Name: Mahesh Abhale
Roll No.: 20110002

ME322 Synthesis and Analysis of Mechanism
Assignment - 4

Q 1.

The single-leg mechanism of the Theo Jansen mechanism is a remarkable example of a one-degree-of-freedom mechanism. It consists of a central "crank" link that rotates in a circular motion, driven by a rotary actuator such as an electric motor or operated manually. This crank link is connected to a series of other links and pin joints, which move in response to the motion of the crank. The other links and pin joints in the mechanism are unactuated, meaning that they do not have any direct connection to the rotary actuator that drives the crank. Instead, they move in response to the motion of the crank link. The positions and orientations of these links and joints are uniquely defined by the angle of the crank, which determines the motion of the entire mechanism.

The central crank link is the driving link of the mechanism and is responsible for generating the motion that drives the movement of the other links and joints. As the crank rotates, it imparts motion to the other links through the pin joints that connect them. This motion causes the other links and joints to move in a coordinated manner, producing a complex and fascinating movement that is characteristic of the Theo Jansen mechanism. The mechanism has only one degree of freedom because the motion of the other links and joints is completely determined by the motion of the crank link. The position and orientation of the other links can be calculated from the angle of the crank, which means that the mechanism has only one independent variable that determines its motion.

The one-degree-of-freedom nature of the Theo Jansen mechanism is what makes it so elegant and efficient. The motion of the mechanism is entirely determined by a single input variable, which simplifies the design and control of the mechanism. This simplicity also allows for a wide range of possible movements, making the mechanism highly versatile and adaptable to different applications.

The mechanism of Theo Jansen's Strandbeest has a single degree of freedom or mobility, as it allows only one independent input variable to determine its motion. It comprises eight links and ten revolute joints, including a ground joint at point B. Out of these links, two are ternary and the rest are binary links.

