SCAN 2nd **Kinematics – Test 2**

SCAN 70-71-72

Geneva Mechanisms are used to transform a continuous rotation into an intermittent rotation on a different axis. An example of such a system is represented in Figure 1.

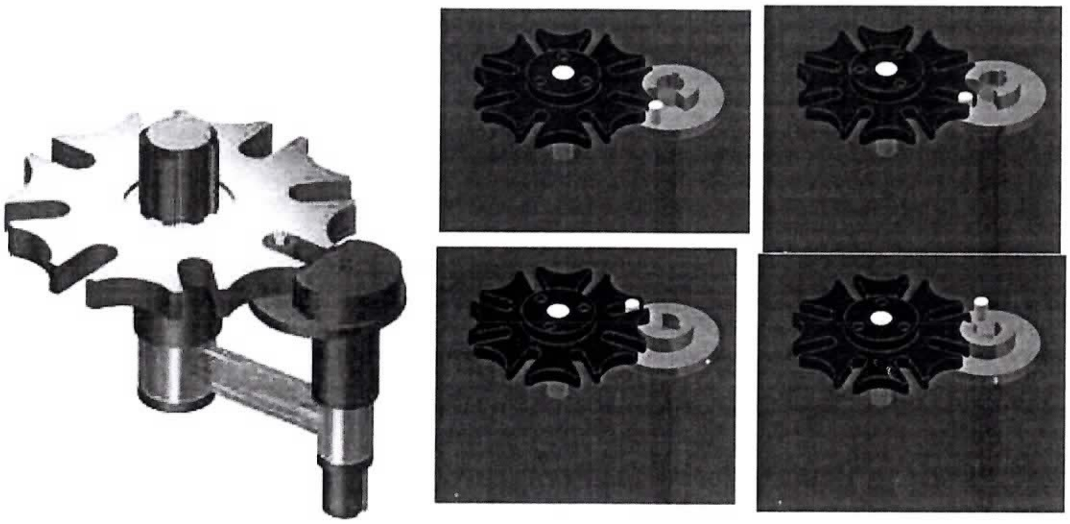

Figure 1 – Model and running of an example of Geneva Mechanism.

Part A:

A simplified analysis of the rotation transfer is proposed based on the kinematic model in Figure 2. The system is decomposed into:

- Solid 0 : ground
- Solid 1: a rod of length $d = O_1M_1$ with a pin at its extremity.
- Solid 2: a cylindrical wheel of centre O_2 and radius R partly cut by a slot (groove) on one diameter (*with the objective of approximating the local geometry of an actual Geneva Mechanism.*). The slot axis is along $(O_2, \vec{y}_2)$.

The joints between the parts are:

- 1/0 : revolute joint of axis $(O_{0,1}, \vec{z}_{0,1})$ and parameter $\theta = (\vec{x}_0, \vec{x}_1)$
- 2/0 : revolute joint of axis $(O_2, \vec{z}_{0,2})$ and parameter $\psi = (\vec{x}_0, \vec{x}_2)$
- 2/1: the pin located at M_1 (tip of the rod) slides in the slot (groove) of the wheel (solid 2) with no clearance. No parameter for this joint.

The centre distance O_1O_2 is such that $O_1O_2 = e$

Questions:

1 – Frame definition, change of basis diagrams and graph of links.

2 – Deduce the constraint equation(s). Give the degree of mobility.

3 – In order to avoid shocks at the pin engagement in the slot, the velocity with respect to the ground at point M_1 must be collinear with the slot axis. Find the relationship between $\vec{y}_1$ and $\vec{y}_2$ for this particular position (engagement). Deduce the necessary condition on the geometrical parameters e, d and R.

4 – For any position of the pin in the slot, calculate $\vec{V}(M_1/0)$ and the sliding velocity vector between the rod and the wheel at point M_1,

a) by analytical means

b) graphically, by using <u>the annex enclosed</u>.

5 – From the graphical construction in question 4- and assuming that the dimensions in the figure in the annex are the real ones, determine the speed ratio $\rho = \dot{\psi}/\dot{\theta}$ for the particular position represented in the annex.

