Universitas
Pembangunan Jaya

Mata Kuliah : Statika
Kode : CVL – 104
SKS : 3 SKS

SISTEM GAYA

Pertemuan - 2

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- TIU :
  - Mahasiswa dapat menjelaskan tentang prinsip keseimbangan, uraian, dan penjumlahan gaya.
- TIK :
  - Mahasiswa dapat menjelaskan Sistem Gaya

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- Sub Pokok Bahasan :
  - Gaya
  - Momen
  - Gaya dua Dimensi
  - Gaya Tiga Dimensi

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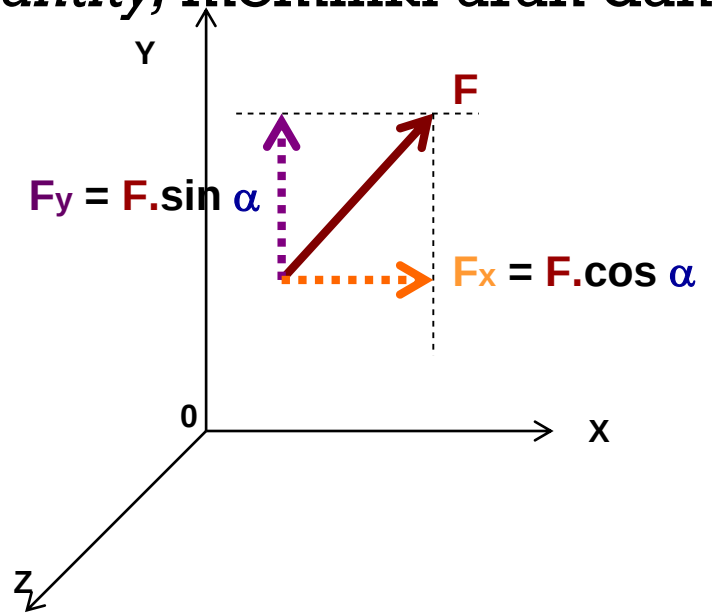
Gaya (Force)

- Aksi suatu benda kepada benda lain
- Aksi yang menyebabkan akselerasi sebuah benda (dynamics)
- Gaya = *Vector quantity,* memiliki arah dan *magnitude*



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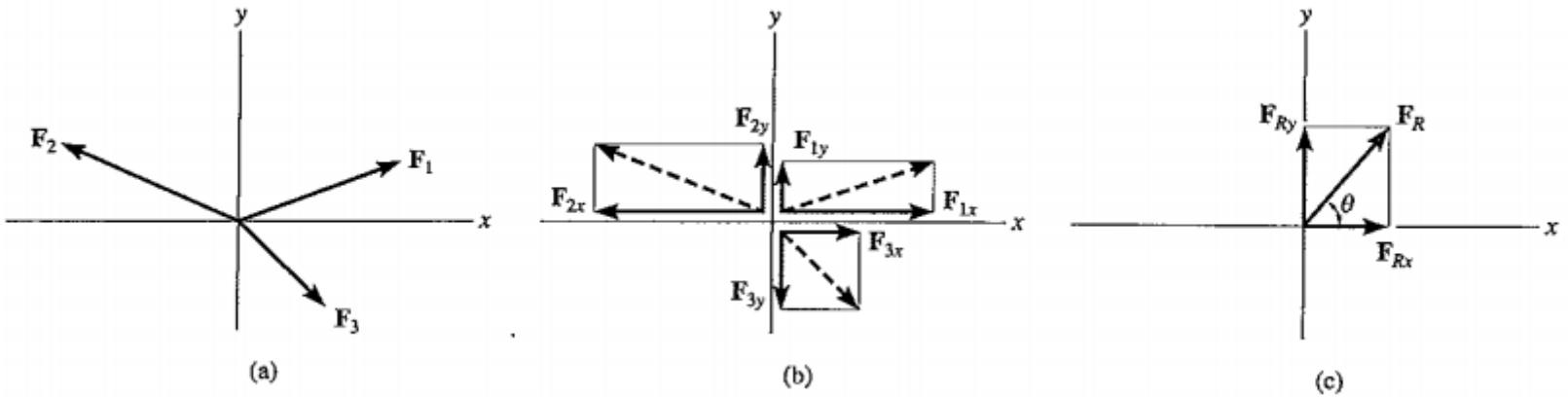
Coplanar Force Resultant

$$F_{R,x} = \sum F_x$$

$$F_{R,y} = \sum F_y$$

$$F_R = \sqrt{{F_{R,x}}^2 + {F_{R,y}}^2}$$

$$\theta = tan^{-1}\left(\frac{F_{R,y}}{F_{R,x}}\right)$$



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Important Points :

- The resultant of several coplanar forces can easily be determined if an x, y coordinate system is established and the forces are resolved along the axes.
- The direction of each force is specified by the angle its line of action makes with one of the axes, or by a slope triangle.
- The orientation of the *x* and *y* axes is arbitrary, and their positive direction can be specified by the Cartesian unit vectors **i** and **j**.
- The *x* and *y* components of the *resultant force* are simply the algebraic addition of the components of all the coplanar forces
- The magnitude of the resultant force is determined from the Pythagorean theorem, and when the resultant components are sketched on the *x* and *y* axes,

