ME 352: Machine Design I **Name of Student**___________________________

Fall Semester 2017 **Lab Section Number**________________________

Lab Project No. 2. A formal report is due on Blackboard before 8:00 am on Monday, October 16th.

Consider the planar five-bar mechanism shown in Figure 1.

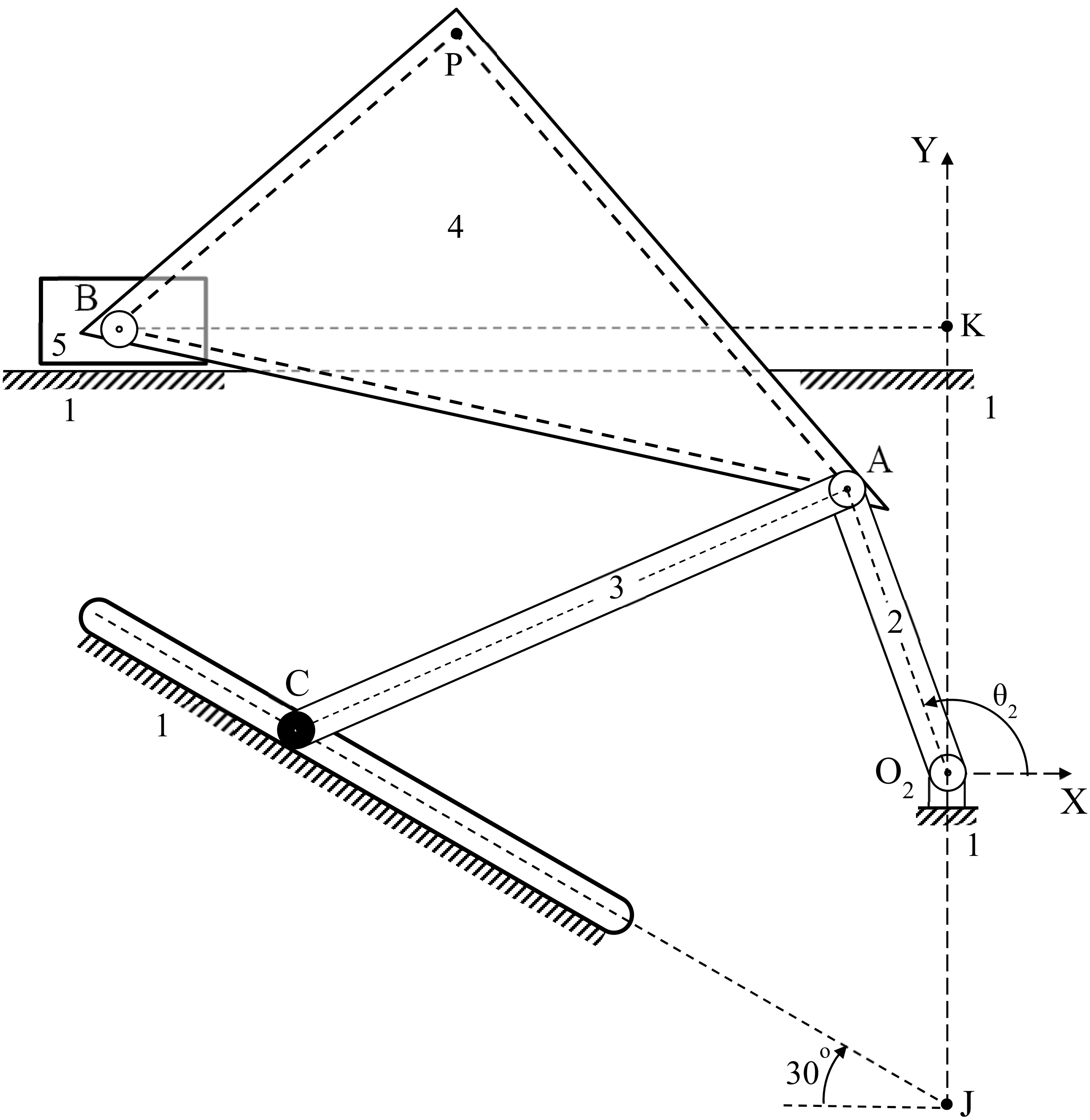

Figure 1. A planar five-bar mechanism. Scale: 1 mm represents 2 mm.

