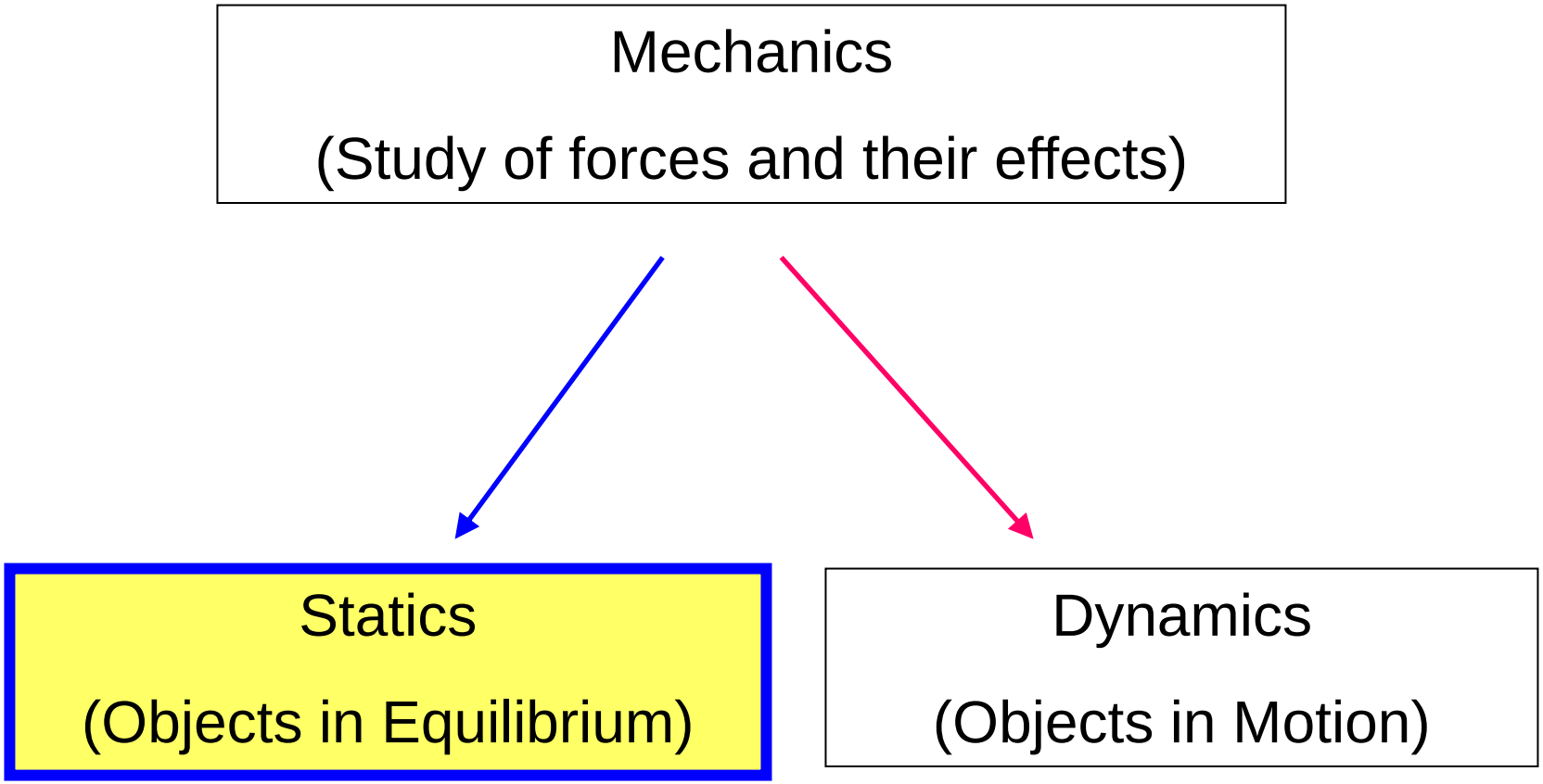
CVLE 211

ENGINEERING MECHANICS I

Engineering & Mechanics



Engineering & Mechanics

Statics

Mechanical and civil engineers use the equilibrium equations derived in statics to design structures.

Dynamics

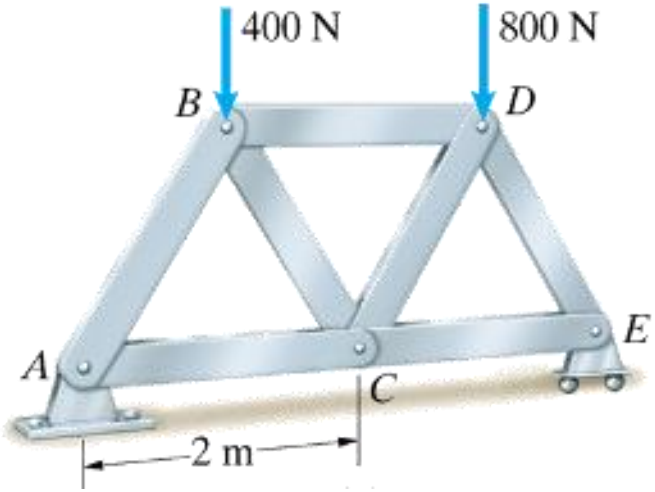
Civil engineers use the equations derived in dynamics to analyze the responses of buildings to earthquakes.

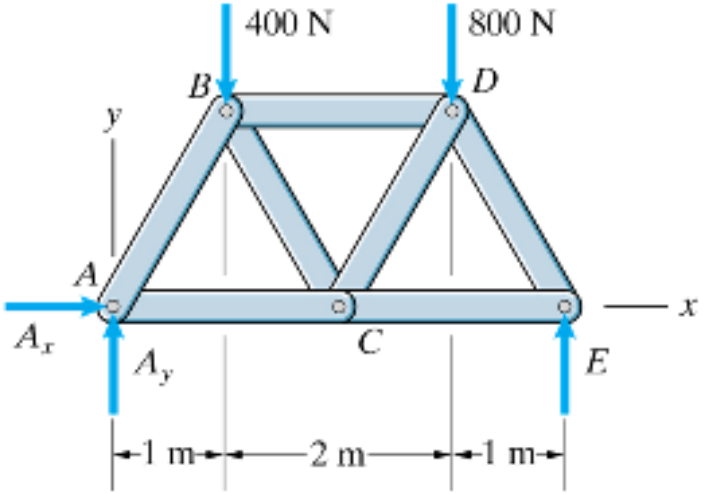
Aerospace engineers use it to determine the trajectories of satellites.

