1. A radial (plate) cam is required for the following task:
   - Accelerate to 5 cm/s through 15° of cam rotation
   - Maintain 5 cm/s through 60° of cam rotation
   - Decelerate to 0 through 20° of cam rotation
   - Dwell through 60° of cam rotation
   - Return to the initial position through 40° of cam rotation
   - Dwell for the remainder of the cycle

   a) Design a cam profile that achieves this task and does not violate the fundamental law of cam design. Plot the SVAJ diagram and define each segment (types of functions, coefficients of polynomials, etc.)

   b) Size a cam with a translating roller follower that creates acceptable pressure angle and radius of curvature. Use eccentricity only if necessary to balance the functions.

2. Shown below is a spatial three-bar GGC linkage.
   a) Use the Kutzbach criterion to determine the number of degrees of freedom of the linkage.

   b) Are there any passive degrees of freedom? If so, how can they be removed?

   c) Verbally describe the path of point B in space.

   ![Spatial GGC Linkage Diagram]

   \[ R_{B/A} = R_{O3/O} = 75 \text{ mm} \]
   \[ R_{B/O3} = 150 \text{ mm} \]
   \[ \theta_2 = 30^\circ \]
3. A spherical mechanism used as a pitching machine has links with the following central angles:
   Input ($\alpha$) = 32°
   Coupler ($\gamma$) = 120°
   Output ($\beta$) = 65°
   Ground ($\zeta$) = 90°

   a) Roughly sketch the mechanism on the spherical drawing guide below (or free-hand if you prefer) in the position with the angle between the input link and ground of 100°.

   b) Label how the transmission angle is measured in this position.
4. The below figure shows the top, front, and profile views of an RGRC crank and oscillating-slider linkage. Link 4, the oscillating slider, is rigidly attached to a round rod that rotates and slides in the two bearings.

a) Create local coordinate systems for each joint in the form for the DH transformations. Hint: Consider how the three degrees of freedom of the spherical joint can be represented and if multiple coordinate systems should be used for this joint.

b) Write the DH parameters for each joint of the mechanism.

c) Write the loop closure equation (using transformation matrices) to solve for all unknown position data.

\[
\begin{align*}
R_{A/O} &= 4 \text{ in} \\
R_{B/A} &= 12 \text{ in} \\
\theta_2 &= 40^\circ \\
\omega_2 &= -48 \text{ rad/s}
\end{align*}
\]