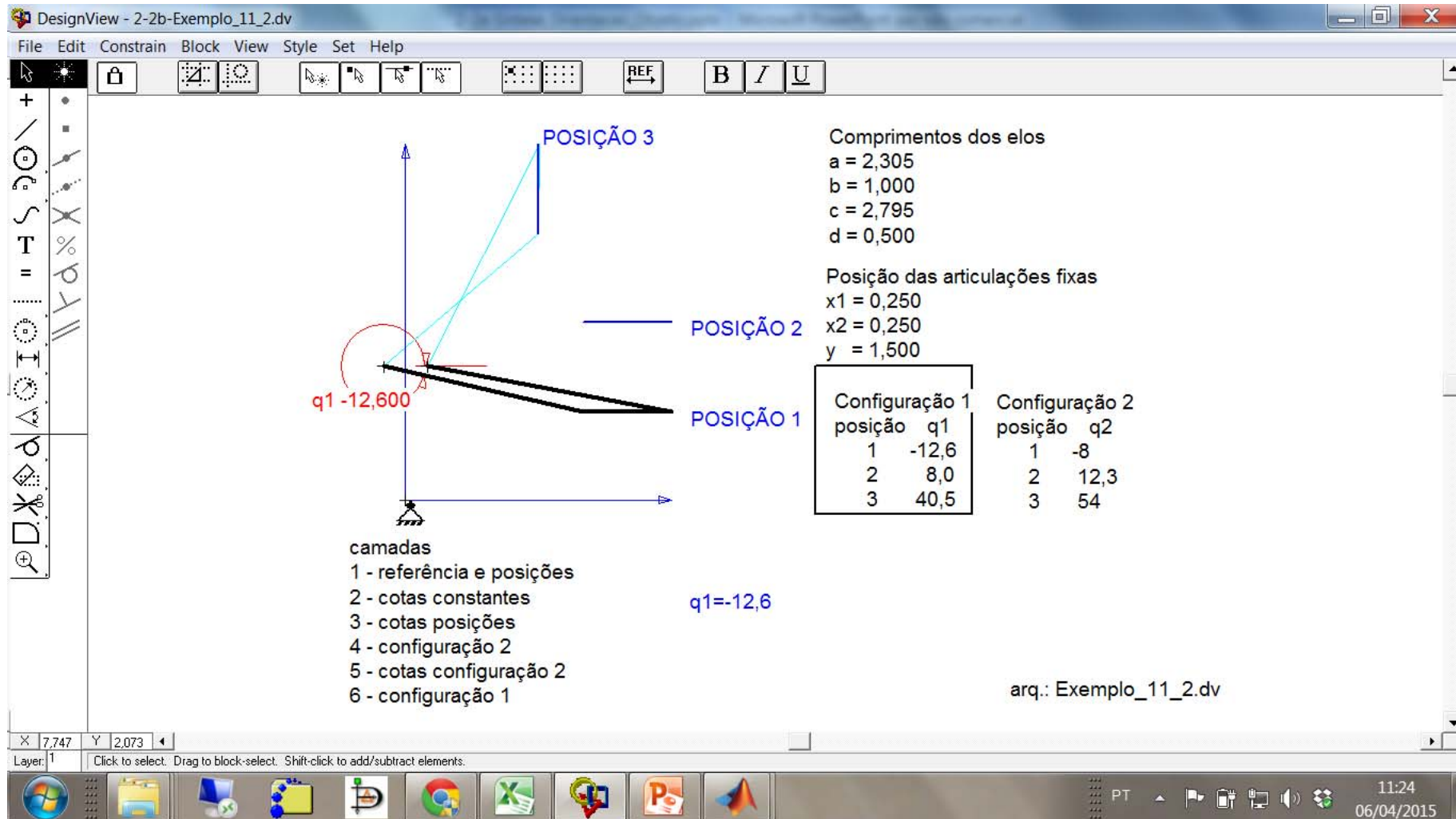
$$d = \sqrt{(x_{OA} - x_{OB})^2 + (y_{OA} - y_{OB})^2}$$

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

The screenshot displays a software interface for a mechanism design. The main workspace shows a diagram of a mechanism with a red circle representing a path or constraint. Three positions are marked: POSIÇÃO 1 (blue), POSIÇÃO 2 (cyan), and POSIÇÃO 3 (blue). A red arrow indicates a displacement of $q2 = -8,000$. A coordinate system is shown with a fixed pivot at the origin.

