4 Homework 7: Velocity and Acceleration Analysis

Problem 4.7

The dimensions of the mechanism shown in Fig. P4.7 are: AB=200 mm, AC=300 mm, CD=500 mm, DE=250 mm, and L_a=400 mm. The constant angular speed of the driver link 1 is n=40 rpm. Find the velocities and the accelerations of the mechanism when the angle of the driver link 1 with the horizontal axis is ϕ=60°. For ϕ=60° the position of the mechanism is given by: x_B=0.1 m, y_B=0.173205 m, x_D=-0.758831 m, y_D=-0.19868 m, x_E=-0.7 m, y_E=0.0442993 m, ϕ_2=0.408638 rad, ϕ_4=1.33324 rad.

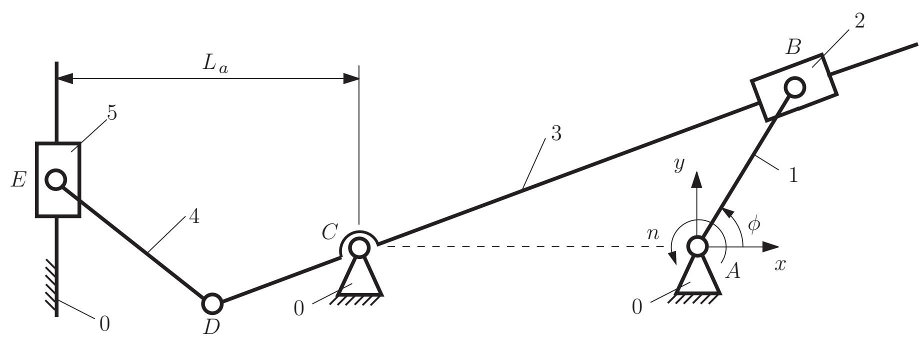

Figure P4.7: Mechanism P4.7

Results

$\dot{x}_{B_1}$=-0.72552 m/s, $\dot{y}_{B_1}$=0.418879 m/s, $\ddot{x}_{B_1}$=-1.7546 m/s^2, $\ddot{y}_{B_1}$=-3.03905 m/s^2,
$\dot{x}_D$=0.30661 m/s, $\dot{y}_D$=-0.708086 m/s, $\ddot{x}_D$=0.841861 m/s^2, $\ddot{y}_D$=1.05257 m/s^2,
$\dot{x}_E$=0 m/s, $\dot{y}_E$=-0.633848 m/s, $\ddot{x}_E$=0 m/s^2, $\ddot{y}_E$=0.846817 m/s^2,
ω_2=$\dot{\phi}_2$=1.54324 rad/s, α_2=$\ddot{\phi}_2$=-1.26276 rad/s^2,
ω_4=$\dot{\phi}_4$=1.26188 rad/s, α_4=$\ddot{\phi}_4$=3.0792 rad/s^2.

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Results

rA = [     0,      0, 0] (m)
rB = [   0.1,  0.173, 0] (m)
rC = [  -0.3,      0, 0] (m)
rD = [-0.759, -0.199, 0] (m)
rE = [  -0.7, 0.0443, 0] (m)
phi3 =   23.4 (degrees)
phi4 =   76.4 (degrees)

Velocity and acceleration analysis

omega1 = [0, 0,   4.19] (rad/s)
alpha1 = [0, 0, 0] (rad/s^2)

vB = vB1 = vB2 = [-0.726,  0.419, 0] (m/s)
aB = aB1 = aB2 = [ -1.75,  -3.04, 0] (m/s^2)

vB3 = vC + omega3 x rCB = vB2 - vB3B2 =>
x-axis: 0.726 - 0.918*vB32 - 0.173*omega3z = 0
y-axis: 0.4*omega3z - 0.397*vB32 - 0.419 = 0
=>
omega3z =   1.54 (rad/s)
vB32 =  0.499 (m/s)

omega2 = omega3 = [0, 0,   1.54] (rad/s)
vB3B2 = [ 0.458,  0.198, 0] (m/s)