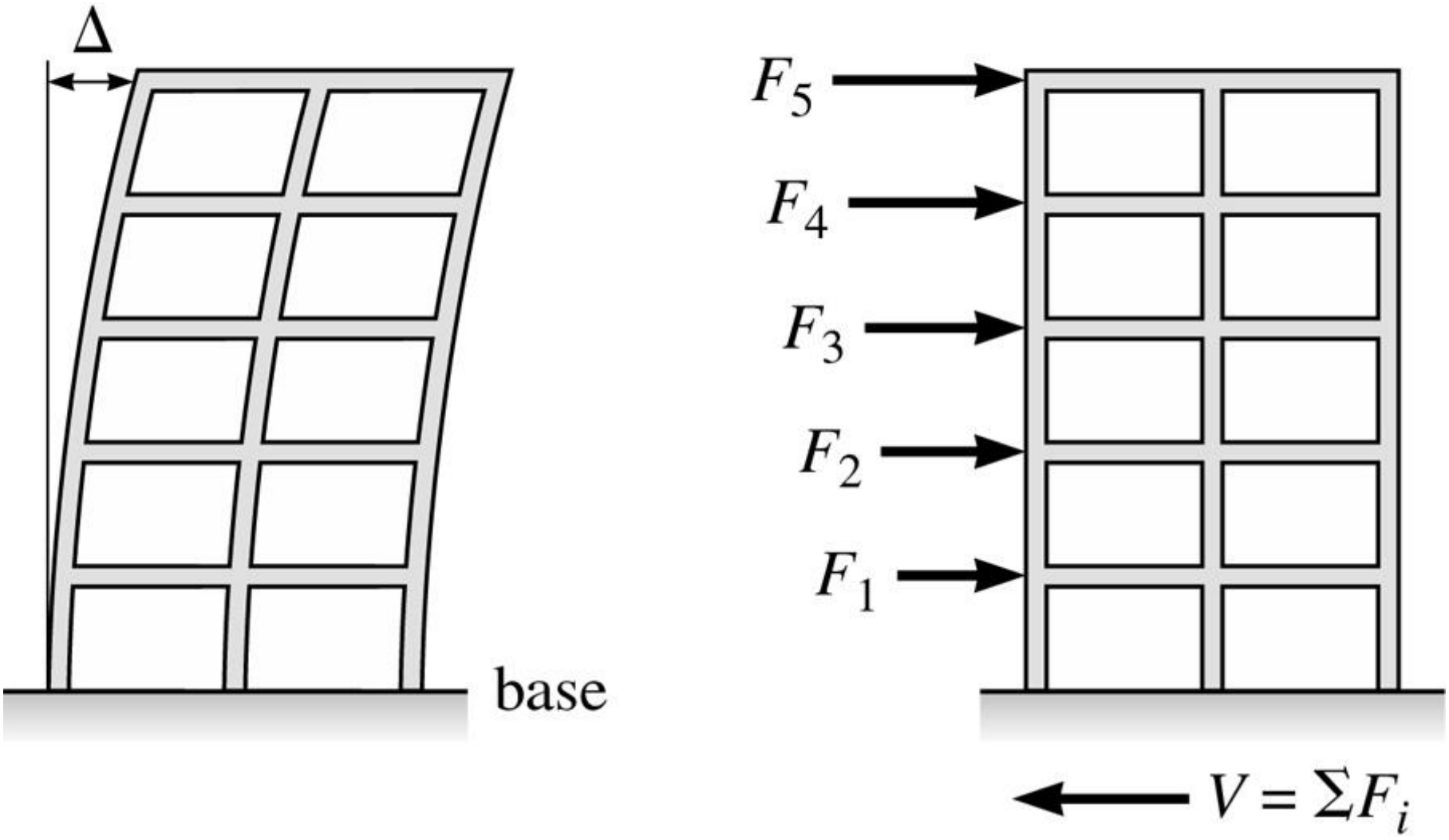
Statics
(Objects in Equilibrium)

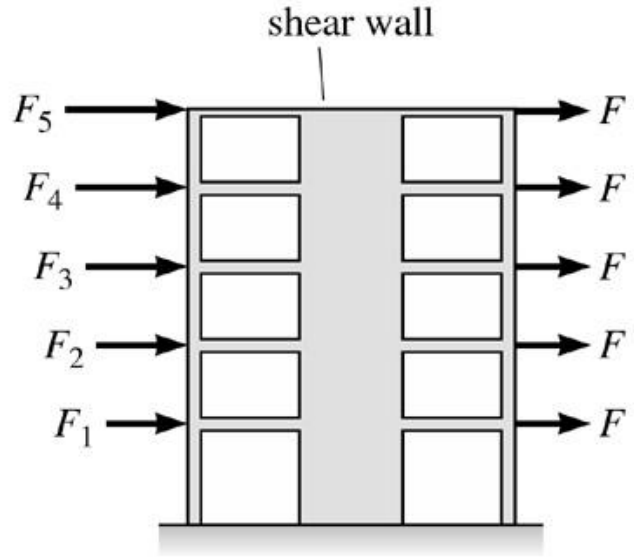
How do Engineers design and construct the devices we use?

Engineers are guided by the principles of statics during each step of the design and assembly of a structure.

