Chapter 3: Torque and Static Equilibrium

Sections 1 – 3, **Due Tuesday, February 4th**

Learning Objectives: Upon completion of the following topic (from in class lectures and completion of the external brain assignments), you will be able to:

1. Explain how the magnitude, orientation, and point of application of forces determine torque applied to an object.
2. Explain how the musculoskeletal system works to produce torques at joints and explain how the attachment site of muscles influences their torque generating capabilities.
3. Explain what is meant by the term "static equilibrium".
4. Define the equations which characterize static equilibrium conditions and apply these equations to solve torque and force equilibrium problems.
5. Explain how the process outlined in objective 4 can be used to estimate the forces being produced by muscles or the loads being applied to joints during human motion.

Assignments:

1. Vocabulary and Definitions

Use words or images to define the following terms:

- Torque
- Line of force application
- Moment Arm
- Force couple
- Torque Equilibrium
- Net Torque
- Center of Gravity

2. Anatomical Influences on Joint Torque and Muscular Force

For the following muscles:

- Biceps brachii
- Vastus lateralis, vastus medialis, vastis intermedius (can consider as a single group)

a. Describe the origin and insertion sites of the muscle on the skeleton. Use proper terminology for the bones and bony landmarks.

b. Draw pictures showing the relevant joint (elbow and knee) in: -
    1. Full extension
    2. Mid-range of flexion
    3. Full flexion

c. Describe how the moment arm of the muscle changes in each of the above three joint configurations and what impact this would have on the muscle force required to complete a bicep curl or a leg extension exercise.

3. Static Equilibrium

a. What does it mean for an object to be in static equilibrium?

b. Explain each of the following formulas in words and explain how they represent the conditions of static equilibrium:

- $\Sigma F = 0$
- $\Sigma F_x = 0$
- $\Sigma F_y = 0$

c. Why are there 3 formulas above? Given this, how many unknowns can you solve for? How might this be different in a 3D scenario?