ME41055
Multibody Dynamics B

Spring Term 2018, Tue 13:45-15:30, room 3mE-IZ L, 4 ECTS credits.

Homework Assignment 2 (HW2)

Redo Homework Assignment 1a–1d but now by using the systematic approach by means of the application of the Virtual Power Method and Lagrangian Multipliers. In doing this you will have to define, among other things, the constraints according to $C_k(x_i) = 0$ and differentiate these. You should take extra care in this differentiation. Be sure that your expressions are correct, preferably use symbolic software like the Symbolic Toolbox in Matlab. An example is readily available on Brightspace. Consider the following cases:

- a: Derive the equations of motion and the joint constraint equations.
- b,c,d: Solve for the accelerations of the center of mass of the two bodies together with the Lagrange multipliers λ_k in the three initial condition cases from Assignment 1. Check your results and interpret the nature and value of the Lagrange Multipliers (this should also be in your report!).

Now add a constraint to the system such that the right end of the second bar, point C, moves over a vertical line going through the origin (Note: the gravity still works horizontally). Calculate the the accelerations of the center of mass of the two bodies together with the Lagrange multipliers (and interpret the Langrange multipliers, in particular the new one!) for the following two initial conditions:

- e. Both bars vertical up and zero speeds.
- f. Both bars vertical up and with an initial angular speed of $\omega = 60$ rpm clockwise on bar 1.
- g. Both bars horizontal, that is point C is at the origin, with zero speeds, but an additional applied force of $F_y = 10$ N in B, that is at the end of bar 1 in the vertical direction. Here you will have trouble finding a unique solution. Can you explain why?
  (Hint: Investigate the rank of the matrix $C_{k,i}$ which is the Jacobian of the constraint equations and think of what the null vectors v_i from the null space $C_{k,i}v_i = 0$ represent. How many degrees of freedom has this system in exactly this configuration? Does this comply with the number of coordinates for the rigid bodies and the number of constraints?)