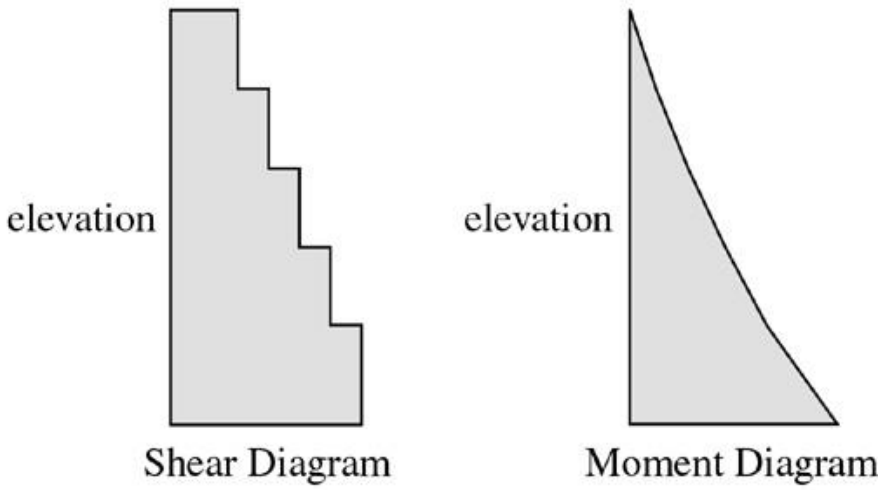

400 N
800 N
B
D
A
C
E
2 m


400 N
800 N
B
D
y
A
x
A_x
A_y
C
E
1 m
2 m
1 m

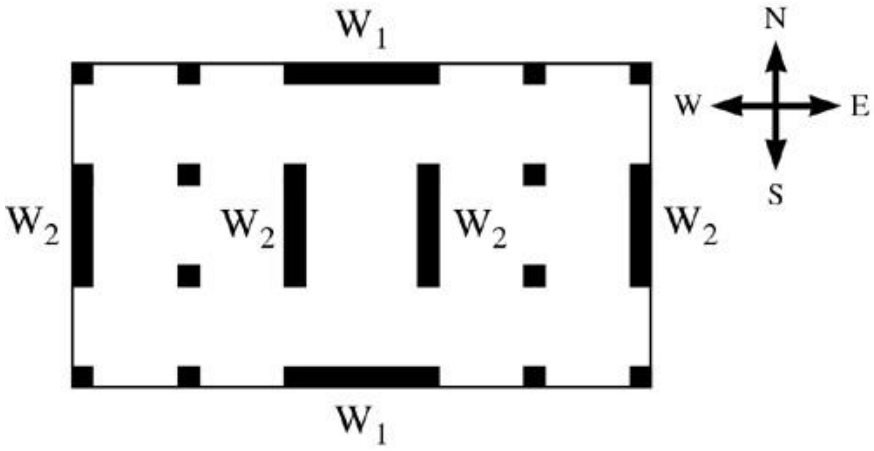

Δ
base
F_5
F_4
F_3
F_2
F_1
$V = \Sigma F_i$
(a)
(b)


shear wall
F_5
F_4
F_3
F_2
F_1
F
F
F
F
F

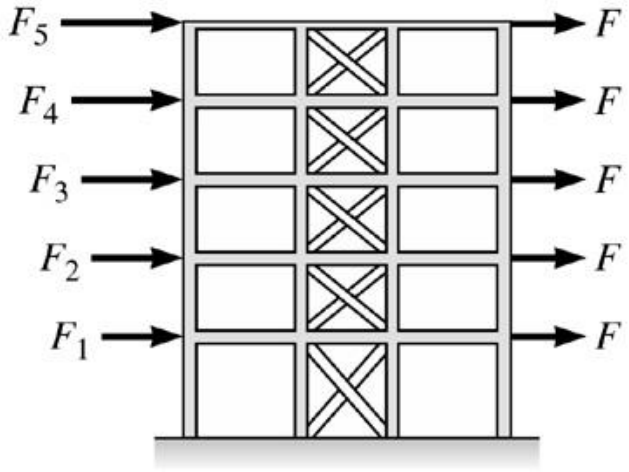
(*a*)


elevation
Shear Diagram
elevation
Moment Diagram

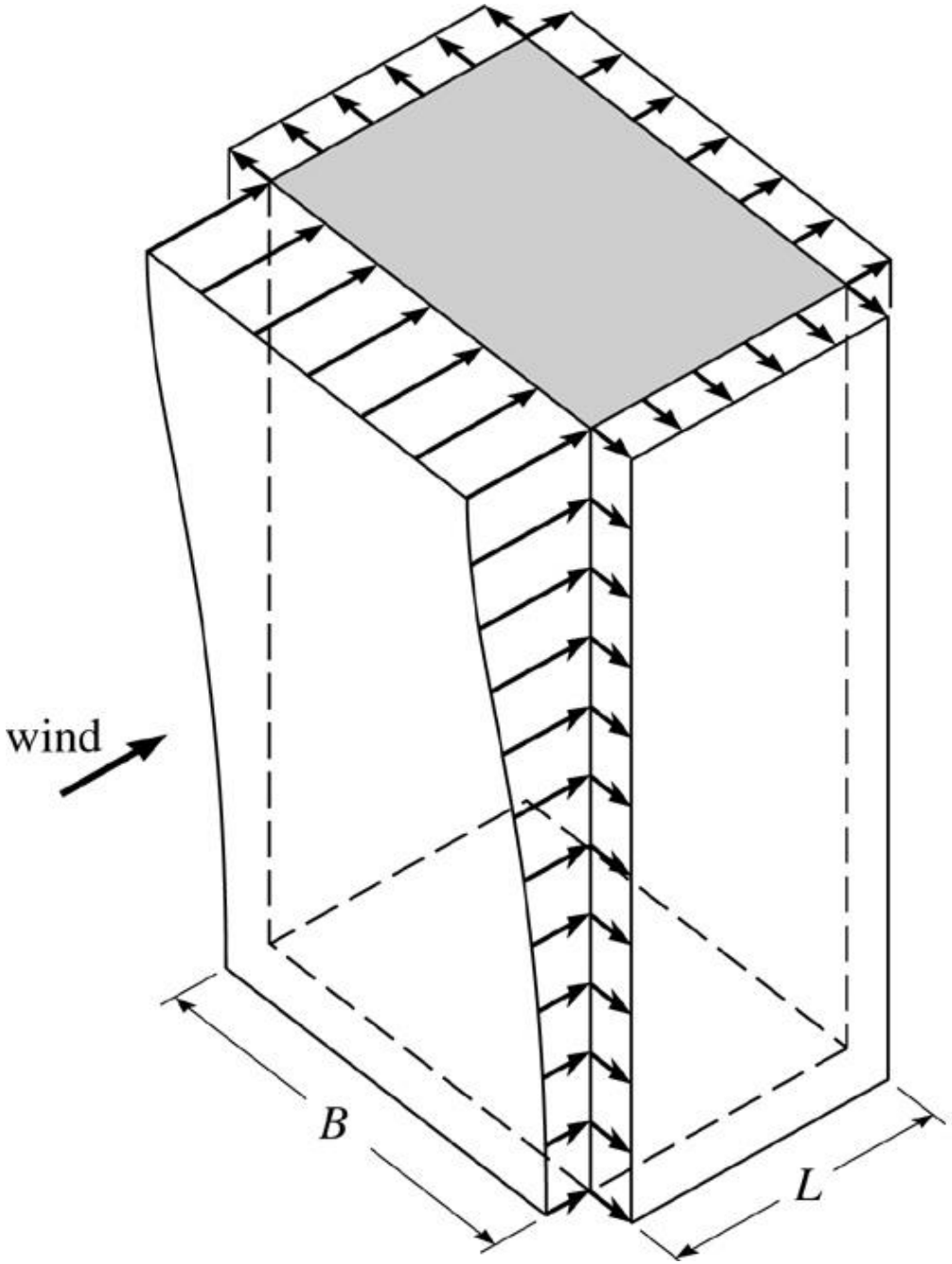
(*b*)

