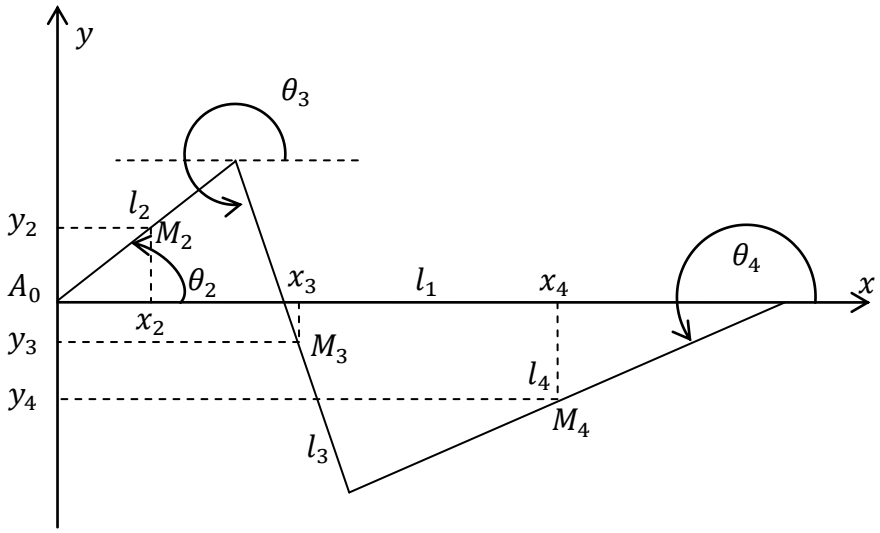
Paths of moving bars' middle points

1. The problem. Is given the four-bar linkage defined by the following lengths of the bars

1.1) $$\begin{cases} l_2 = 0.2m \\ l_3 = 0.7m \\ l_4 = 0.5m \\ l_1 = 0.8m \end{cases}$$

with the bodies linked with four hinged joints, as in figure.

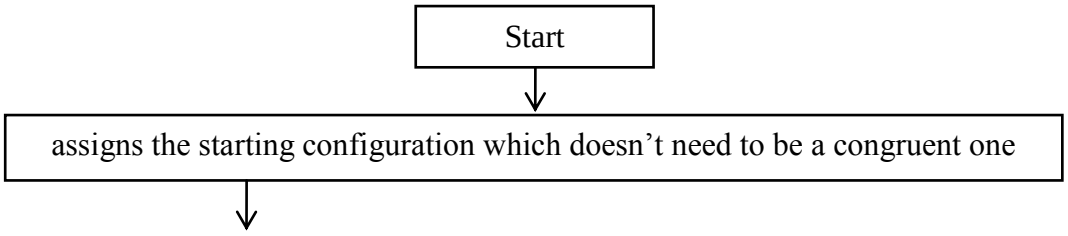


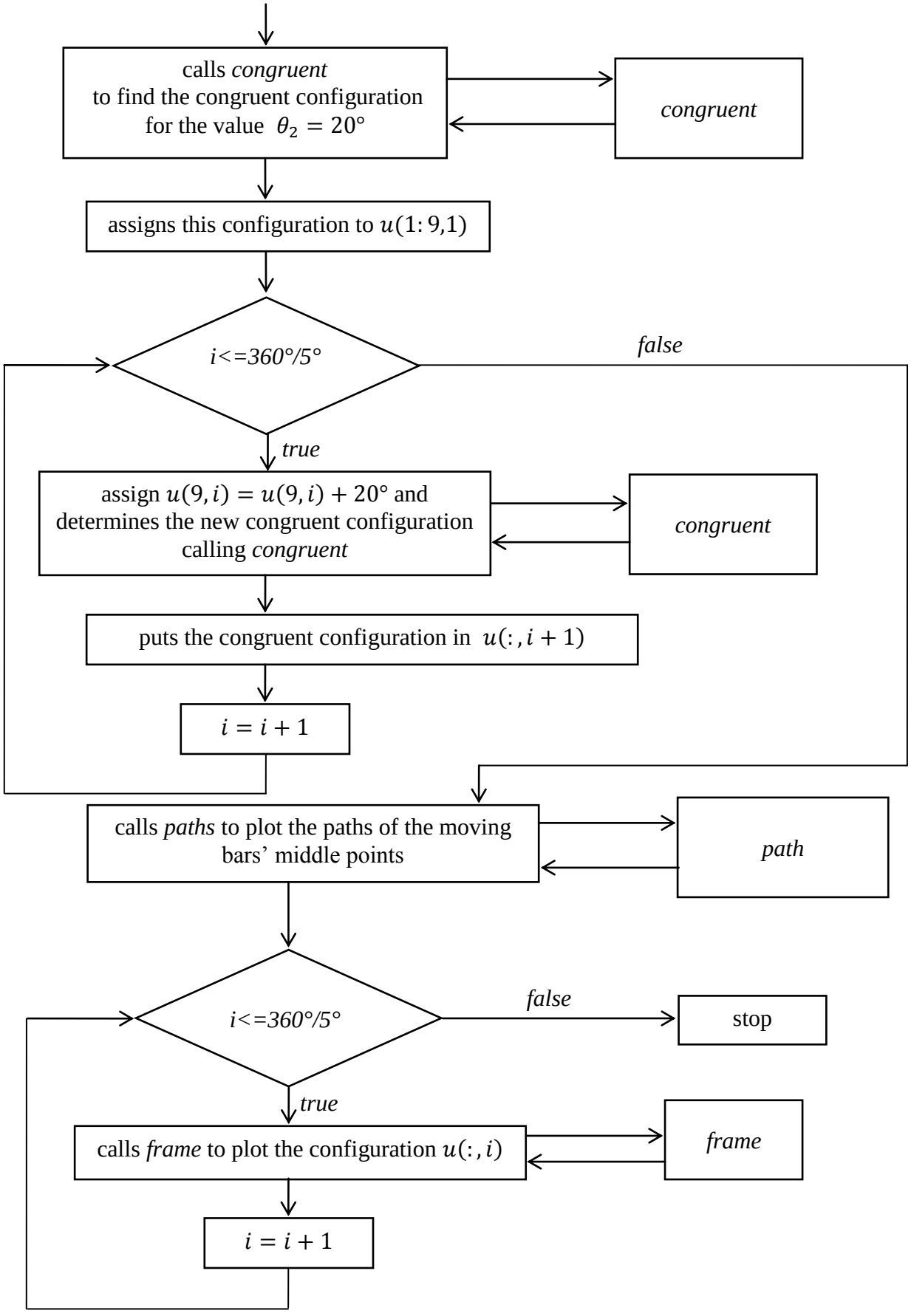
The code here described allows to find the paths of the middle points of each moving bar, with the driving bar describing a full angle. It uses the Newton-Raphson method to determinate the congruent configuration for each value of the angle $\theta_2 \in [0,2\pi]$.