Comprimentos dos elos
a = 2,305
b = 1,000
c = 2,795
d = 0,500

Posição das articulações fixas
x1 = 0,250
x2 = 0,250
y = 1,500

Configuração 1		Configuração 2	
posição	q1	posição	q2
1	-12,6	1	-8
2	8,0	2	12,3
3	40,5	3	54

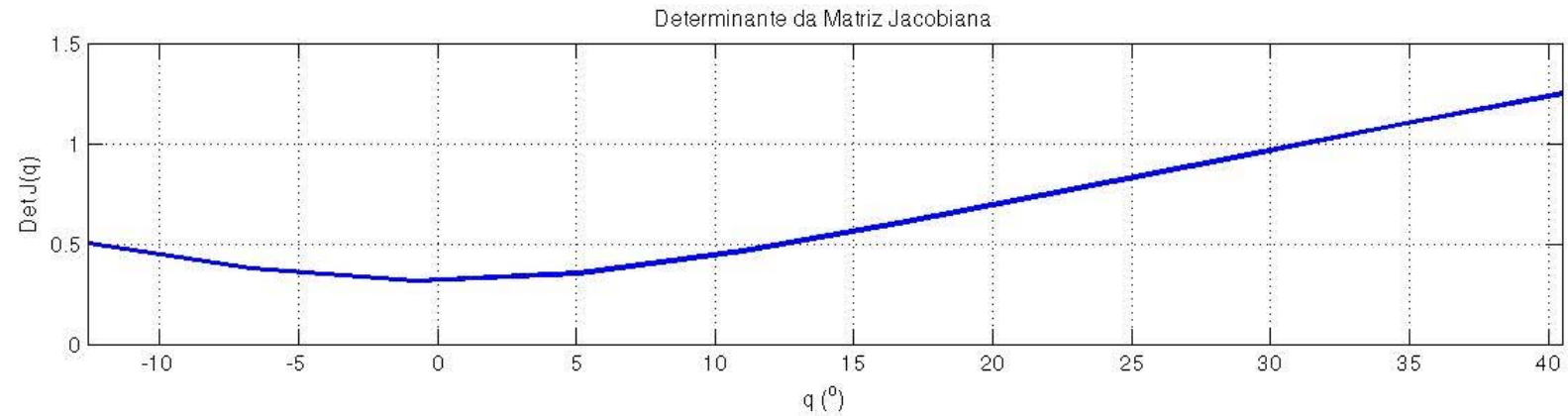
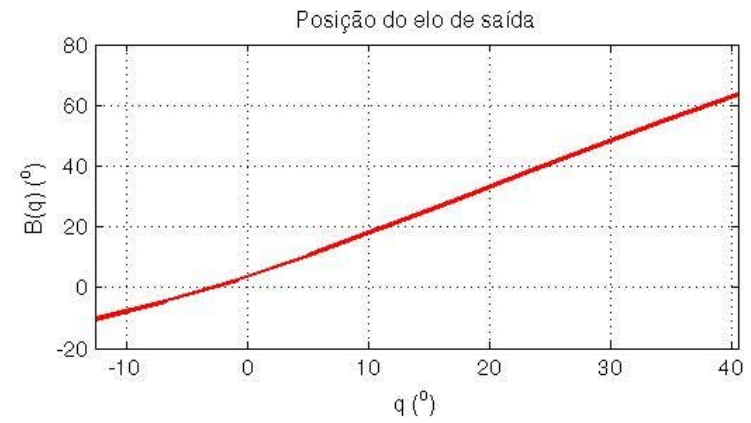
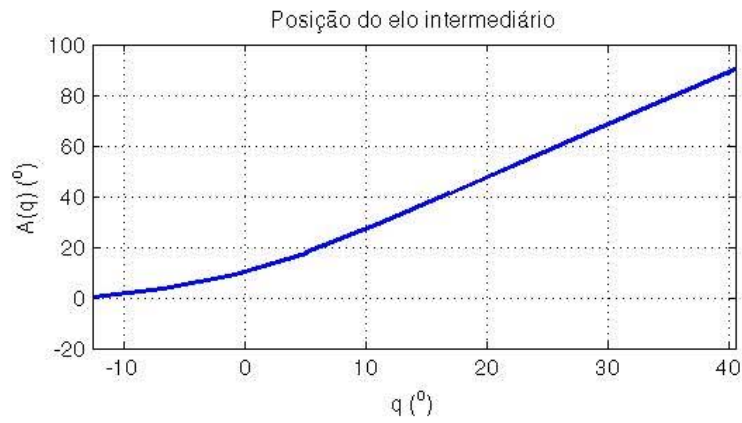
camadas
1 - referência e posições
2 - cotas constantes
3 - cotas posições
4 - configuração 2
5 - cotas configuração 2
6 - configuração 1

