

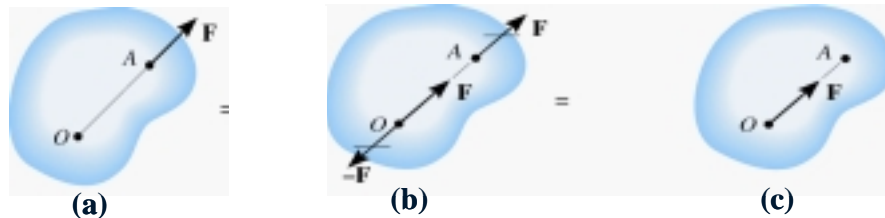
## Forces and Moments: Part 5

### Equivalent system:

An equivalent system is:

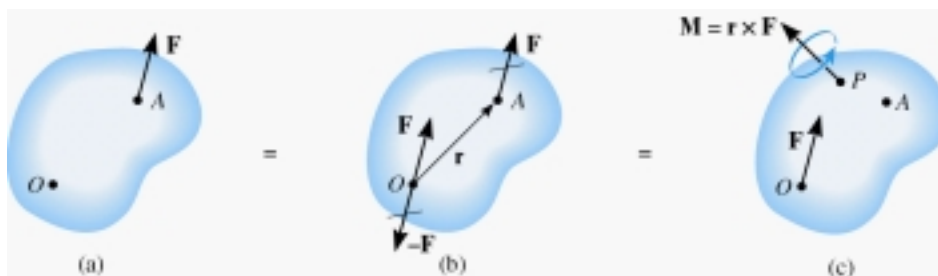
A system in which forces and couple moments acting on a body are simplified to a single resultant force and couple moment acting at a specified point O.

Consider the figure below in which point O is on the line of action of the force:



$\mathbf{F}$  is applied at A (Fig. a). It is needed to move the force  $\mathbf{F}$  to point O (keeping the external effects on the body constant). Imagine we apply  $+\mathbf{F}$  and  $-\mathbf{F}$  at O (Fig. b). As  $+\mathbf{F}$  at A and  $-\mathbf{F}$  at O are cancelled out, hence  $+\mathbf{F}$  is applied at O (Fig. c).

Now if point O is not on the line of action of the force:



Force  $\mathbf{F}$  is applied at A (Fig. a) and OA does not pass through the line of action of  $\mathbf{F}$ . It is needed to move force  $\mathbf{F}$  to O (keeping the external effects on the body constant).

In this case: Apply  $+\mathbf{F}$  and  $-\mathbf{F}$  at O (Fig. b), then  $+\mathbf{F}$  at A and  $-\mathbf{F}$  at O create a couple moment ( $\mathbf{M} = \mathbf{r} \times \mathbf{F}$ ).  $\mathbf{M}$  is a free vector, so remember that it can be applied on any point P (Fig. c)

So,  $\mathbf{F}$  is applied at O and also a moment  $\mathbf{M}$  is produced (Fig. c).