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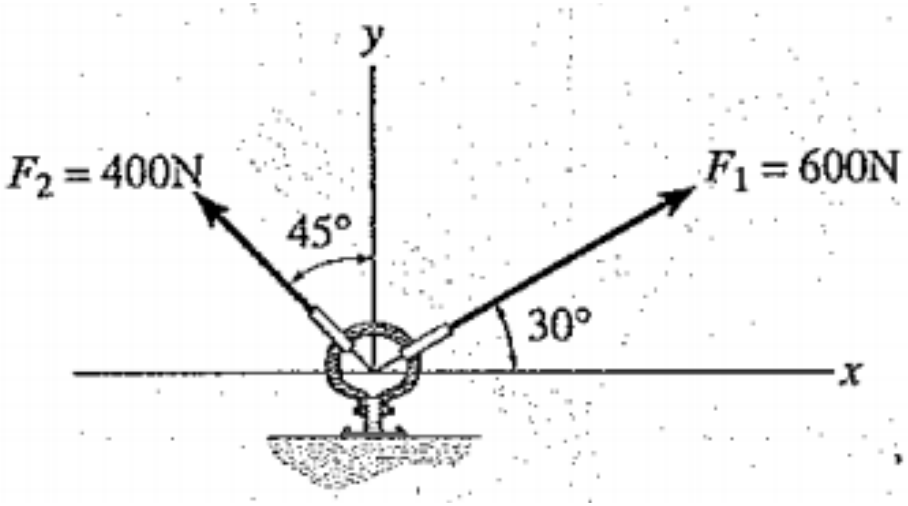
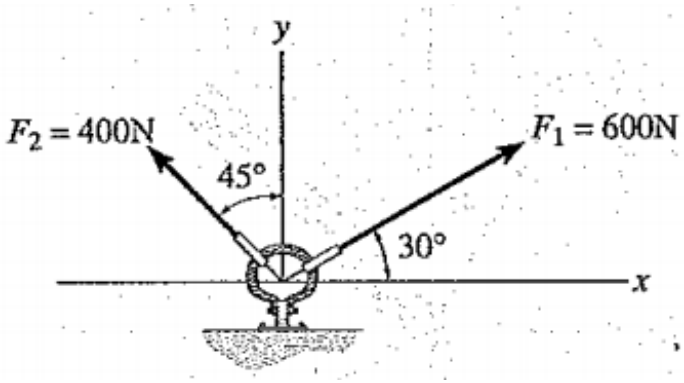
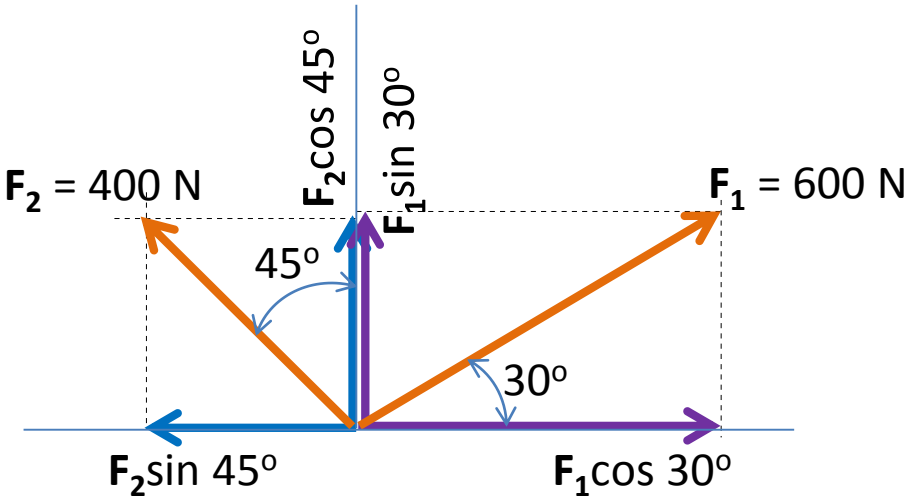
Example 1

- The link in fig. is subjected to two forces F_1 and F_2. Determine the magnitude and orientation of the resultant force.





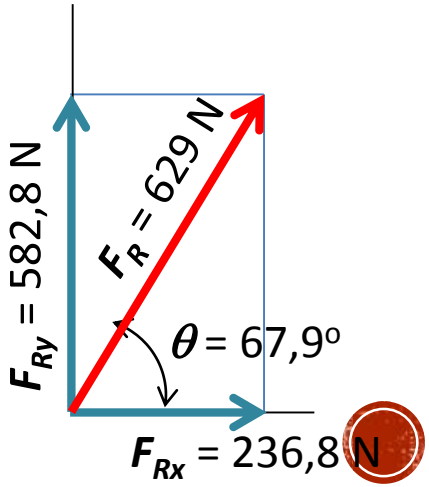


$$\xrightarrow{+} F_{Rx} = \sum F_x; \quad F_{Rx} = 600\cos 30^o - 400\sin 45^o = 236{,}8N(\rightarrow)$$

$$+\uparrow F_{Ry} = \sum F_y; \quad F_{Ry} = 600\sin 30^o + 400\cos 45^o = 582{,}8N(\uparrow)$$