arq.: Exemplo_11_2.dv

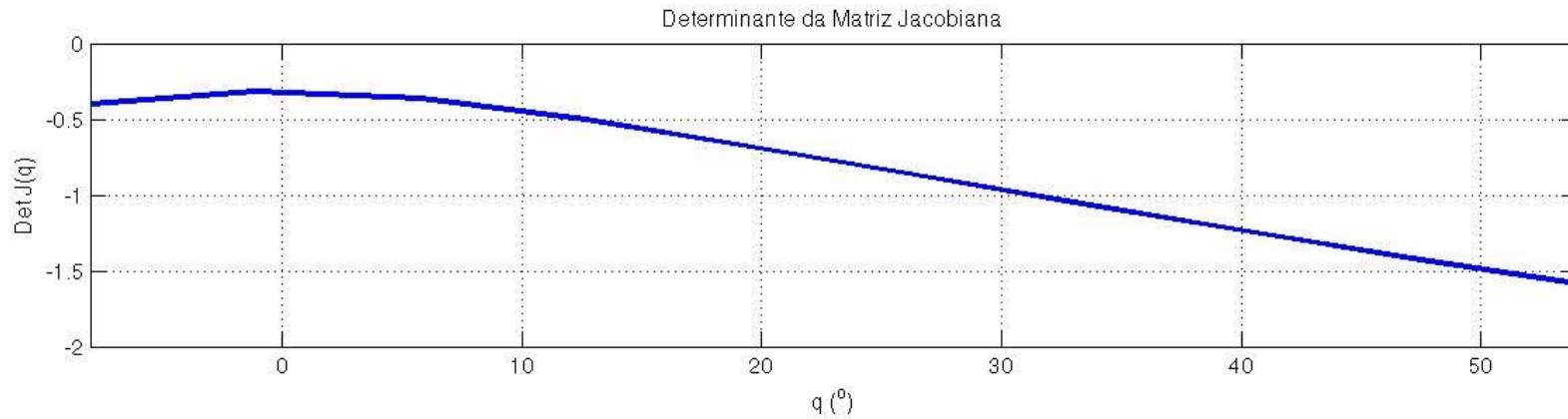
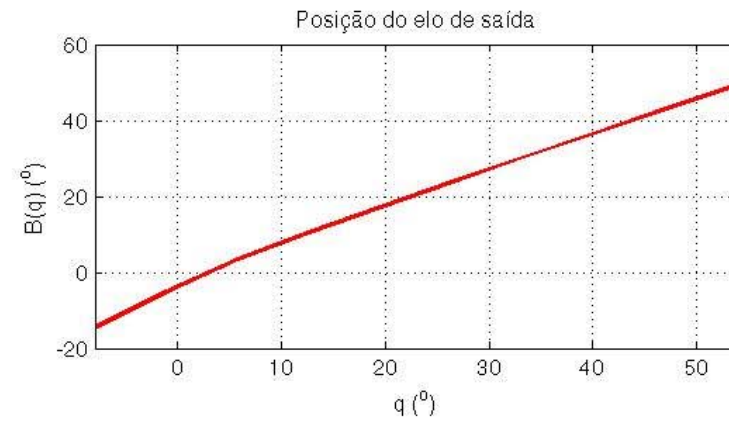
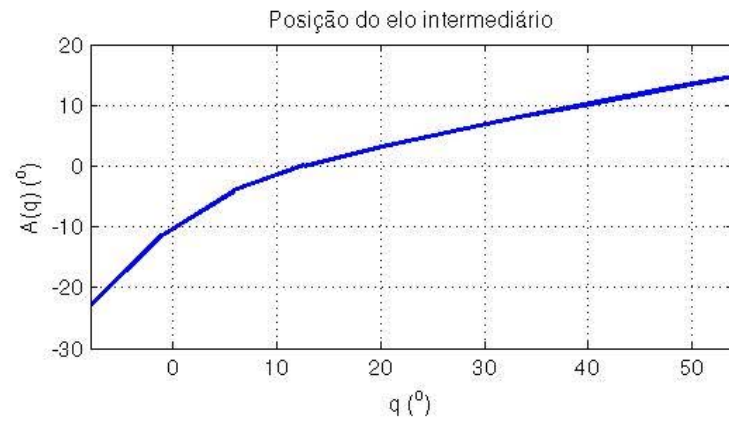
Layer: 1 DesignView - Copyright © Computervision Corp. 1987-1994

