محاضرة رقم 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

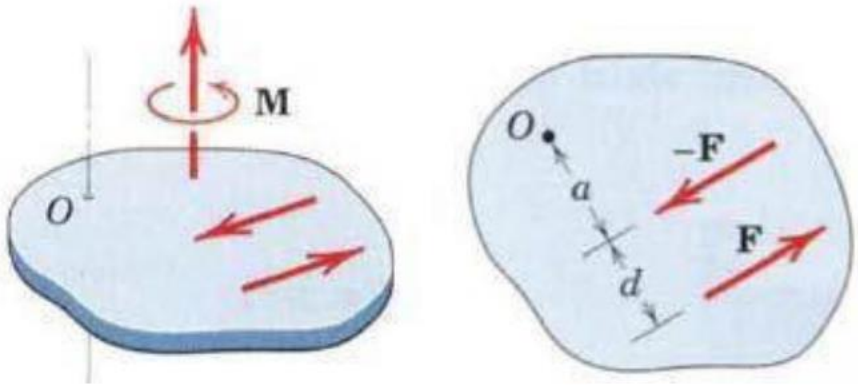
in Figure. This two force s cannot be combined into a single force because their sum in every

direction is zero. Their only 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



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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

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$$M = F(a + d) - Fa$$

Or

$$M = Fd$$

Equivalent Couples

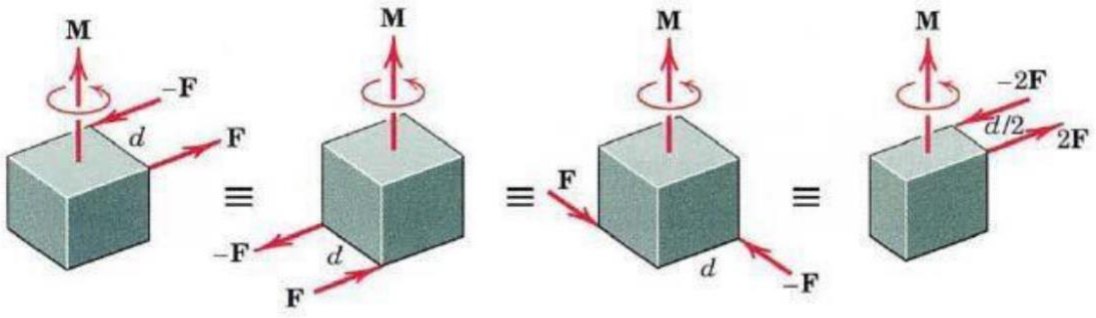
Changing the values of F and d does not change a give n couple as long as the product

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.

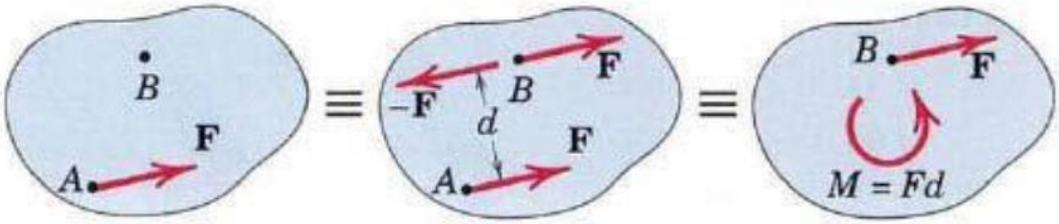


Force-Couple Systems

The replacement of a force by a force and a couple is illustrated in Figure, where the

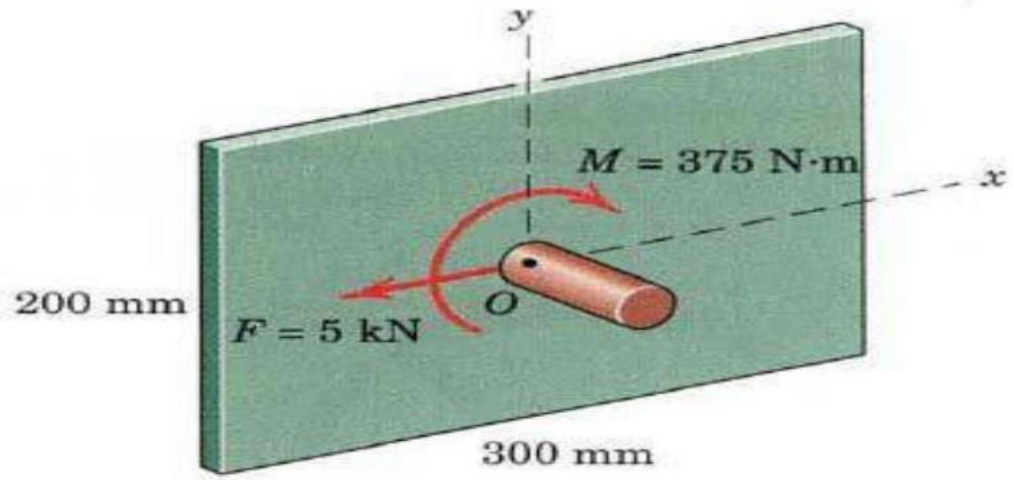
given force F acting at point A is replaced by an equal force F at some point B and the

counterclockwise couple M = Fd



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.



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MO = Fd

375 = 5× 1000 d

375=5000 d

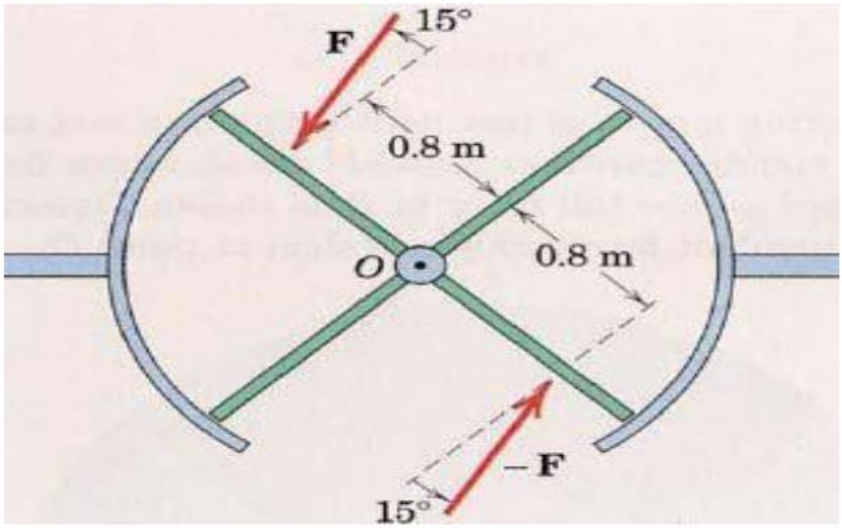
d= $\frac{375}{5000}$

= 0.075 m

d= 0.075 × 1000 = 75mm

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



$$M_O = Fd$$

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

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

$$F = 16.176\ N$$