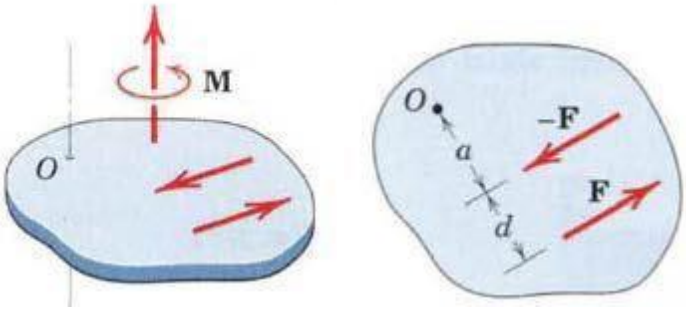
Al-Mustaqbal University / College of Engineering & Technology
Electrical Techniques Engineering Department Class (1st)
Subject (Engineering Mechanics) / Code (UOMU025021)
Lecturer (Msc Hiba Mohsin AL-Bawi)
1stterm – Lecture No.6

Couples

The moment produced by two equal, opposite, and noncollinear forces is called a *couple*. Couples have certain unique properties and have important applications in mechanics. Consider the action of two equal and opposite forces **F** and **- F** a distance *d* apart, as shown in Figure. This two force s cannot be combined into a single force because their sum in every direction is zero. Their on ly effect is to produce a tendency of rotation. The combined moment of the two forces about an axis normal to their plane and passing through any point such as a in their plane is the couple M.

This couple has a magnitude



M= F (a + d) – Fa

Or

M = Fd

E-mail: hiba.mohsin.abd@uomus.edu.iq

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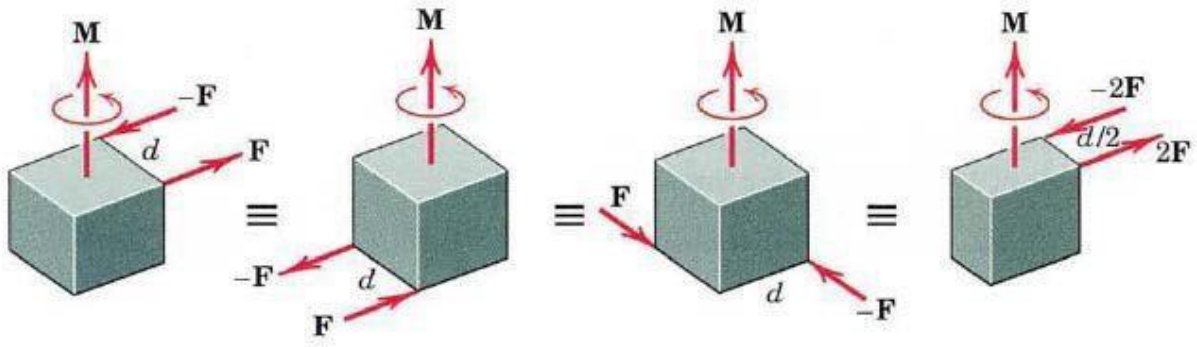
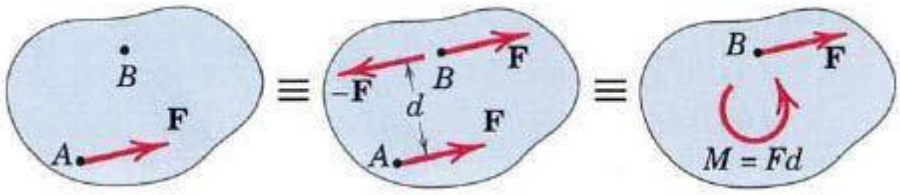
Equivalent Couples

Changing the values of **F** and **d** does not change a give n couple as long as the product **Fd** remains the same. Likewise, a couple is not affected if the forces act in a different but parallel plan e. Figure shows four different configurations of the same couple **M**. In each of the four cases, the couples are equivalent and are described by the same free vector which represents the identical tendencies to rotate the bodies.



Force-Couple Systems

The replacement of a force by a force and a couple is illustrated in Figure, where the given force F acting at point A is replaced by an equal force F at some point B and the counterclockwise couple M = Fd.



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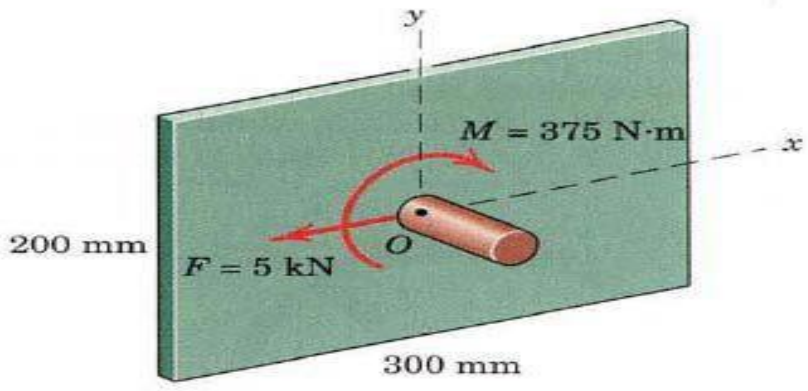
Example 1

The indicated force- couple system is applied to a small shaft at the center of the rectangular plate. Replace this system by a single force and specify the coordinate of the point on the y-axis through which the line of action of this resultant force passes.



$M_O = Fd$

$375 = 5\times 1000\ d$

$375=5000\ d$

$d= \frac{375}{5000}$

$= 0.075$ m

$d= 0.075 \times 1000 = 75$mm

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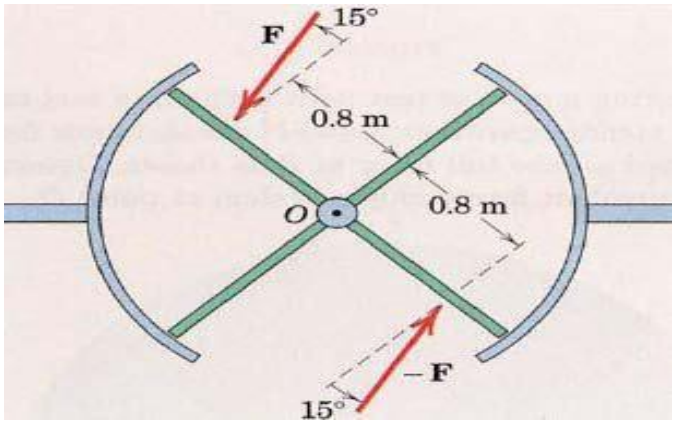
Example 2

The top view of a revolving entrance door is shown. Two persons simultaneously approach the door and exert forces of equal magnitudes as shown. If the resulting moment about the door pivot axis at O is 25 N .m, determine the force magnitude F.



$M_O = Fd$

$25 = 2\,F(\cos 15^o) \times 0.8$

$$F = \frac{25}{2\,(\cos 15o) \times 0.8}$$

F=16.176 N