11:26
06/04/2015

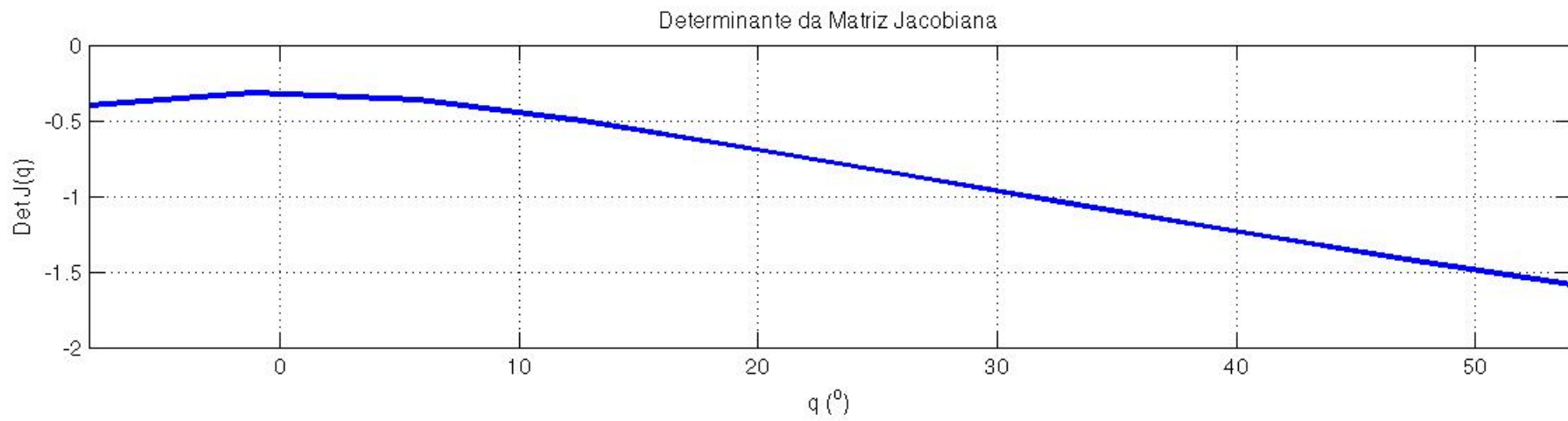
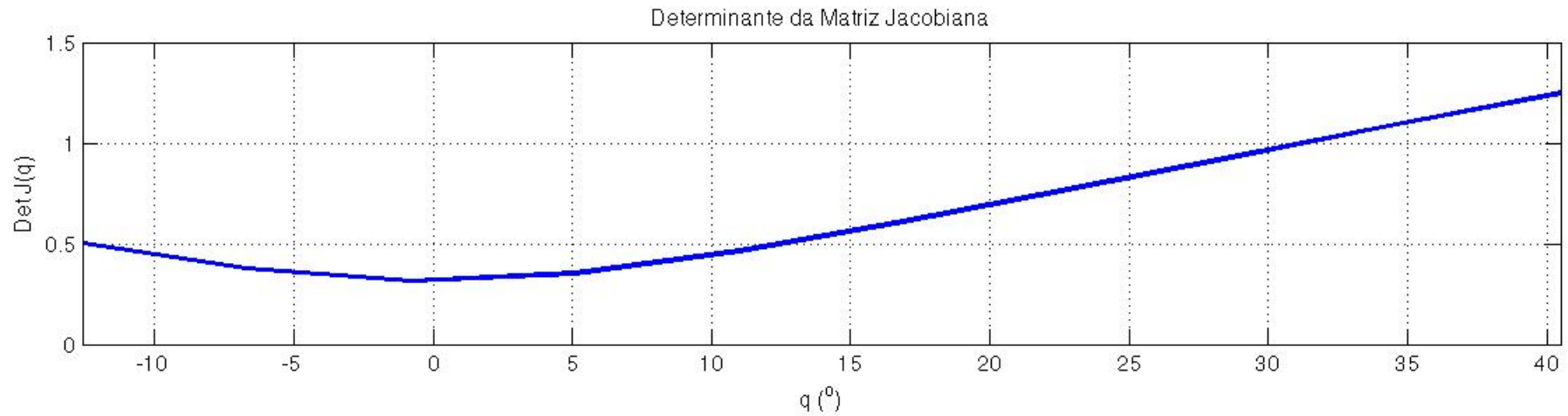
configuração 1