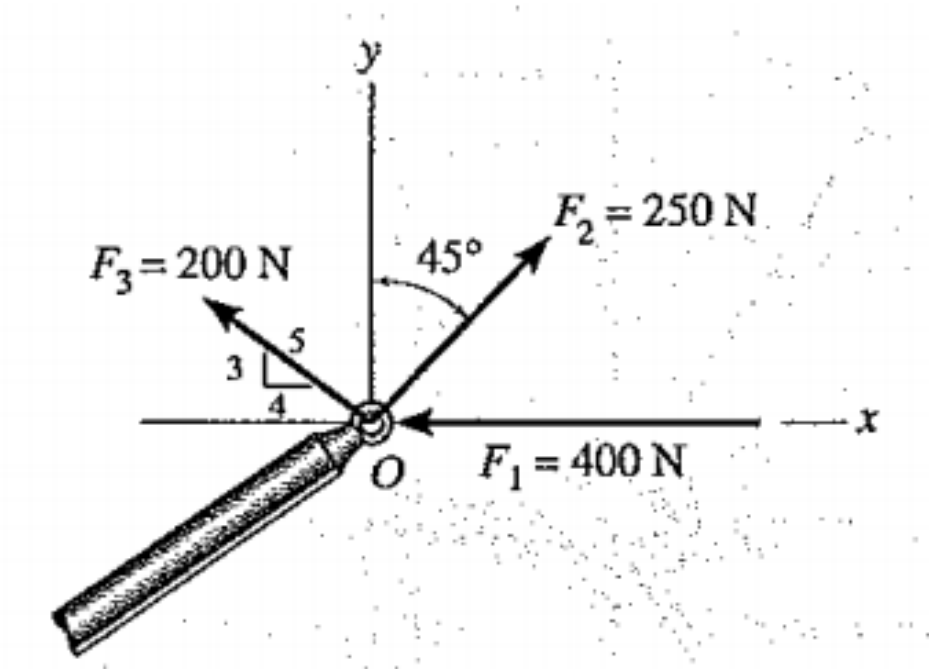
$$F_R = \sqrt{236{,}8^2 + 582{,}8^2} = 629N$$

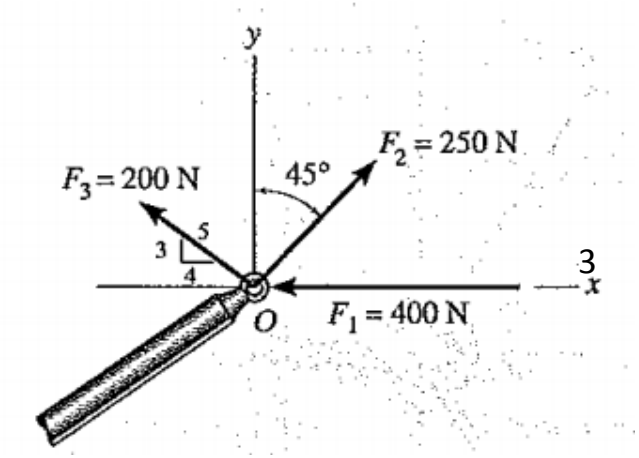
$$\theta = tan^{-1}\left(\frac{582{,}8}{236{,}8}\right) = 67{,}9^o$$

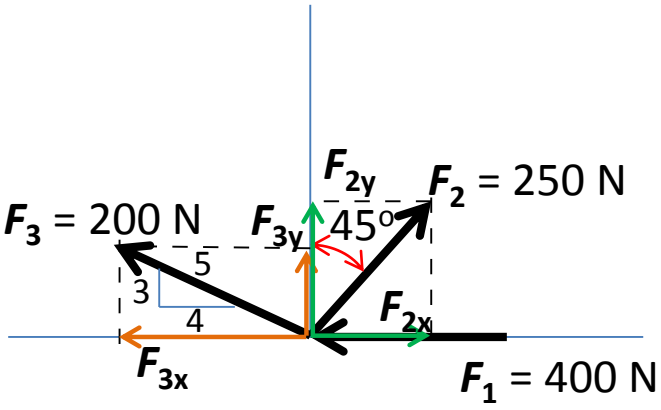


Example 2

- Determine the magnitude and orientation of the resultant force.





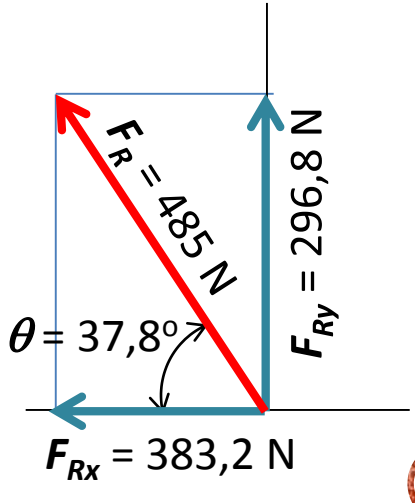


$$\xrightarrow{+} F_{Rx} = \sum F_x; \quad F_{Rx} = -400 + 250\,sin\,45^o - 200\left(\frac{4}{5}\right) = -383{,}2N = 383{,}2N(\leftarrow)$$

$$+\uparrow F_{Ry} = \sum F_y; \quad F_{Ry} = 250\,cos\,45^o + 200\left(\frac{3}{5}\right) = 296{,}8N(\uparrow)$$

$$F_R = \sqrt{(-383{,}2)^2 + 296{,}8^2} = 485N$$

$$\theta = tan^{-1}\left(\frac{296{,}8}{383{,}2}\right) = 37{,}8$$



Transmissibility

a force may be moved along its action line without changing the external effect of it procedures in body