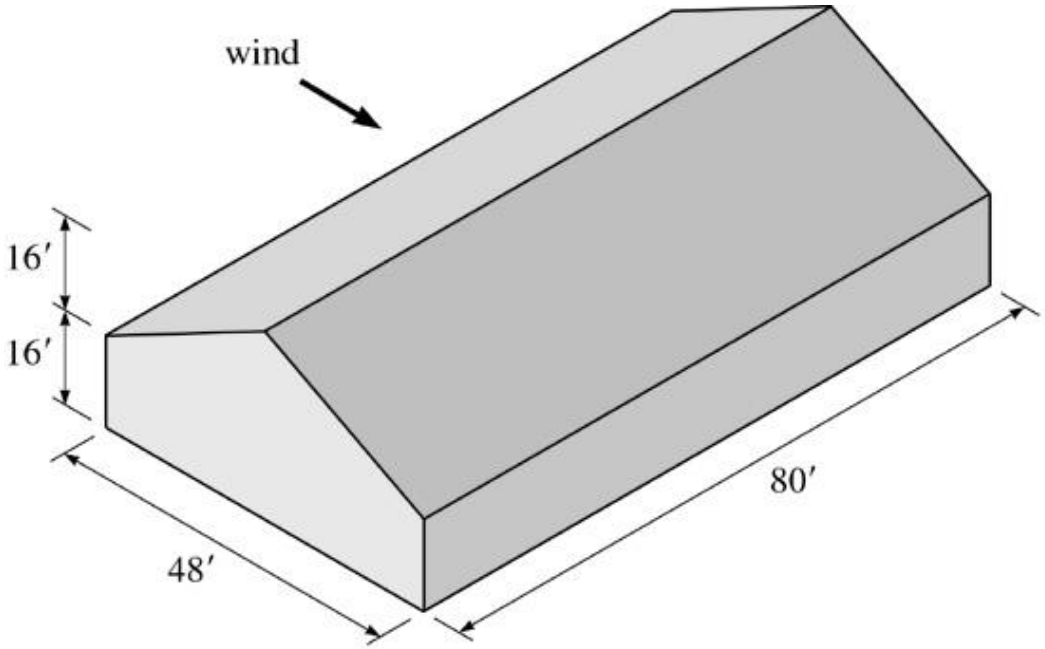

W_1
W_2
W_2
W_2
W_2
W_1
N
W
E
S

(*c*)

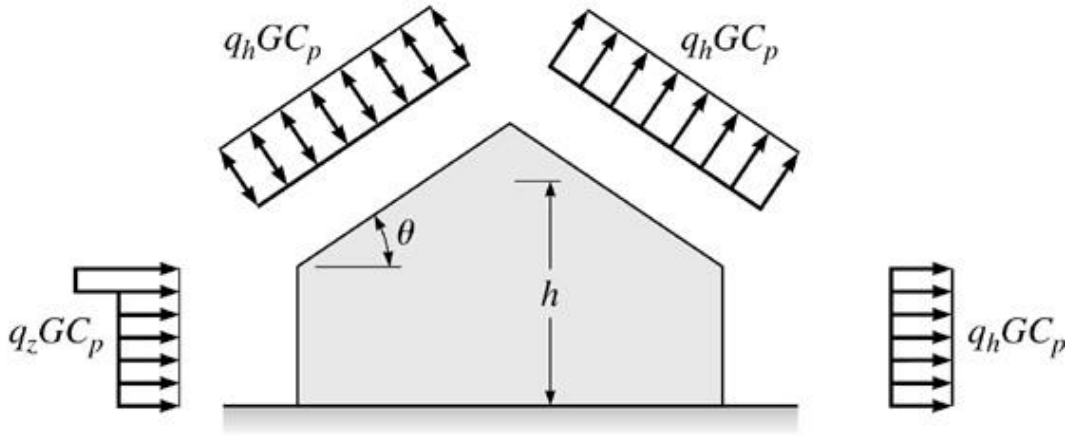

F_5
F_4
F_3
F_2
F_1
F
F
F
F
F

(*d*)