configuração 2



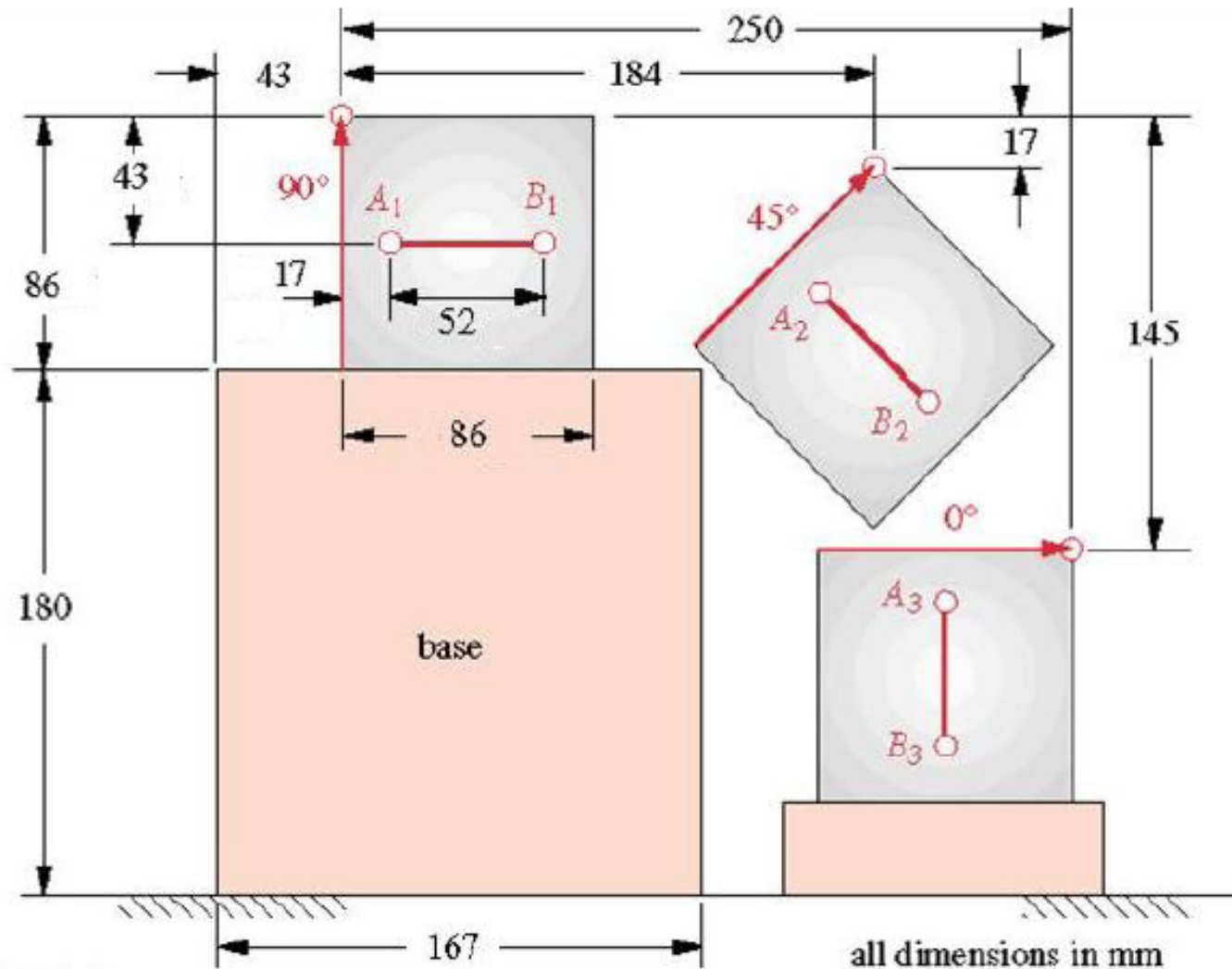
configurações 1 e 2



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