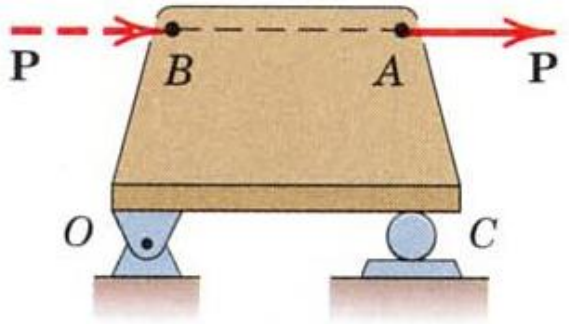
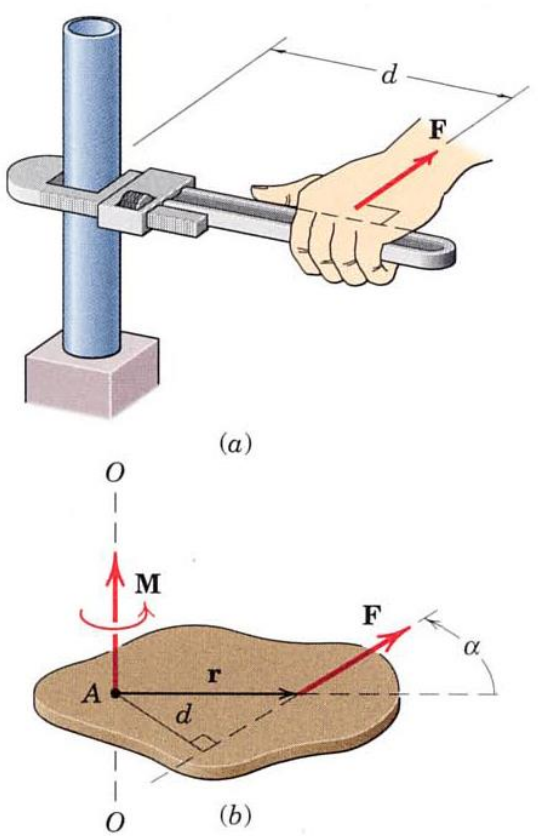


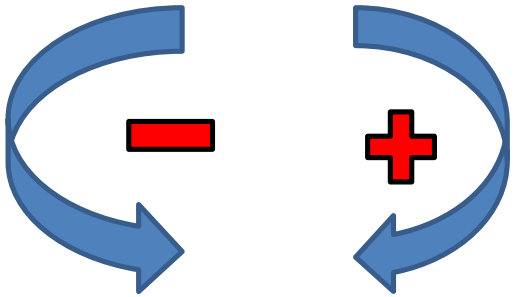
Figure 2/2

Momen :

Kecenderungan gaya untuk memutar benda terhadap suatu sumbu.

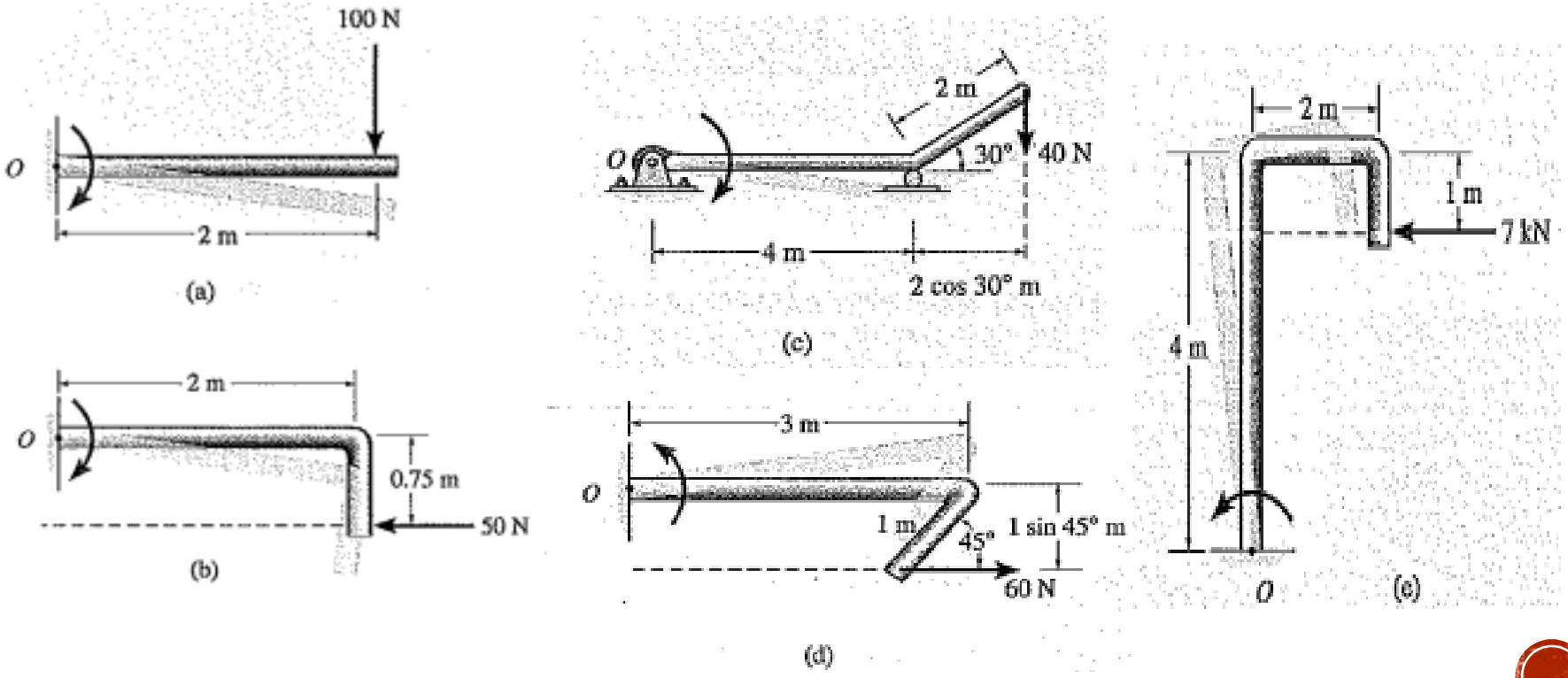


$$M = F \cdot d$$



Example 2

For each case determine the moment of the force about point O.