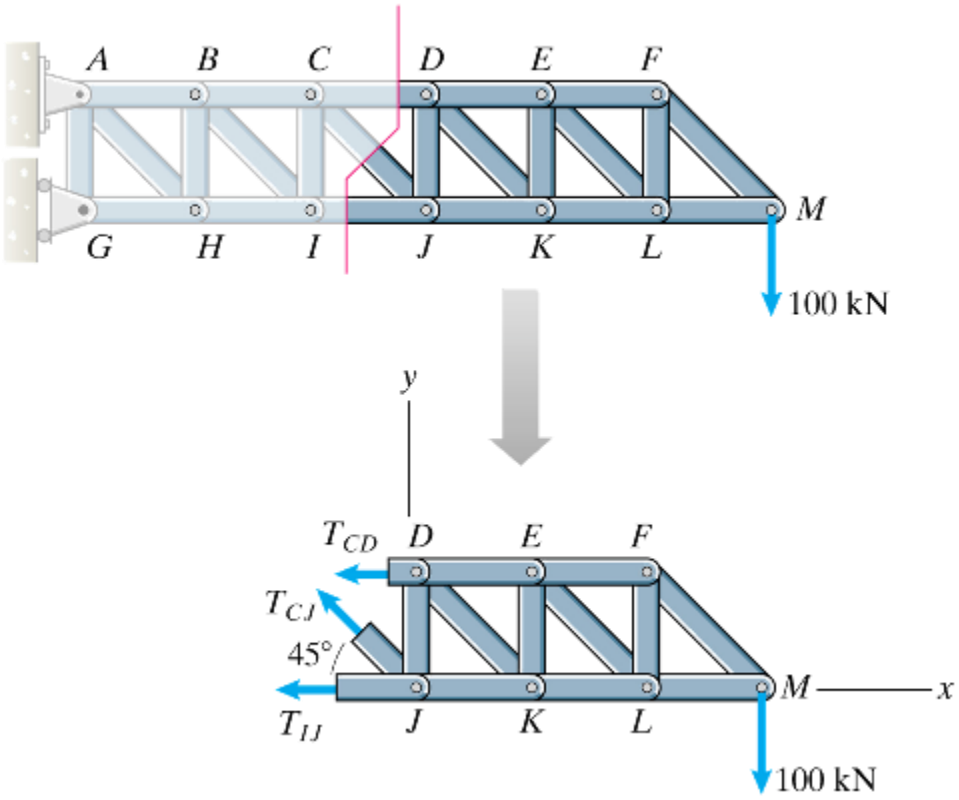

wind
B
L

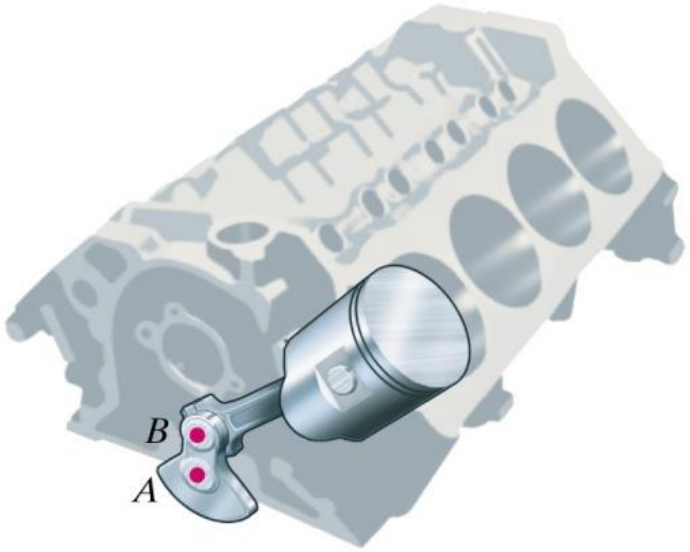


(*a*)

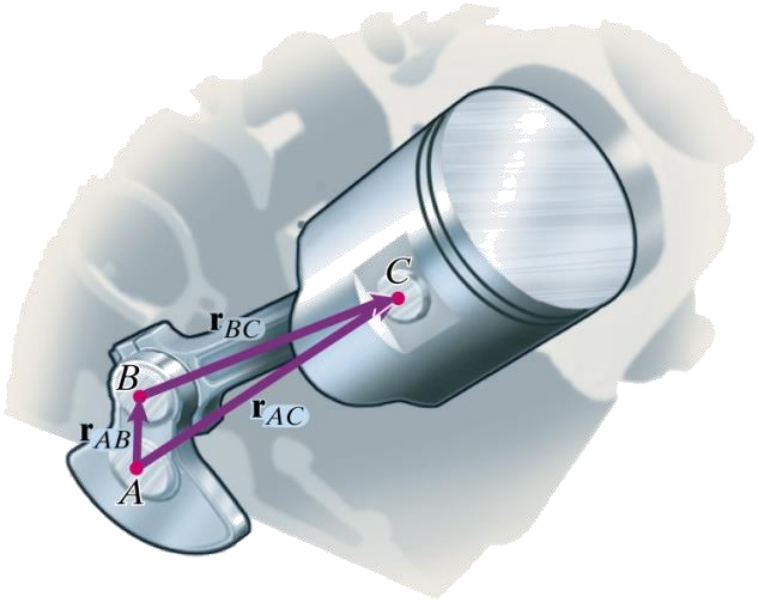


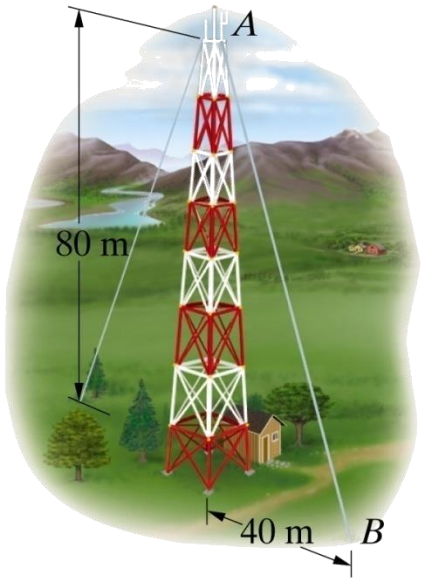
(*b*)

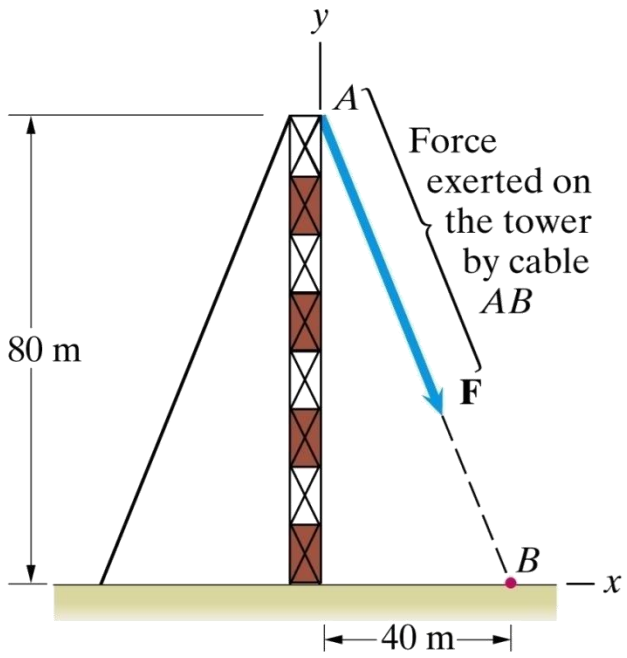

A
B
C
D
E
F
G
H
I
J
K
L
M
100 kN
y
T_{CD}
T_{CJ}
45°
T_{IJ}
x
100 kN



(a)




