Advanced engineering dynamics, 5C1150
Hand in assignments, batch 4, HT 2006
Due Friday 13/10

1) Do Problem number 17 in *A Collection of Problems in Rigid Body and Analytical Mechanics.*

2) Three identical straight homogeneous slim bars, AB, BC, and CD, each of mass $m/3$ and length l, are connected by smooth joints at B and at C so that they can turn about parallel axes perpendicular to the rods. The three rods are therefore always in the same plane. The mid point O of the rod BC is mounted so that it can rotate freely about a fixed vertical axis perpendicular to the rod and parallel to the axes in B and C. The three link mechanism is thus always in a horizontal plane and there is rotation about vertical axes at O, B, and C.

a) The rods are all at rest and form a straight line when a horizontal impact I is applied to the mid point of CD perpendicular to CD. Find the angular velocities of the rods immediately after the impact.

b) Assume that torsion springs, all with torsional stiffness κ, are placed at the joints. The spring at O tends to keep the rod BC parallel to a fixed horizontal direction while the two springs at B and C tends to keep the rods parallel to each other. At equilibrium the rods are therefore parallel to each other as well as parallel to a fixed horizontal direction, the x-axis. Find the general solution for the motion of the system assuming small oscillations about the equilibrium configuration.

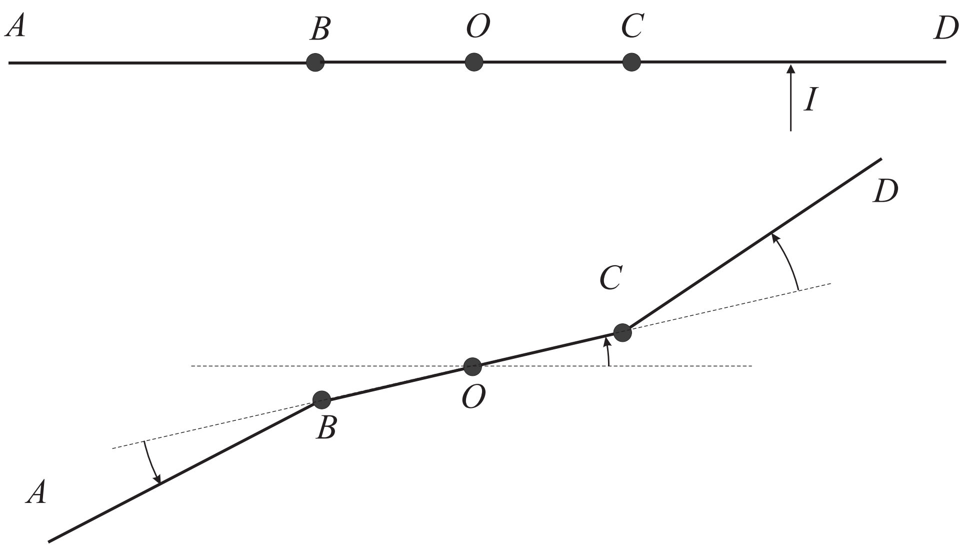

Figure 1: Figures to hand in assignments, batch 4. The horizontal three link mechanism is seen from above in these figures. In the lower figure the three angles affected by torsion springs are marked.

2a) **Answer:** the angular velocities (of the relative angles affected by the springs) should be:

$$\dot{\varphi}_{AB} = -\frac{63}{20}\frac{I}{ml}, \ \dot{\varphi}_{BC} = \frac{9}{5}\frac{I}{ml}, \ \dot{\varphi}_{CD} = \frac{27}{20}\frac{I}{ml}$$

2b) Part of **Answer:** the angular frequencies of oscillation squared should be:

$$\omega_1^2 = 9\frac{\kappa}{ml^2}, \ \omega_{2,3}^2 = \frac{18}{10}\left(31 \pm \sqrt{921}\right)\frac{\kappa}{ml^2}$$

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