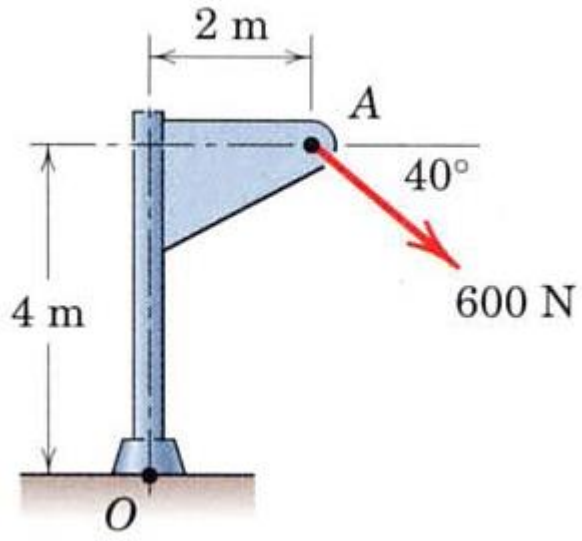
- Salah satu dari prinsip mekanika yang cukup penting adalah **Teorema Varignon**, atau prinsip penjumlahan momen, yang menyatakan bahwa :

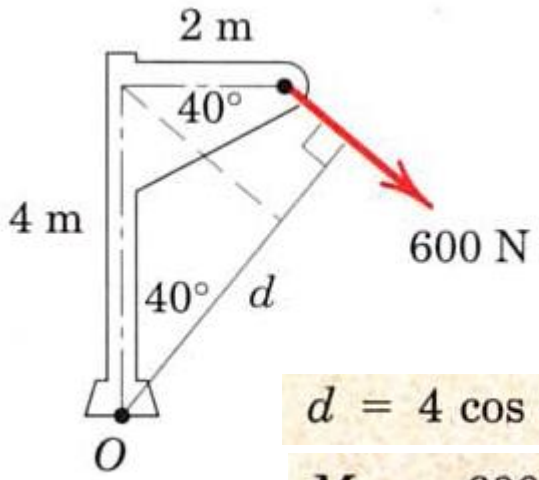
" Momen dari sebuah gaya terhadap suatu titik adalah sama dengan jumlah momen dari komponen-komponen gayanya terhadap titik yang sama".

- Untuk pembuktiannya dapat dilihat dalam contoh soal berikut

Example 3

Hitunglah momen terhadap titik O akibat gaya 600 N seperti pada gambar.

