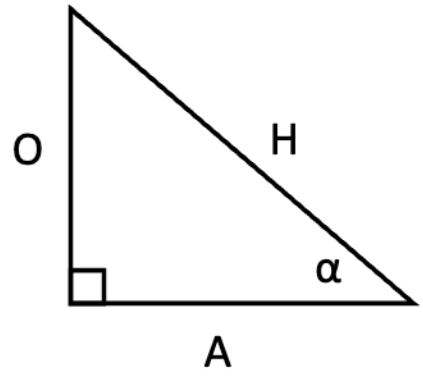
Learning Objectives: by the completion of this lab assignment and accompanying prelab, students will be able to:

- Demonstrate basic mathematical competencies as described in the KIN 325R entry competencies in the syllabus.
- Generate a resource for future reference on specific mathematical procedures.
- Demonstrate proficiency in specific skills within the Microsoft Excel software which will be required over the course of the semester.
- Demonstrate how simple trigonometry and geometry relationships can be used to quantify joint angles during human movement.

Background Mathematics Review

Below are a few mathematical formulas and relationships that we will use throughout the semester.

For right triangles (i.e. a 90° angle in them) we can use sine, cosine, and tangent functions to determine the length of a side based on an angle and length of another side. We could also use this to solve for an unknown angle. We can also use Pythagorean theorom to solve for the length of the hypotenuse if we know the length of the other two sides.



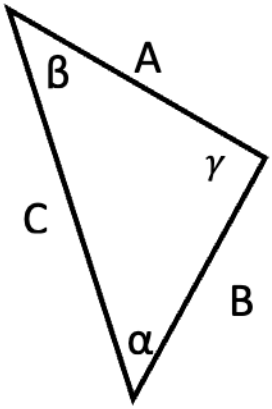
$$\sin\alpha = \frac{O}{H}$$

$$\cos\alpha = \frac{A}{H}$$

$$\tan\alpha = \frac{O}{A}$$

$$H^2 = \sqrt{O^2 + A^2}$$

For non-right triangles we can calculate the length of an unknown side (or solve for an unknown angle) using the Law of Cosines:



Law of Cosines:

$$A = \sqrt{B^2 + C^2 - 2BC\cos\alpha}$$

$$B = \sqrt{A^2 + C^2 - 2AC\cos\beta}$$

$$C = \sqrt{A^2 + B^2 - 2AB\cos\gamma}$$

Background

In this lab you will compare knee kinematics during running for two individuals. Participant 1 (S1) is a healthy 63-year old male while participant 2 (S2) is a 64-year old male who is two years post total knee arthroplasty. They were both evaluated running on a treadmill at a speed of 2.8 m/s.

Using Excel, you will calculate three specific variables describing their knee kinematics: 1) knee flexion at heel strike, 2) peak knee flexion during stance phase, and 3) knee flexion range of motion during stance phase. *Before you start any calculations, make a hypothesis for each of the three variables.*

Procedure

1. The Excel files on D2L contain X and Y coordinates for the hip (greater trochanter), knee (lateral femoral epicondyle) and ankle (lateral malleolus) markers. There are five trials for each participant. Use this marker coordinate data to calculate the inner angle between the thigh and shank segments for each frame on each trial. You may want to refer to the math review and law of cosines to complete this portion of the assignment.

   An IMPORTANT NOTE: If you put in any formulas or calculations they will only remain if you save the file as .xlsx. Saving as a .txt or a .csv will save numbers only, not any formulas or calculations you have entered.

2. Adjust the knee angles to be in anatomically relevant terms. I.e. adjust the numbers so that they are showing the knee joint flexion/extension angles. To do this, subtract the inner angle you calculated in part 1 from 180. This will put it anatomically relevant terms. Remember that if the leg is straight, then knee flexion would be 0°. If the knee were flexed all the way so that the foot was touching the butt, then the knee flexion would be about 135°.

3. For each trial determine:
   - The knee angle at heel strike (frame 1).
   - The peak knee flexion during stance phase (the maximum).
   - The knee range of motion (maximum – angle at heel strike).

4. Repeat steps 1-3 for each of the five trials for both subjects. In doing so, you may want to set up your first trial as a template so that you can copy and paste the equations for all the other trials and they will calculate automatically.

5. Perform the appropriate statistical analysis to determine if the knee angle at contact, peak knee flexion during stance, and knee range of motion are statistically different between participants. If you need assistance please reference the statistics tutorial video for this lab.

Questions to Consider When Writing Your Discussion Section

1. Are the knee kinematics you calculated representative of normative values found in the literature?

2. What might explain some of the differences between participants? In other words, how might the knee arthroplasty influence knee joint motion?