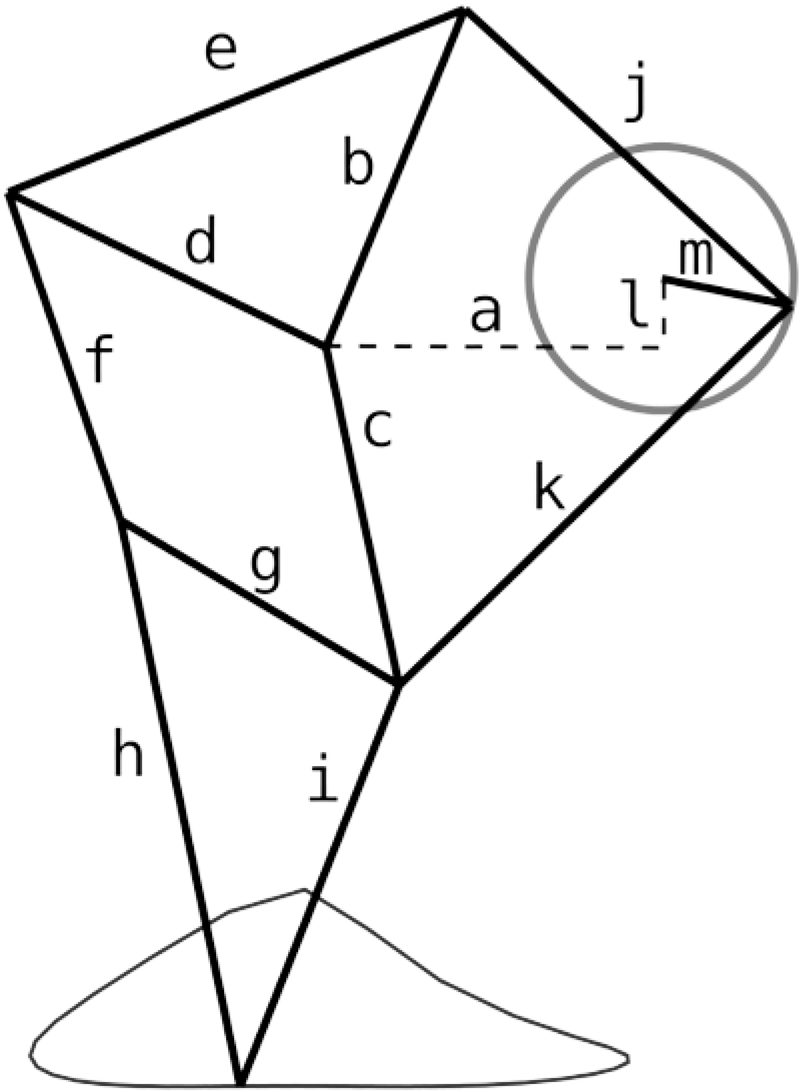


Fig: Stranbeest leg Mechanism

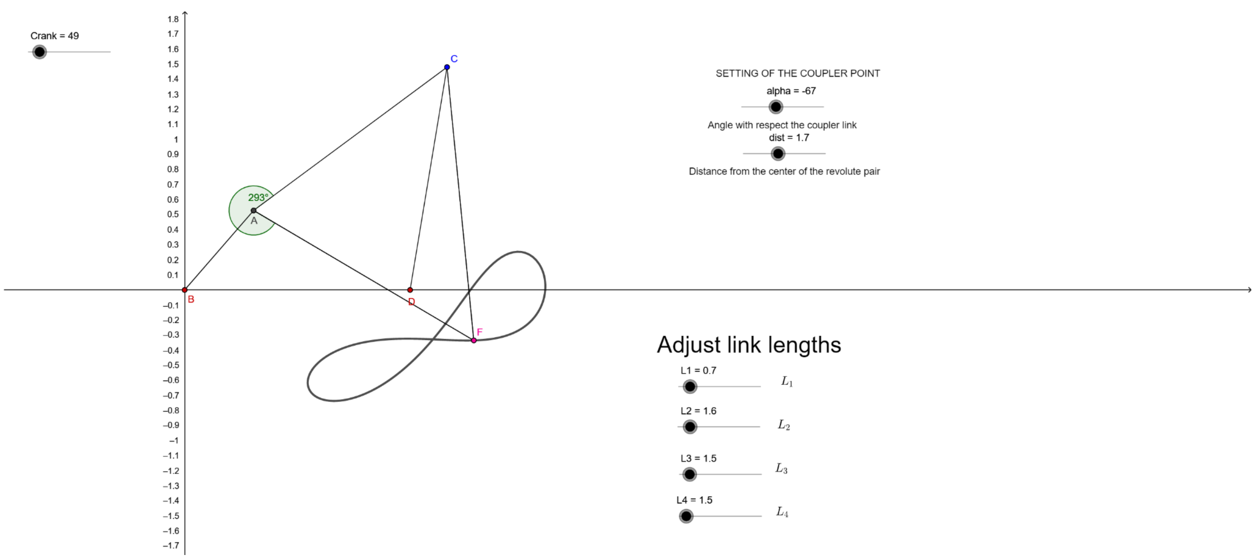
Image Source: Jansen's linkage. (2023, March 5). In Wikipedia.
https://en.wikipedia.org/wiki/Jansen%27s_linkage