2. The algoritm. The code in Fortran is composed by the following units:

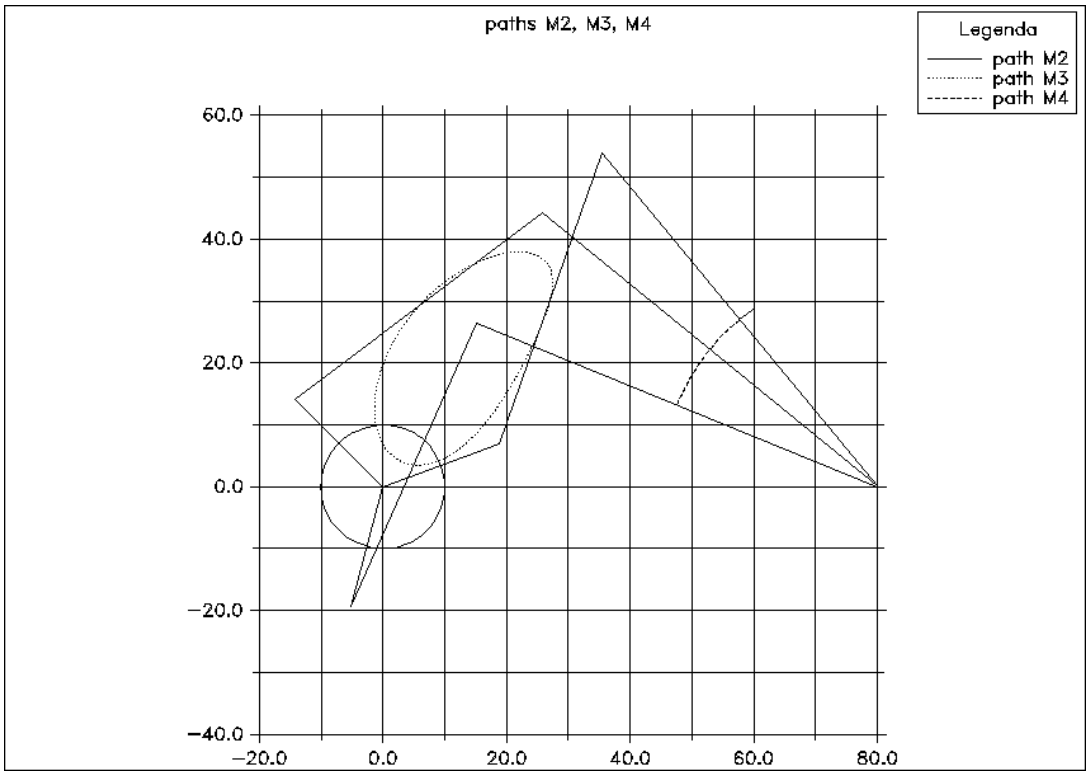
- the main program *main*, which has the only purpose to call the procedures;
- the module *mod* which contains the parameters **1.1** and the following procedures:
  - subroutine *inverse* which inverts the jacobian matrix;
  - subroutine *paths* which plots the paths of the points M_2, M_3, M_4;
  - subroutine *congruent* which calculates, using Newthon-Raphson, the congruent configuration for each value of $\theta_2 \in [0,2\pi]$;
  - subroutine *frame* which plots some of the configurations determined.

Here you can see the flow diagram.




calls *congruent*
to find the congruent configuration
for the value $\theta_2 = 20°$
congruent
assigns this configuration to $u(1:9,1)$
i<=360°/5°
false
true
assign $u(9,i) = u(9,i) + 20°$ and
determines the new congruent configuration
calling *congruent*
congruent
puts the congruent configuration in $u(:,i+1)$
$i = i + 1$
calls *paths* to plot the paths of the moving
bars' middle points
path
i<=360°/5°
false
stop
true
calls *frame* to plot the configuration $u(:,i)$
frame
$i = i + 1$

The graphic output of this code is represented by the following figure where you can see the paths of the three middle points M_2, M_3, M_4, and also three configurations of the mechanism.



The configurations plotted by the subroutine *frame* have been used to make an animation of the mechanism where the angular speed of the moving bar is 50°/s.