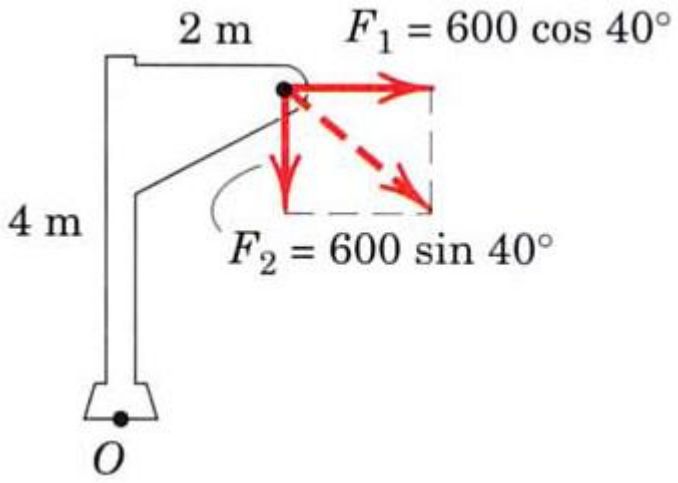




$$d = 4 \cos 40° + 2 \sin 40° = 4.35 \text{ m}$$

$$M_O = 600(4.35) = 2610 \text{ N} \cdot \text{m}$$

Uraikan gaya 600 N pada titik A menjadi komponen gaya terhadap sumbu *x* dan *y*



D ka Mo

$$F_1 = 600 \cos 40° = 460 \text{ N}$$

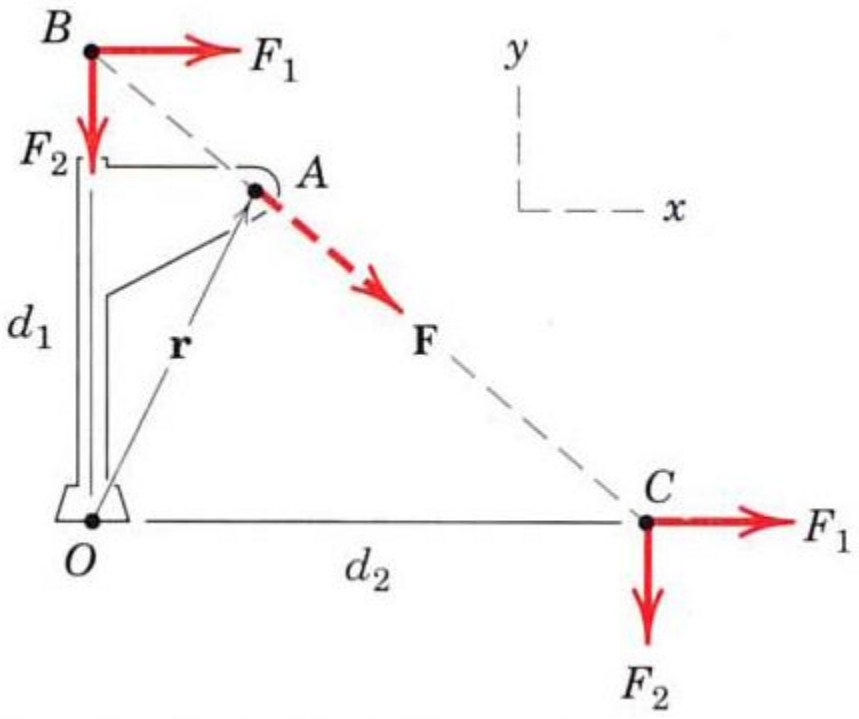
$$F_2 = 600 \sin 40° = 386 \text{ N}$$

$$M_O = 460(4) + 386(2) = 2610 \text{ N} \cdot \text{m}$$

Dengan prinsip transisibility, pindahkan komponen gaya 600 N ke titik B (yang menghilangkan Momen pengaruh gaya F_2 terhadap titik O).

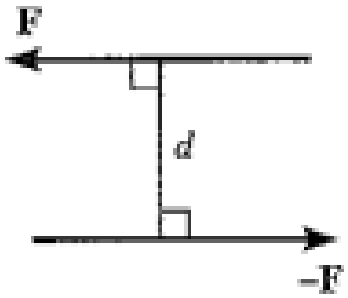
Lengan Momen F_1 terhadap O : $d_1 = 4 + 2 \tan 40° = 5.68 \text{ m}$

$$M_O = 460(5.68) = 2610 \text{ N·m}$$



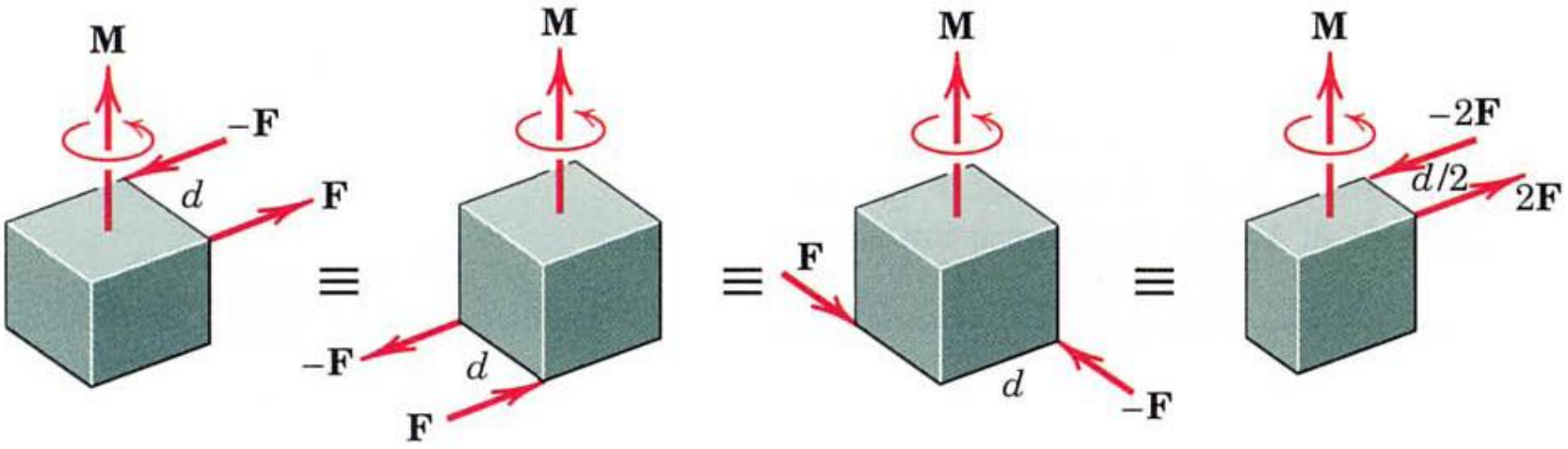
Kopel

Dua gaya yang sejajar, sama besar dan tidak segaris kerja.