Pin C, fixed in link 3, slides in a slot which is inclined at 30^{o} to the horizontal X-axis and $O_2J = 110$ mm. The piston, link 5, is sliding parallel to the X-axis where the distance $O_2K = 150$ mm. The dimensions are $O_2A = R_2 = 100$ mm, $AC = R_3 = 200$ mm, $AB = R_4 = 250$ mm, $AP = 200$ mm, and $BP = 150$ mm.

The general procedure for a complete kinematic analysis of this five-bar mechanism is as follows:

I(a). A Posture Analysis.

(1) Determine the mobility of the mechanism. Does the Kutzbach criterion give the correct answer?

(2) Draw the vector loop(s) that are necessary for the kinematic analysis of the mechanism. How many vector loops are required for this analysis? List the knowns, the unknown variables, and any constraints. How many unknown variables are there for this mechanism? Write the constraint equations for any constraints that you identified.

(3) Write the symbolic equations to solve for the unknown variables using the Newton-Raphson technique. Write a computer program using Matlab to solve for the posture and position variables and present your results in a tabular format. Show the plots of these variables against the input posture θ_2. Identify and discuss the singular postures of the mechanism.

(4) Determine the total distance that point C travels down the slot and the stroke of the piston (that is, link 5) for a single rotation of the input link 2. Is link 2 a crank (that is, can the input link rotate continuously)?

I(b). A Velocity and Acceleration Analysis.

(5) Write symbolic equations for the first-order and the second-order kinematic coefficients of the mechanism. Expand your program to solve for these kinematic coefficients. Present your results in a tabular format. Show, and discuss, the plots of the first-order and the second-order kinematic coefficients of the mechanism against the input posture θ_2.

(6) Show the locations of the instant centers of the mechanism for two, or more, input postures. Perform checks of the first-order kinematic coefficients of the mechanism using the locations of the instant centers.

(7) Perform checks of the first-order and the second-order kinematic coefficients of the mechanism using the method of finite difference for four, or more, input postures.

(8) Tabulate and plot the angular velocities and angular accelerations of links 3 and 4 and the linear velocities and accelerations of point C and the piston against the input posture θ_2.

If the input link 2 is a crank, see (4) above, then assume for this project that the input link is rotating with a constant angular velocity $\bar{\omega}_2 = 25\,\bar{k}$ rad/s. If the input link 2 is not a crank then suitable kinematic information will be provided at a later date.

The general procedure for a complete kinematic analysis of the coupler point P is as follows:

II(a). A Position Analysis.

(9) Write symbolic equations for the position of the coupler point P. Plot the path of point P on an XY plot. Specify the total X and Y displacements of point P and the values of the input posture θ_2 when this point has the maximum X and Y displacements and the minimum X and Y displacements. Supplement your program to compute the position of point P.

II(b). A Velocity and Acceleration Analysis.

(10) Determine the first-order and the second-order kinematic coefficients of point P against the input posture θ_2. Present the results in a tabular format. Show, and discuss, the plots of the first-order and the second-order kinematic coefficients of point P against the input posture θ_2.

(11) Tabulate and plot the velocity and the acceleration of point P against the input posture θ_2.

(12) Using the method of instant centers, check the velocity of point P for two, or more, postures of the input link.

(13) Using the method of finite difference, check the acceleration of point P for four, or more, postures of the input link.

III. The Geometry of the Coupler Curve.

(14) Tabulate the unit tangent vector and the unit normal vector to the path of point P against the input posture θ_2.

(15) Tabulate the radius of curvature and the center of curvature of the path of point P against the input posture θ_2. Show, and discuss, the plots of the radius of curvature and the center of curvature of the path of point P on an XY plot. Are there inflection points on the coupler curve?

Note that a machine design project can be open-ended, so if you have original contributions or unanswered questions then please include them in your report.