MFM120 - MBD - WS 2011 - Prof. Dr. O. Wallrapp **Project 2**
Date of issue 16.11.2011, **Deadline 12.12.2011 - 18:00 am.**

Version 16.11.11

Requirements:

1) Write the following header (Kopfzeile) on the top of the report and all the files:

MFM120-MBD-WS2011 **Project2 Group xx**

Personal No. o List	Fam. Name	First Name	Sem-Ident	Mat.-No.

Please add lines for each user of the group.

2) A group has maximum 2 persons. The groups are defined before handout and can not changed later.
3) I want to get a report in paper form, simple fixed. Please clip together the report without folder, etc. One group has one report. The hand over must be in time and in post ______ case near the faculty office and Prof. room.
4) I want a folder compressed by **zip** format containing the pdf files and scripts of the used MBS package and all other files.
5) Send me the file via mail to Wallrapp@hm.edu.
   Mail-Subject: mbd_project1_groupxx << very important.
   attached **File-Name:** mbd_project1_groupxx.zip << very important, other files are not accepted!
   Never use "Umlaute" in the text of programs and file names !!!
6) The project is a part of the exam in MBD and will be valid by points / later by a mark.
   Project 2 contains max. 40 points. A good layout gives 3 points extra!
   Each user in a group will get the same points. The project has a workload of about 16 hours per student.

Simulation of a 2 Body MBS:

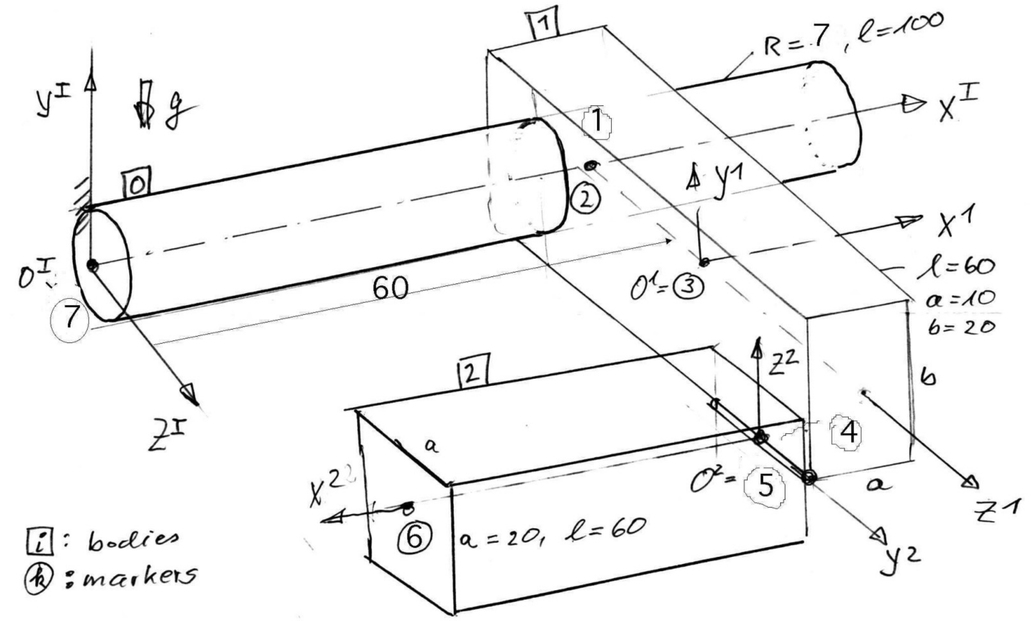

Fig. 1: Double pendulum with helical joint in the gravitational field.

