Variables:

Separation: the distance between two stages (25mm).

Range: transition length (25mm)

Rotation angle

Depthmin: Needle insert minimum depth (65mm).

Depthmax: needle insert depth (165mm).

Depth: needle insert depth (range 100mm).

P1: the needle point on the top stage. (x1, y1, z1)

P2: the needle point in the bottom stage. (x2, y2, z2)

Pt: the target point.

Pe: the entrance point

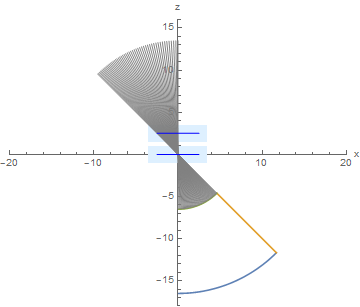
**The coordinate origin** is at the center of bottom stage.

Draw the 1 stage MK3 robot cross section. This should be revolved about the Z axis.

Top arch:

Side slant:

Bottom arc:



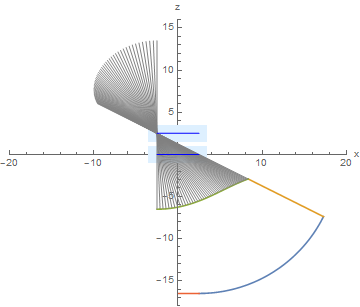
Draw the 2 stage MK3 robot cross section. This should be revolved about the Z axis.

Top arch:

Side slant:

Bottom arc:

Bottom flat side



Forward Kinematic (vector calculation):

Given:, , depth

For one stage MK3 P2(0, 0, 0)

Inverse Kinematic (vector calculation, P1 Z axis should always be zero, P2 Z axis should be the magnitude of separation (25)):

Given: Pt, Pe, depth

After get the coordinate of each stage, separately substitute into following equations: