Problem 1

1. By Gruebler's Equation, for this planar mechanism: F = 3(numlinks-1) - 2 * numjoints = 3(3 - 1) - 2*2 = 6 - 4 = **2** degrees of freedom.
2.

   a = 0.6 * 150mm = 90 mm
   b = 1.4 * 150mm = 210 mm
   c = 0.5 * 150 mm = 75 mm
   d = 150 mm

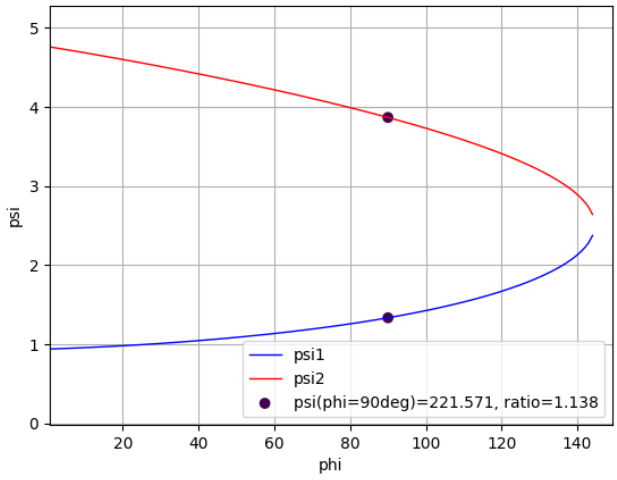
   The longest link length L = b = 210 mm (1.4d)
   The length of the shortest link S = c = 75 mm (0.5d)

   The length of one remaining link P = d = 150 mm (1d)
   The length of one remaining link Q = a = 90 mm (0.6d)

   Grashof condition: S + L = c + b = 75 + 210 = 285 <=? a + d = 150 + 90 = 240

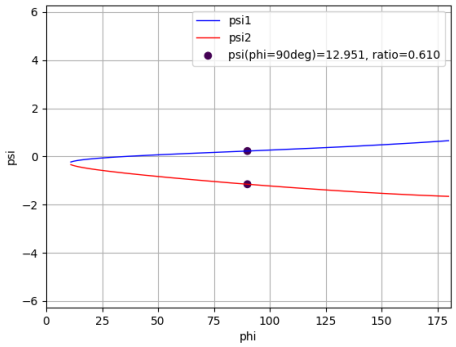
   Since S + L (285, 1.9d) > P + Q (240 1.6d), the Grashof condition **does not hold, so linkage is non-Grasholf, no linkage can fully rotate**

3. From the diagram relationship, we observe that as phi INcreases, psi DEcreases. Plotting a range of these angle values, we can rule out one of the signed roots if it increases as phi increases. So the candidate is the **positive** root (red line)
   a. **psi(phi=90deg)=3.867 radians=221.6deg**
   b. Angular velocity ratio for the **positive** root @ 90 deg = **1.138**



Problem 2a

1. By Gruebler's Equation, for this planar mechanism: F = 3(numlinks-1) - 2 * numjoints = 3(3 - 1) - 2*2 = 6 - 4 = **2** degrees of freedom.
2. Using the same logic and calculus as in Problem 1, we find that (S + L) = 2 + 4 = 6 > 2.5 + 3 = 5.5. **Non-Grashof**
3. We see from the diagram that as phi increases, **psi increases**. So it is the **negative root** that is the one that shows this positive relation (blue line).
    a. The deg of psi @ (phi = 90 deg) = **12.95 deg**
    b. The angular velocity ratio @ (phi = 90 deg) = **0.610**



Problem 2a

1. By Gruebler's Equation, for this planar mechanism: F = 3(numlinks-1) - 2 * numjoints = 3(3 - 1) - 2*2 = 6 - 4 = **2** degrees of freedom.
2. Using the same logic and calculus as in Problem 1, we find that (S + L) = 1.5 + 3.5 = 5 < 2.5 + 3. **Grashof**
3. From the diagram, we can see that as phi increases, **psi increases**. So it is the **negative root** that is the one that shows this positive relationship (blue line). So at phi = 90 deg
    a. psi = **28.7 deg**
    b. angular velocity ratio = **0.359**