Letter depicting length above	**Value of length**
a	38
b	41.5
c	39.2
d	40.1

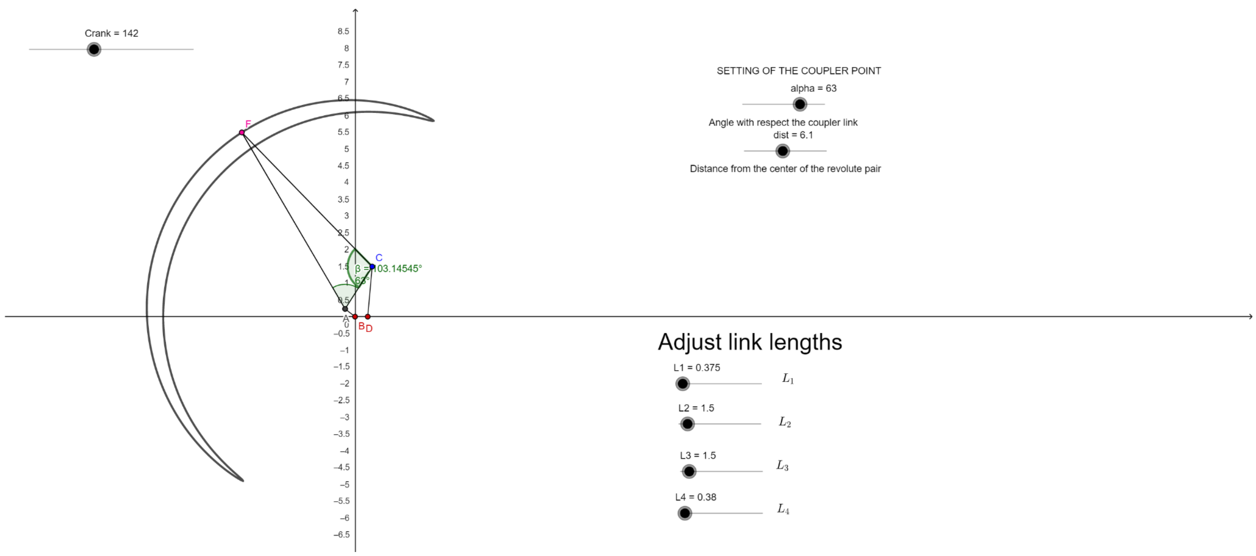
e	55.7
f	39.3
g	36.7
h	65.6
i	49.1
j	50
k	61.8
l	7.8
m	15

Q 2.

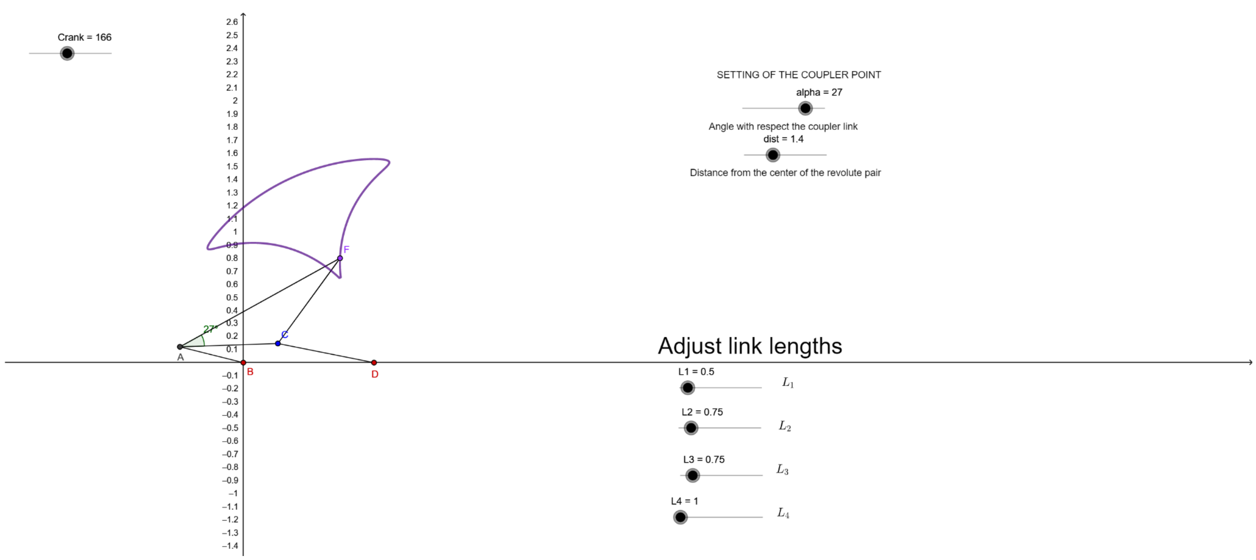
a)



b)