A
80 m
40 m
B


y
A
Force
exerted on
the tower
by cable
AB
80 m
F
B
x
40 m

STUDY FORCE SYSTEMS

STUDY FORCE SYSTEMS

Coplanar force systems 2D systems

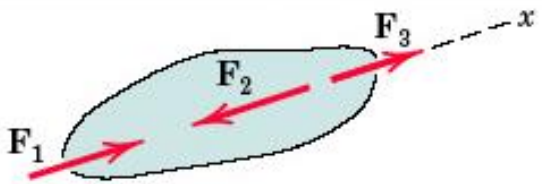
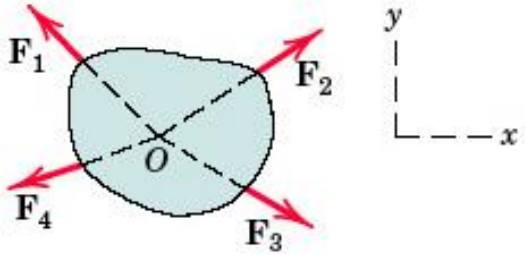
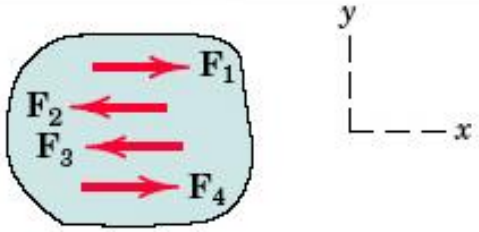
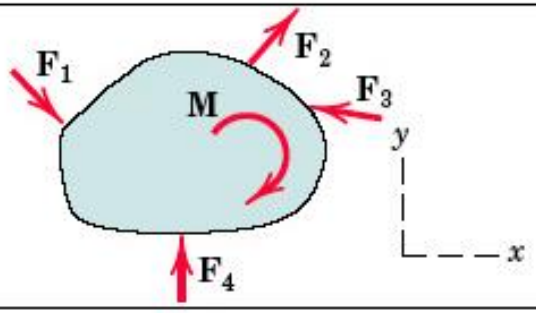
Force System	Free-Body Diagram
1. Collinear	
2. Concurrent at a point	
3. Parallel	
4. General	

Figure 3/3

Force systems in Space 3D systems

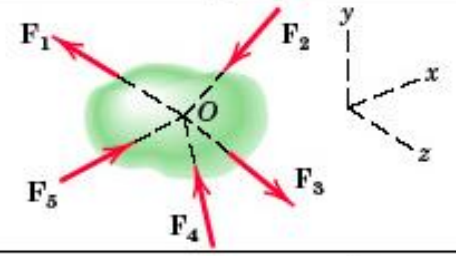
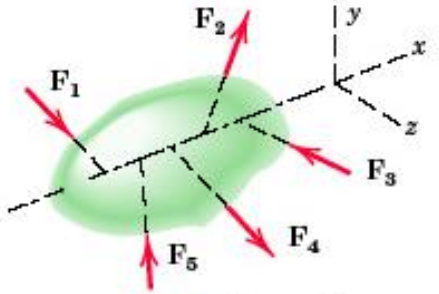
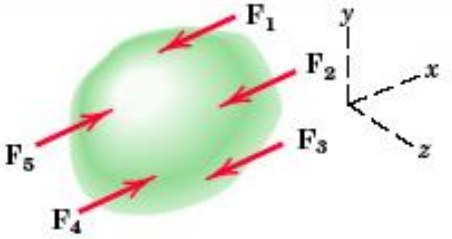
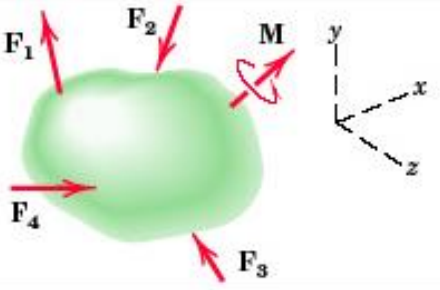
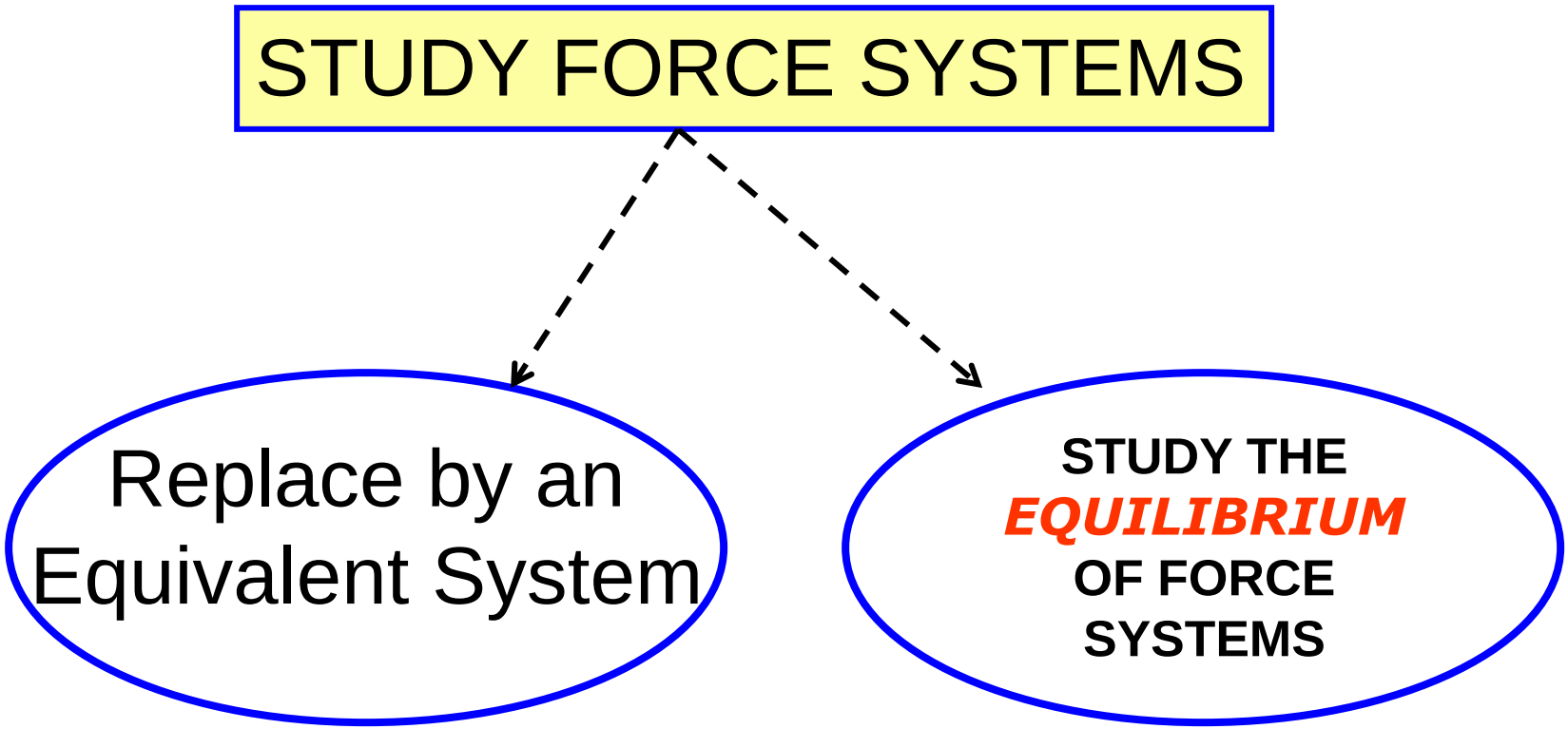
Force System	Free-Body Diagram
1. Concurrent at a point	
2. Concurrent with a line	
3. Parallel	
4. General	