aB32cor = [-0.612,   1.41, 0 ] (m/s^2)

aB3=aC+omega3xrCB-(omega3.omega3)rCB=aB2+aB3B2+aB3B2cor =>
x-axis: 1.41 - 0.173*alpha3z - 0.918*aB32 = 0
y-axis: 0.4*alpha3z - 0.397*aB32 + 1.21 = 0
=>
alpha3z =  -1.26 (rad/s^2)
aB32  =   1.78 (m/s^2)

alpha2 = alpha3 = [0, 0,  -1.26] (rad/s^2)
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aB3B2 = [  1.63,  0.707, 0] (m/s^2)
vD = [ 0.307, -0.708, 0] (m/s)
aD = [ 0.842,   1.05, 0] (m/s^2)

vE5 = vE4 = vD + cross(omega4, rE-rD) =>
x-axis: 0.243*omega4z - 0.307 = 0
y-axis: vEy - 0.0588*omega4z + 0.708 = 0
=>
omega4z =   1.26 (rad/s)
vEy = -0.634 (m/s)

omega4 = [0, 0,   1.26] (rad/s)
vE = [0, -0.634, 0] (m/s)

aE5=aE4=aD+omega4xrDE-(omega4.omega4)rDE=>
x-axis: 0.748 - 0.243*alpha4z = 0
y-axis: 0.0588*alpha4z - 1.0*aEy + 0.666 = 0
=>
alpha4z =   3.08 (rad/s^2)
aE  =  0.847 (m/s^2)

alpha4 = [0, 0,   3.08] (rad/s^2)
aE = [0,  0.847, 0] (m/s^2)
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Problem 4.8

The dimensions of the mechanism shown in Fig. P4.8 are: AB=180 mm, AC=90 mm, and CD=200 mm. The constant angular speed of the driver link 1 is n=180 rpm. Find the velocities and the accelerations of the mechanism for $\phi=\phi_1=60°$. For $\phi=60°$ the position of the mechanism is given by: x_B=0.09 m, y_B=0.155885 m, x_D=-0.16138 m, y_D=-0.0281381 m, ϕ_2=0.631914 rad=36.206°, ϕ_4=0.172624 rad=9.89064°.

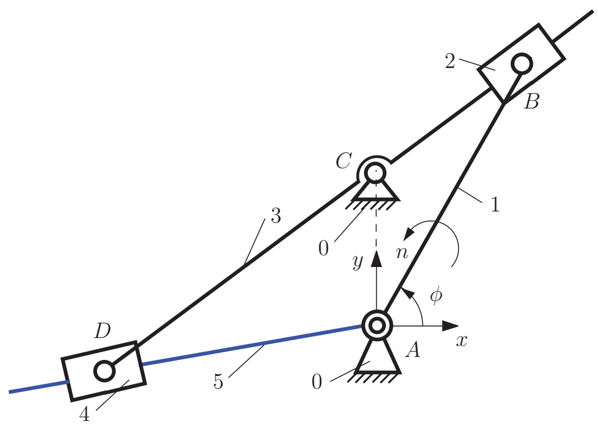

Figure P4.8: Mechanism P4.8

Results

$\dot{x}_{B_1}$=-2.93835 m/s, $\dot{y}_{B_1}$=1.69646 m/s, $\ddot{x}_{B_1}$=-31.9775 m/s^2, $\ddot{y}_{B_1}$=-55.3867 m/s^2, $\dot{x}_{D_3}$=3.28823 m/s, $\dot{y}_{D_3}$=-4.4918 m/s, $\ddot{x}_{D_3}$=178.405 m/s^2, $\ddot{y}_{D_3}$=18.6037 m/s^2, $\omega_2=\dot{\phi}_2$=27.8338 rad/s, $\alpha_2=\ddot{\phi}_2$=451.854 rad/s^2, $\omega_4=\dot{\phi}_4$=30.4604 rad/s, $\alpha_4=\ddot{\phi}_4$=992.942 rad/s^2.