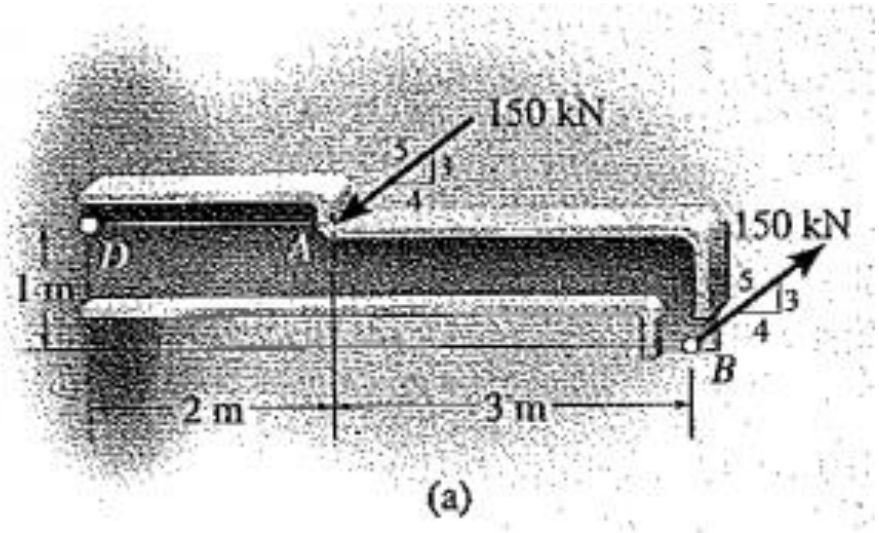
$$M = F \cdot d$$

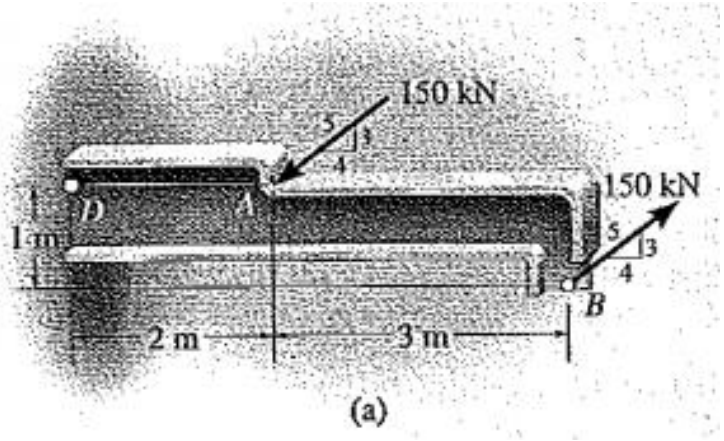
Kopel tidak berubah selama besar dan arah vektornya tidak berubah. Suatu kopel tidak akan berubah oleh pergantian harga dari F dan d selama produknya tetap sama. Hal ini bisa dilihat pada Gambar berikut yang menunjukkan empat konfigurasi kopel yang berbeda dengan hasil kopel yang sama M = Fd.