Crank = 142
SETTING OF THE COUPLER POINT
alpha = 63
Angle with respect the coupler link
dist = 6.1
Distance from the center of the revolute pair
F
C
A
B
D
β = 103.14545°
63°
Adjust link lengths
L1 = 0.375
L2 = 1.5
L3 = 1.5
L4 = 0.38

c)


Crank = 166
SETTING OF THE COUPLER POINT
alpha = 27
Angle with respect the coupler link
dist = 1.4
Distance from the center of the revolute pair
F
C
A
B
D
27°
Adjust link lengths
L1 = 0.5
L2 = 0.75
L3 = 0.75
L4 = 1

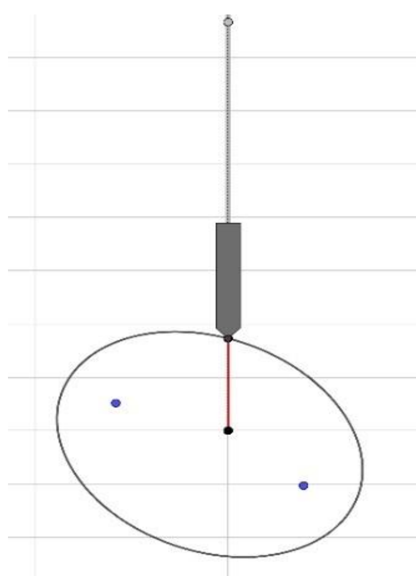
Q 3.

The SPOT robot is a highly mobile robot with four legs, each with three degrees of freedom, allowing for movement in pitch, roll, and yaw directions. The legs are designed with several segments, making them flexible and maneuverable, and are powered by hydraulic actuators. The robot's leg mechanism consists of a total of 20 links, including the upper and lower legs, two joints, and a foot, enabling it to navigate rough terrain, climb stairs, and overcome obstacles with ease.

The MIT Cheetah robot is another four-legged robot with even greater agility and speed. Each leg has four links, including the thigh, shank, heel, and foot, and three revolute joints and one prismatic joint, allowing for pitch, roll, and yaw movements. The leg mechanism of the MIT Cheetah has a three-link mechanism, with each link actuated by a separate motor, giving it greater control and flexibility in leg movements.

The leg mechanism of both robots contributes significantly to their mobility and agility, allowing them to perform complex movements and navigate challenging environments. In addition, the use of multiple motors and joints enables the robots to achieve higher speeds and greater control, making them highly effective for a wide range of applications, from search and rescue to military operations.

Q 5.



In our project, we utilized a cam gear mechanism to create synchronized movements of the legs and arms of a skier model. This mechanism was also used to move the skier model up and down, mimicking the motions of skiing.

To change the direction of the skier, we added a circular disc on top of the cam gears, which were arranged in a 180-degree phase. This caused the skier to move in oscillations, enabling us to simulate the turns and twists of skiing.

However, depicting this mechanism in a 3D motion using GeoGebra can be challenging, as it mainly displays 2D motion. Despite this limitation, we were able to successfully incorporate this mechanism into our project, providing a more realistic and engaging simulation of skiing.

The above screenshot of the geogebra depicts the up down motion of the character.

Q 6.

Followings are some of the key learnings that we learn through the second mini project:

1. Iteration and testing are essential: Mechanism design is an iterative process that requires multiple iterations and testing to refine and improve the design. Prototyping and testing are important steps in the design process to ensure that the mechanism performs as expected and we can identify any problems or areas for improvement.

2. Collaboration and communication: Mechanism design often involves collaboration between multiple team members with different areas of expertise. Effective communication and collaboration are essential to ensure that everyone is working towards the same goals and that the final design meets all requirements.

3. The most important aspect of designing a mechanism is to ensure that the mechanism fulfils what kind of motion is expected from it. Main task is to make a design functioning.

4. One of the important things that I learn through this project is a better comprehension of cam and gear geometry and their role in transmitting motion between different components of a mechanism. As with any project, it's probable that some difficulties will occur, such as gear/cams misalignment or interference. Addressing these obstacles would necessitate effective problem-solving abilities and the capacity to approach problems in innovative ways.