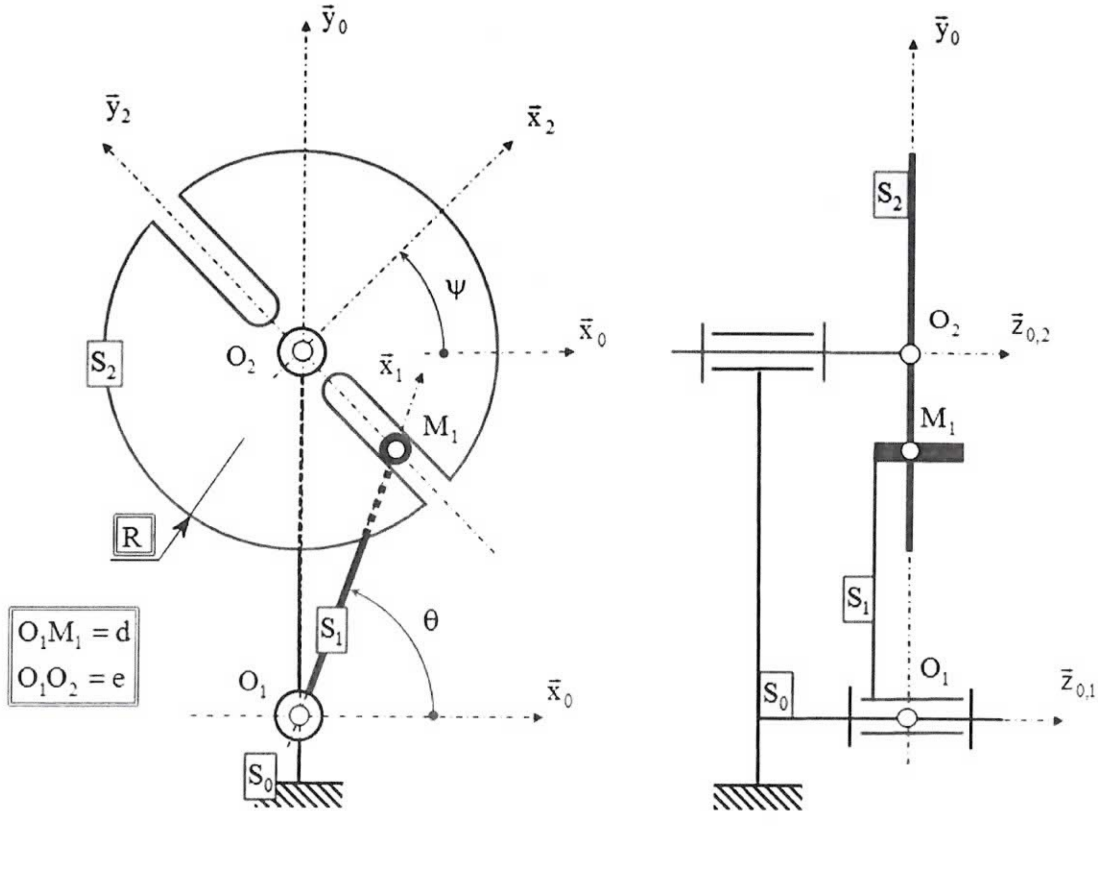

Figure 2

Part B:

In order to avoid excessive slipping between the wheel and the rod, the pin is replaced by a roller (disc, solid 3) of centre M_1 and radius r (see Figure 3).

The joint between the roller (solid 3) and the rod (solid 1) is a revolute joint of axis $(M_1, \vec{z}_{1,3})$ and parameter $\gamma = (\vec{x}_1, \vec{x}_3)$. It is assumed that the contact between the roller (solid 3) and the wheel (solid 2) takes place at point I only (on the lower surface of the slot); this contact is considered as permanent and **without slipping (no sliding)**.

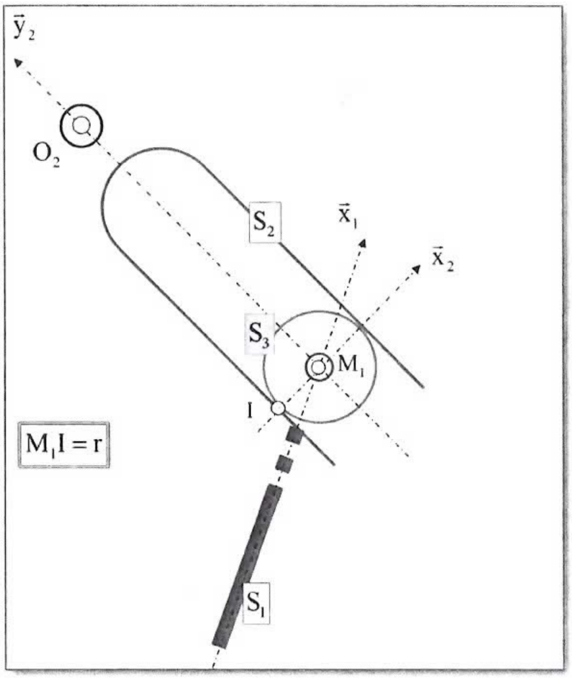

Figure 3

(Zoom on 2/3 contact)

Questions:

1- Change of basis diagrams and graph of links. Deduce the constraint equation(s) (geometric and kinematic) associated with this new configuration.

2- Using the fact that the sliding velocity vector should always lies in the tangent plane for permanent contacts, determine the speed ratio $\rho = \dot{\psi}/\dot{\theta}$. Do you think that it should be different from that in Part A? Justify.

3- Specify the nature of the tangent motion to the motion 3/2. Is it possible to have no slipping at the point opposite to I on the $(I, \vec{y}_2)$ axis (on the same diameter)? Justify.