Figure 3/9


STUDY FORCE SYSTEMS
Replace by an Equivalent System
STUDY THE EQUILIBRIUM OF FORCE SYSTEMS

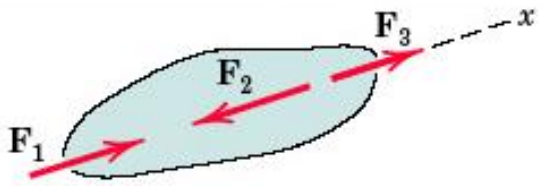
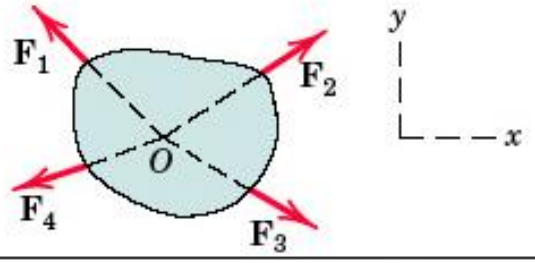
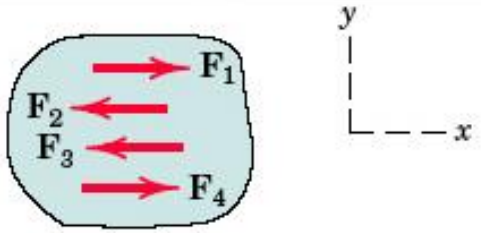
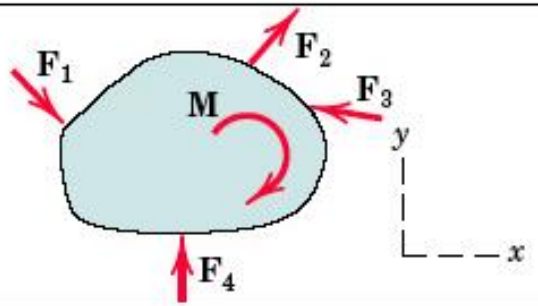
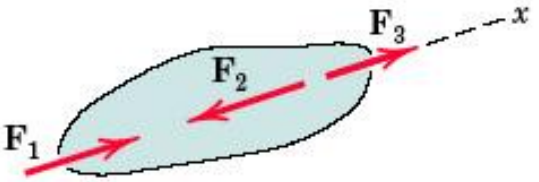
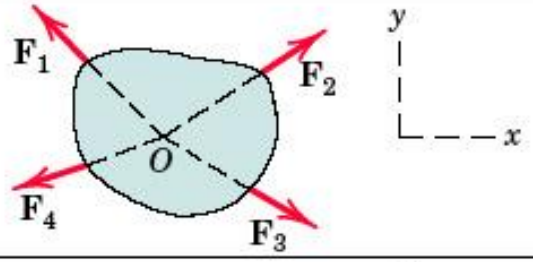
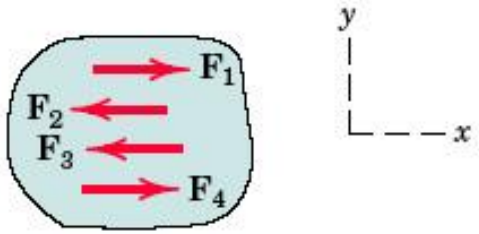
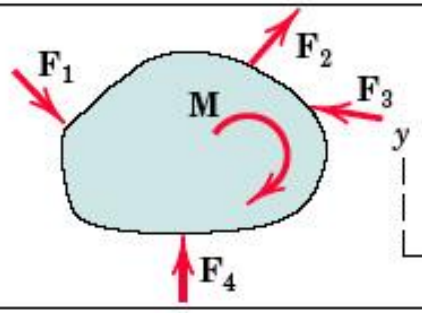
Force System	Free-Body Diagram
1. Collinear	
2. Concurrent at a point	
3. Parallel	
4. General	

Figure 3/3

Replace by Equivalent System

STUDY THE *EQUILIBRIUM* OF FORCE SYSTEMS

CATEGORIES OF EQUILIBRIUM IN TWO DIMENSIONS		
Force System	Free-Body Diagram	Independent Equations
1. Collinear		$\Sigma F_x = 0$
2. Concurrent at a point		$\Sigma F_x = 0$ $\Sigma F_y = 0$
3. Parallel		$\Sigma F_x = 0 \quad \Sigma M_z = 0$
4. General		$\Sigma F_x = 0 \quad \Sigma M_z = 0$ $\Sigma F_y = 0$