Fig. 1 shows the 2 body pendulum in the gravitational field and in the initial state.
Body 1 is joined by a helical joint of thread length *pHel* to ground (body 0): marker 1 on body 0 -> marker 2 on body 1.
Body 2 is connected by a hinge along the y_2 axis: marker 4 on body 1 -> marker 5 on body 2.
There are also some force elements:

1) Between marker 1 and 2 consider rotational **Coulomb** friction like a function $L_a^1 = F_n\ R_1\ \mu(\dot{\beta}^1)$, where F_n is normal force, μ the friction coefficient and $\dot{\beta}^1$ the angular velocity of the helical joint; herein use the simplified function based on y:= μmax *2/Pi*arctan(30*x); (please test it using Maple).

2) Between marker 4 and 5 consider rotational spring to model the body's contact of body 1 and 2. Please use fct. like $L_a^2 = f(\beta^{s=2})$, where $\beta^{s=2}$ is the angle of the hinge joint; herein use the simplified function f:= fmax*(x-1)^9;, where x must be scaled belongs to 0 .. β .. π/2 from one contact side to the next and fmax is torque at each contact side. (please test it using Maple). We add also a lin. rot. damper with damping value d_{T2} .

3) There is a linear rotational spring with stiffness k_{T3} between marker 7 and 2 to drive body 1. In the initial state the spring is pre-stressed by $\beta_0 = -\pi$ rad to produce a positive rotation of body 1.

Use the data (in addition the data given in figs 2 and 3:
pHel = 8 mm, g = 9.81 m/s^2, μmax = 0.5, F_n = (m1+m2)*g N, fmax = 0.001 Nm, d_{T2} = 0.001 Nms/rad, k_{T3} = 0.002 Nm/rad, $\beta_0 = -\pi$ rad, tEnd = 4 sec.

Tasks:

1) < 8 points >
Draw a mbs sketch (exploded drawing) including all bodies, markers, joints, force elements, required frames;
List all bodies, markers, joints, force elements, required frames (in tables) and describe briefly.
Explain DOF and generalized coordinates of the mbs.

2) < 9 points >
Referring to the desired body frames compute the required mass body data of body 1, 2.
Herein consider, that body 1 has an additional hole (use R1 for the out-side radii of the screw.), the material is brass
and body 2 is formed like a H -profile. The material is steel.

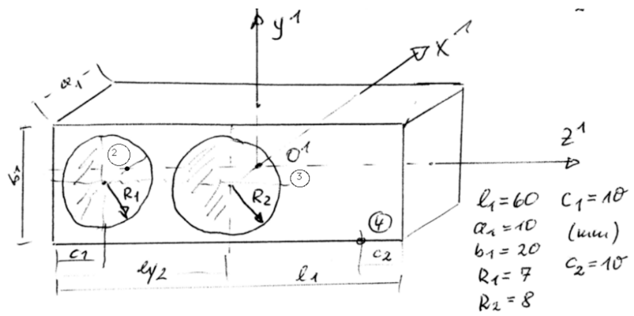

Fig. 2: Body 1.

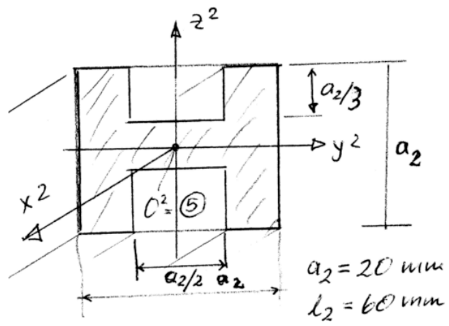

Fig. 3: Body 3.

3) < 10 points >
Set-up the model using the maple script RMBS-V60 or SIMPACK
* complete the file **MBS_Sys-proj1_groupxx.mw**
* show me the set of input data (with comments) and plot initial state of the mbs in 3D view.

4) < 10 points >
Provide the solution in time domain for t from 0 to tEnd (steady state solution)

in file **MBS_ SoluODE-proj1_groupxx.mw**

Show me the main results in the report:
* initial values (including accelerations)
* time history in plots and final values at t = tEnd
containing state variables, their time derivation
path of marker 6
torques of force elements
* animation of mbs

5) < 3 points >
Discuss the results