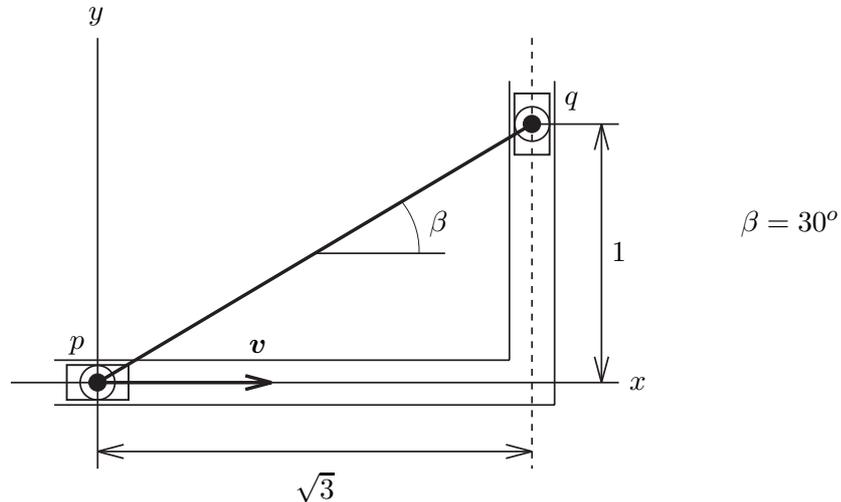


Exercise 1

Consider the sliding bar of example 4.3.1 in the lecture notes. In this exercise we will try to make some very simple SPACAR input files and run this example.



The sliding bar is a rigid bar pq of length 2 m is suspended from two sliders. The bar is driven by the condition $x^p - vt = 0$, where $v = |v|$ is the constant horizontal velocity component of point p . Thus $\dot{x}^p = v$ and $\ddot{x}^p = 0$. We want to compute \dot{y}^q and \ddot{y}^q for $0 \leq t \leq 2\sqrt{3}$ s and $v = 1$ m/s.

1. First we create the kinematic input for SPACAR, see section 2.2 in the manual. Check the following statements and answer the questions:

For the bar we need only one element. What is the simplest choice?

How many nodal points are connected to this element. Are these translational nodes and/or rotational nodes? What are the initial conditions for the nodal coordinates.

How can we deal with the constraints? Note that a constraint along a straight line parallel to one of the axes can be specified easily by FIX-ing one of the nodal coordinates.

How can we deal with the prescribed motion? In the kinematic part of the input file we only need to specify which coordinates and/or deformations are prescribed DOF's.

With this information and the keywords in section 2.2 we can create the kinematic part of the input file. It must be concluded with two lines with the keywords END and HALT respectively, see manual section 2.1.

2. Although there are not much "dynamics" involved in this example, SPACAR always needs a dynamic section in the input file, manual section 2.3. Actually there are (at least) two things that we still have to specify anyway: A (mathematical) description of the prescribed DOF's and the duration of the simulation.

For the first, the keywords INPUTX and INPUTE can be used to specify simple second order functions for the prescribed DOF's. How can we use these keywords for this exercise? It is often misleading that these keywords are used twice: In the kinematic section they only specify *which* coordinates and/or deformations are prescribed DOF's. In the dynamic section they can specify *how* these DOF's evolve in time in the case simple second order functions of the time are applied. For all other functions e.g. user defined inputs with M-scripts can be used, see keyword USERINP.

Next, we need to specify the duration of the simulation and the number of time steps. Put this in your input file and take e.g. 100 time steps.

Finally, the dynamic part of the input file is concluded with two lines with twice (!) the keywords END, see manual section 2.1.

3. Save your input file. Make sure it has extension (or file type) `.dat` and that it is in your current MATLAB working directory (either save the file at the correct location or change the working directory).

Run your simulation with the command `spacar(1, 'yourfile')` where `yourfile` is of course the name of your input file (without the extension `.dat`). Does it look OK?

4. Next we want to have a closer look at the results:

Are the constraints satisfied for the coordinates and deformations? You will have to use the `lnp` and/or `le` matrices to determine the exact location of the coordinates and deformations in the simulation output.

Do the velocities and/or accelerations look reasonable? In the lecture notes some symbolic expressions are given for the initial configuration. See also section 3.1 of the manual.

SPACAR always carries out a dynamic analysis. What do you expect for the forces and stresses in this case? Check this expectation with the actual results from the simulation.

5. When you did nothing wrong, you have not seen any error messages yet. It may be illustrative to force errors, so that you can understand what is wrong in cases you did not make an error on purpose. Some deliberate errors are:

I. Increase the duration of the simulation beyond $t = 2 + \sqrt{3}$ s.

II. FIX an additional coordinate or release a deformation (keyword RLSE). You will see that SPACAR imposes very strict demands on the correct kinematic definition of a mechanism. In SPACAR terms: The number of NXC (dependent or calculable nodal coordinates) must be exactly equal to NEO+NEM (prescribed plus independent deformations), see e.g. figure 5.3.1 in the lecture notes.

6. In part B of this course the dynamics will be discussed on Tuesday, but we can already give it a try (after part A of the course): Adding a mass should give already some more interesting dynamic results. Look in section 2.3 of the manual how you can add e.g. a mass of 1 kg in one of the nodes.

Is it very “dynamic” to add this mass in node p ? You may try and look at the results if you want. Add the mass in node q and run a simulation. Now look at forces and stress(es). What do you expect for the forces and stress(es) in the bar? Hint: look e.g. at:

```
plot(time, cos(atan2(fx(:,lnp(1,2)),fx(:,lnp(1,1)))))  
plot(time, [sqrt(fx(:,lnp(1,1)).^2+fx(:,lnp(1,2)).^2) sig(:,le(1,1))])
```

7. SPACAR does not implicitly add gravity to a model, so we always have to do that explicitly. Add to the previous model a gravity force in the node with the mass (keyword XF), run a simulation and compare the results with what we had so far.