EQUILIBRIUM EQUATIONS

CONDITIONS OF ***EQUILIBRIUM***

Figure 3/3

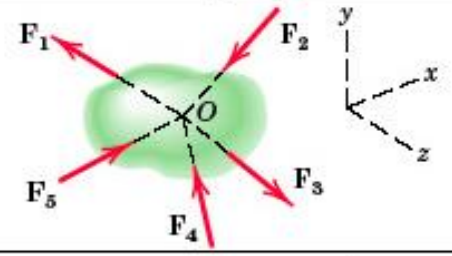
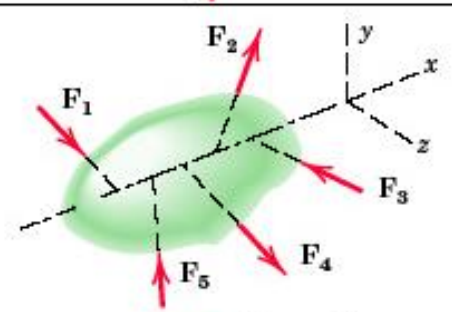
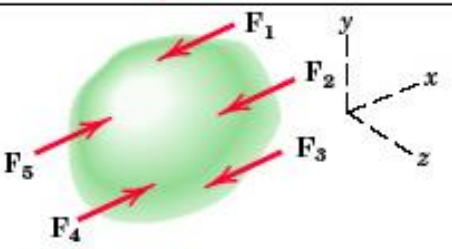
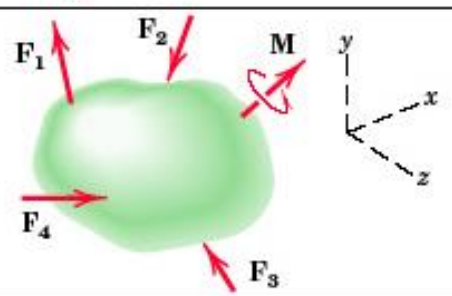
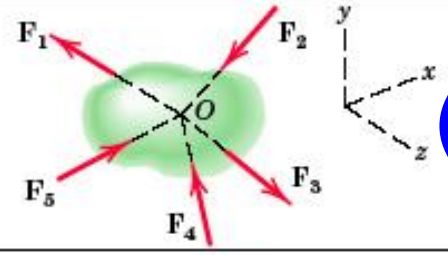
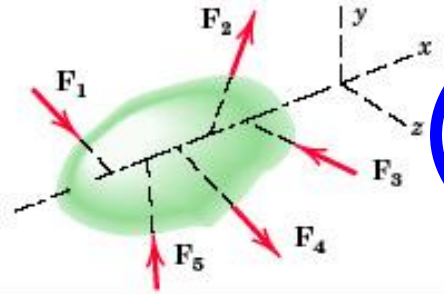
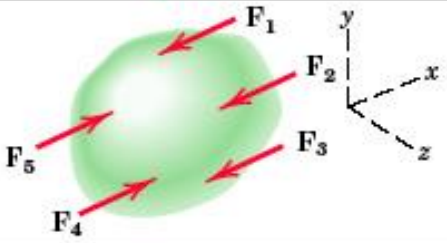
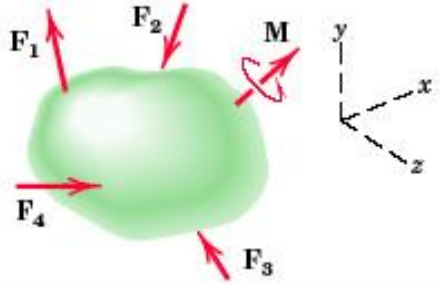
Force System	Free-Body Diagram
1. Concurrent at a point	
2. Concurrent with a line	
3. Parallel	
4. General	

Figure 3/9

Replace by Equivalent System

STUDY THE *EQUILIBRIUM* OF FORCE SYSTEMS

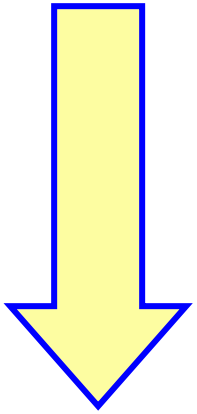
CATEGORIES OF EQUILIBRIUM IN THREE DIMENSIONS		
Force System	Free-Body Diagram	Independent Equations
1. Concurrent at a point		$\Sigma F_x = 0$ $\Sigma F_y = 0$ $\Sigma F_z = 0$
2. Concurrent with a line		$\Sigma F_x = 0$ $\Sigma M_y = 0$ $\Sigma F_y = 0$ $\Sigma M_z = 0$ $\Sigma F_z = 0$
3. Parallel		$\Sigma F_x = 0$ $\Sigma M_y = 0$ $\Sigma M_z = 0$
4. General		$\Sigma F_x = 0$ $\Sigma M_x = 0$ $\Sigma F_y = 0$ $\Sigma M_y = 0$ $\Sigma F_z = 0$ $\Sigma M_z = 0$

EQUILIBRIUM EQUATIONS

CONDITIONS OF ***EQUILIBRIUM***

Figure 3/9

FORCES ARE VECTORS



THEREFORE WE NEED TO USE THE TECHNIQUES OF VECTOR ALGEBRA

VECTOR ALGEBRA

- *ADD AND SUBTRACT FORCES*
- *UNIT VECTORS*
- *RECTANGULAR COMPONENTS OF A FORCE*
- *DOT PRODUCT OF VECTORS*
- *CROSS PRODUCT OF VECTORS (FIND MOMENT OF A FORCE)*

- **Statics will build upon what you were supposed to learn in your basic physics and mathematics courses.**

- **We will talk about forces –vector forces – about moments and torques, reactions and the requirements of *static equilibrium* of a particle or a rigid body.**

- **You have seen a good bit of the basic stuff of this course before, but we will not assume you know the way to talk about, or work with, these concepts, principles, and methods so fundamental to our subject. So we will recast the basics in our own language, the language of engineering mechanics.**

- **For the moment, think of this course as a language text; of yourself as a language student beginning the study of Engineering Mechanics (Statics).**
-

- **You must learn the language if you aspire to be an engineer.**

- **But this is a difficult language to learn, unlike any other foreign language you have learned.**

- **It is difficult because, on the surface, it appears to be a language you already know. That is deceptive: You will have to be on guard, careful, not to presume the word you have heard before bears the same meaning. Words and phrases you have already encountered now take on a more special and, in most cases, narrower meaning; a *couple of forces* is more than just two forces.**

- **The best way to learn a new language is to use it – speak it, read it, listen to it on audio tapes, watch it on television; better yet, go to the land where it is the language in use and use it to buy a loaf of bread, get a hotel room for the night, ask to find the nearest post office.**

- **So too in statics, we insist you begin to use the language. Doing problems and exercises, taking quizzes and the final, is using the language.**

- **Statics course contains exercises explained as well as exercises for you to tackle such as homeworks...**