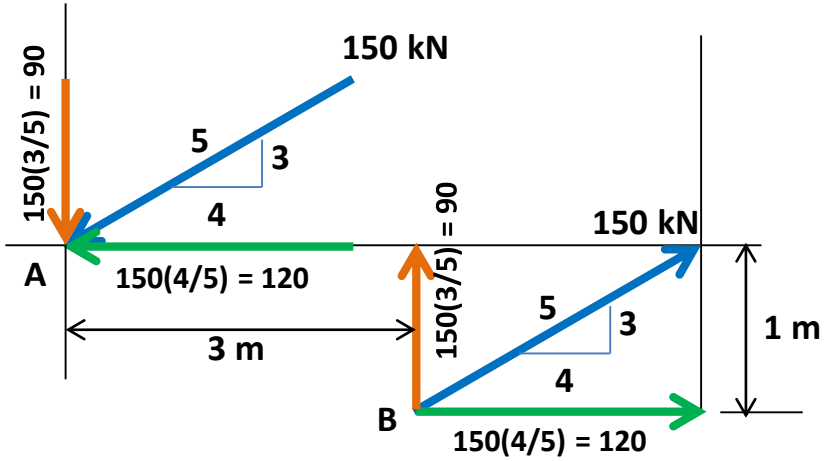


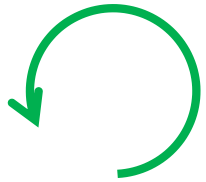
Example 4

- Determine the moment of the couple acting on the member shown in figure



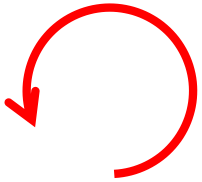






120× 1 = **120 kN·m**

90× 3 = **270 kN·m**



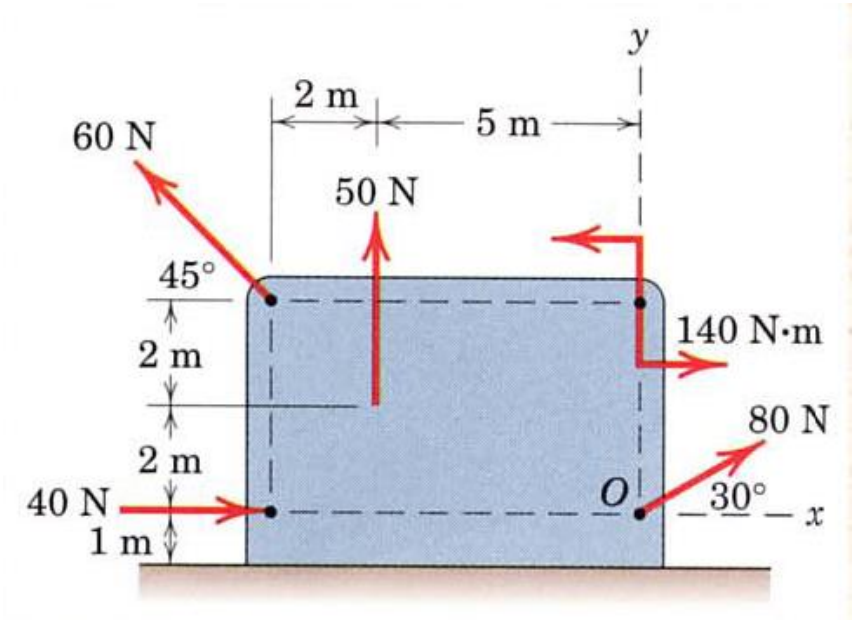
120+270 = 390 kN·m

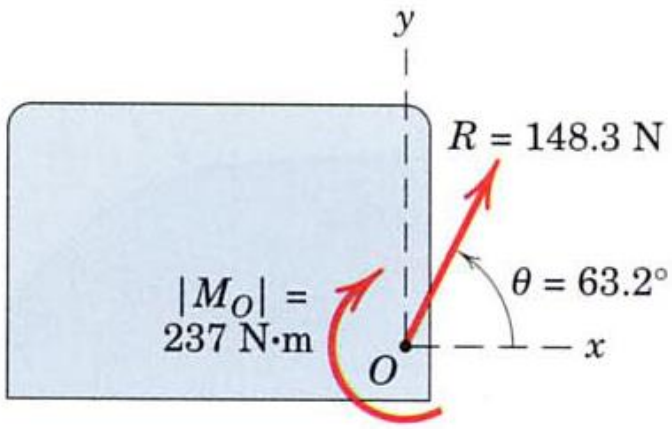
Resultante Dari Sistem-Sistem Gaya

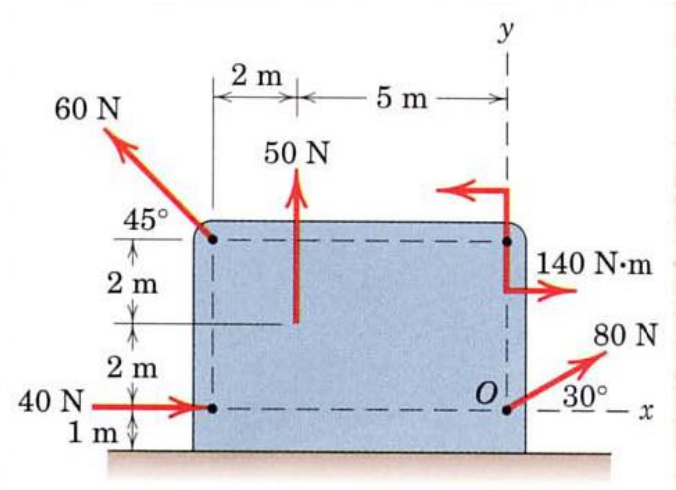
- Resultante gaya-gaya dari suatu sistem gaya adalah gaya tunggal pada sistem gaya dimana dapat menggantikan gaya-gaya asli dari suatu sistem gaya tanpa merubah pengaruh luar pada suatu benda kaku. Keseimbangan pada sebuah benda adalah keadaan dimana resultante dari semua gayanya sama dengan nol.
- Sifat-sifat gaya, momen, dan kopel yang telah dibahas dalam sub bab terdahulu sekarang akan dipakai dalam menentukan resultante dari sistem-sistem gaya yang sebidang.

Example 5

Tentukan Resultant dari gaya dan kopel berikut pada titik O







$$[R_x = \Sigma F_x] \qquad R_x = 40 + 80\cos 30° - 60\cos 45° = 66.9 \text{ N}$$

$$[R_y = \Sigma F_y] \qquad R_y = 50 + 80\sin 30° + 60\cos 45° = 132.4 \text{ N}$$

$$[R = \sqrt{R_x^2 + R_y^2}] \qquad R = \sqrt{(66.9)^2 + (132.4)^2} = 148.3 \text{ N}$$

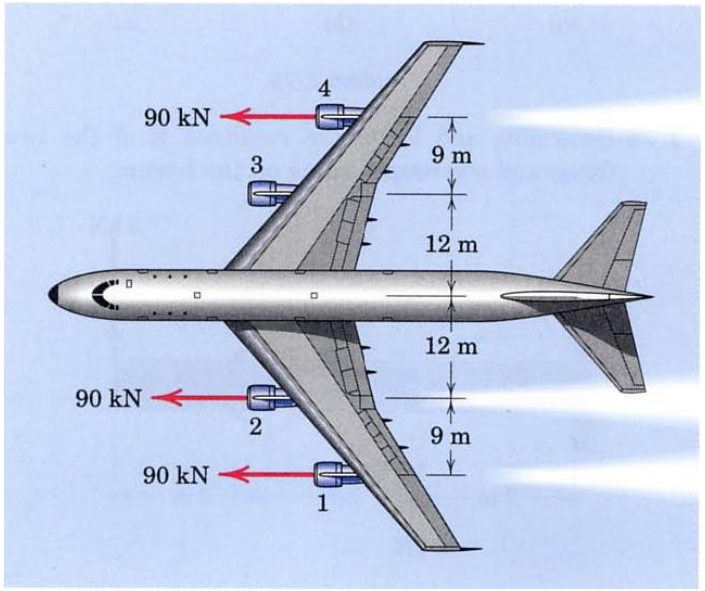
$$\left[\theta = \tan^{-1}\frac{R_y}{R_x}\right] \qquad \theta = \tan^{-1}\frac{132.4}{66.9} = 63.2°$$

$$[M_O = \Sigma(Fd)] \qquad M_O = 140 - 50(5) + 60\cos 45°(4) - 60\sin 45°(7)$$

$$= -237 \text{ N}\cdot\text{m}$$

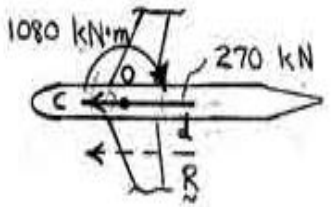
- **Example 5**

A commercial airliner with four jet engines, each producing 90 kN of forward thrust, is in a steady, level cruise when engine number 3 suddenly fails. Determine and locate the resultant of the three remaining engine thrust vectors. Treat this as a two-dimensional problem.



Force-Couple system at point O:

$$\begin{cases} R = 3(90) = 270\ \text{kN} \ (\leftarrow) \\ +\circlearrowleft M_O = 12(90) = 1080\ \text{kN}\cdot\text{m} \end{cases}$$



$$d = \frac{M_O}{R} = \frac{1080}{270} = 4\ \text{m}$$

Assignment (1 Kelompok = 5 Orang)

- Tentukan Pengaruh momen gaya-gaya berikut pada titik A dan letak resultant gaya tersebut pada balok