Week 2 Homework

Mirna Alnoukari

Task 1

You should find:

1. simulate this mechanism (obtain all positions.)
2. velocities for A, B, C, E, F, D. Find angular velocities for all links.
3. acc. for A and B and ang. vel for AB
4. draw plots for previous statements.

Needed variables:
$\omega_{O_1A} = 2\ rad/s$;
$\phi = 60°;\ a = 56;\ b = 10;\ c = 26;\ d = 16;\ e = 25;$
$O_1A = 21;\ O_2B = 25;\ O_3F = 20;\ AB = 54;\ BC = 52;$
$CD = 69;\ CE = 35;\ EF = 32.$

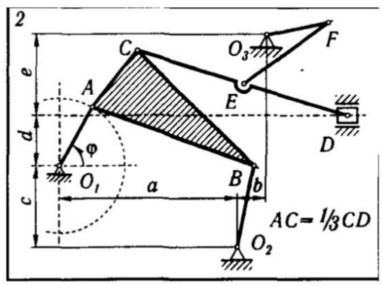

Figure 3: HW 2, task 1
(Yablonskii (rus) K4)

Let O1 be the origin

$$x_A = O_1A \begin{bmatrix} cos(\phi(t)) \\ sin(\phi(t)) \end{bmatrix}$$

Writing the equations of intersections of two circles to find XB

$$\begin{cases} (x_B - x_A)^2 + (y_B - y_A)^2 = (AB)^2 \\ (x_B - x_{o_2})^2 + (y_B - y_{o_2})^2 = (O_2B)^2 \end{cases}$$

From the triangle ABC, we can find Xc in the intersection of two circles:

$$\begin{cases} (x_C - x_A)^2 + (y_C - y_A)^2 = (AB)^2 \\ (x_C - x_B)^2 + (y_C - y_B)^2 = (BC)^2 \end{cases}$$

point D slides horizontally over axis x, thus

$$X_D = \begin{bmatrix} x_D(t) \\ d \end{bmatrix}$$

$$|X_c - X_D| = CD$$

We know that D is on CD, hence

$$X_E = X_C + CE\,\frac{\overrightarrow{CD}}{|\overrightarrow{CD}|}$$

F can also be found from the equation of intersection of two circles:

$$\begin{cases} (x_F - x_E)^2 + (y_F - y_E)^2 = (EF)^2 \\ (x_F - x_{o_3})^2 + (y_F - y_{o_3})^2 = (O_3F)^2 \end{cases}$$

let us use Instantaneous Velocity Centre to find the angular velocity for AB

$$\omega_{AB} = V_A\, r_{AB}$$

r can be found with the intersection of two lines O1A and O2B

$$r_{AB} = \begin{cases} y = (\frac{y_A - y_{o_1}}{x_A - y_{o_1}})x + (y_A - \frac{y_A - y_{o_1}}{x_A - y_{o_1}}x_A) \\ y = (\frac{y_B - y_{o_2}}{x_B - y_{o_2}})x + (y_B - \frac{y_B - y_{o_2}}{x_B - y_{o_2}}x_B) \end{cases}$$

Now after finding all positions, we can obtain velocities and accelerations by differentiating once and twice in order.

Task 2

Body B is static, A – moves. No friction. You should find:
1. angular vel. and angular acc. for A;
2. vel. and acc. for M point;
3. draw plots for previous statements.

Needed variables:
$OM_0 = 40;\ \omega_1 = 2;\ \varepsilon_1 = 3.7;\ M_0M = 5.$

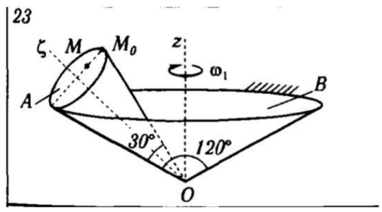

Figure 4: HW 2, task 2 (Yablonskii (rus) K6)

$$O = (0;0;0), Z = (0;0;ZO), S = (0;0;SO) A = (SA, 0, SO),$$
$$P = (PZ.cos(\phi(t)), PZ.sin(\phi(t)), ZO)$$
$$AO = M_0O$$
$$OP = AO.cos(15)$$
$$AP = AO.sin(15) = PM_0$$
$$AE = PE = AP.cos(45)$$
$$PZ = AS - AE$$
$$SO = AO.sin(30)$$
$$ZO = SO + PE$$

Point p is on a circle where

$$z = ZO$$

$$X_P(t) = \begin{bmatrix} PZ.cos(\phi(t)) \\ PZ.sin(\phi(t)) \\ ZO \end{bmatrix}$$

$$V_P(T) = w_1(t) \times OP$$

Rolling happens without slipping, then:

$$\phi(t).AS = \phi_M(t).AP$$
$$\phi_M(t) = \frac{AS}{AP}.\phi(t)$$
$$v_M = v_P + w_2 \times r_{PM}$$
$$a_M = a_{M_t} + a_{M_n} + a_{P_t} + a_{P_n}$$

tangential and normal accelerations can be obtained from the equations

$$a_n = \frac{v^2}{r}$$

$$a_t = \alpha . r$$