DSM **2024** **Homework #05**

Deadline: March 26, 2024 (via dropbox)

(Dropbox file request: https://www.dropbox.com/request/7iEiEkZqNiFQ2WRSZ7H1

Name:_____**Number:**_____

Use the MuboDAP code, distributed via dropbox and demonstrated in class to study the dynamics of multibody system associated to your student number. All systems are landing gears for airplanes. An actuator involving the shaded bodies shown in the figures acts the landing gear mechanism shown in the figure. The complete mass of the landing gear (airplane fuselage not included) is 200Kg, which you may distribute appropriately among all bodies involved in your model.

Deliver the following contents:

a) In the exploded views of each body identify the body fixed frames, points required to define the kinematic joints and provide their coordinates.

b) Establish a set of initial positions and initial velocities for the bodies that are consistent with the kinematic constraints.

c) Show, in tables, the data for the multibody model to be used in MuboDAP (assign values for masses and moments of inertia of the moving body.

d) Simulate the system using MuboDAP and deliver:

   (i) Input file for the model;

   (ii) In a graph show the position of the wheel center as function of the actuator extension; and, in another XY graph, the trajectory of the wheel center.

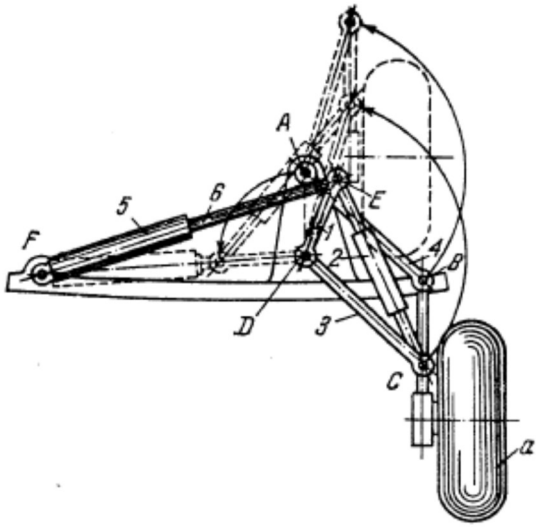
   (iii) The joint reaction forces on the joints defined in point B for the actuation selected for the pneumatic actuator;

(Note: The second part of your exam will have a structure not very different from this homework)

NOTE: (New way to calculate the number of your mechanism) Depending on your student number, select one of the 4 mechanisms for your homework. The algorithm for the selection is:
SystemNumber = 9xStudentNumber – Integer(9xStudentNumber/4)x4 + 1.
Note that Integer(9*StudentNumber/4) is the integer obtained by truncation of the real number. In `Matlab` just calculate the mechanism number using:

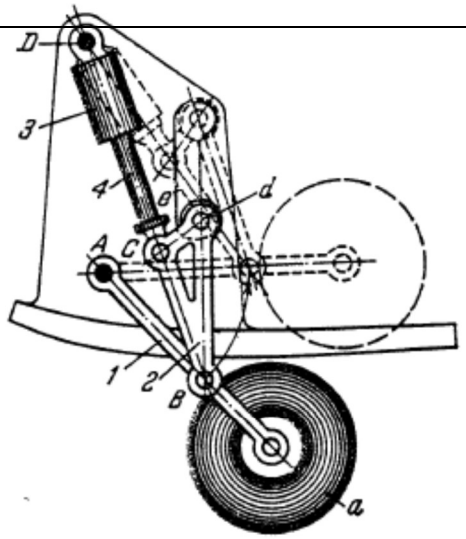
```
SystemNumber = 9*StudentNumber - floor(9*StudentNumber/4)*4+1;
```

SystemNumber 1



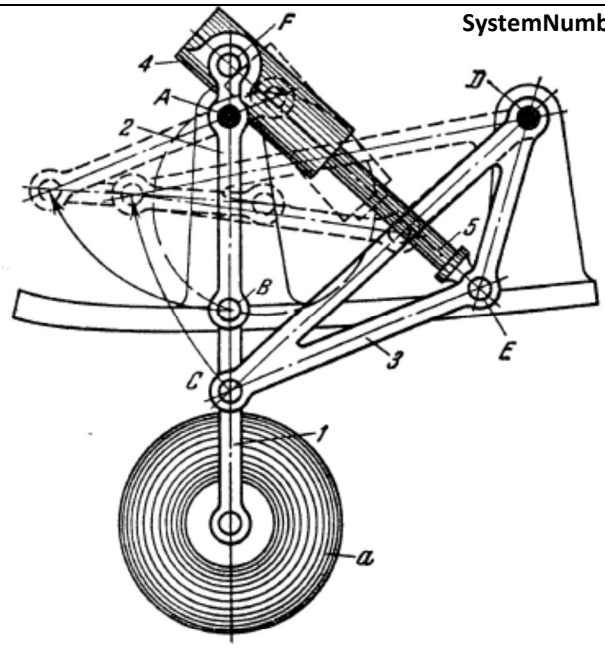
The lengths of the links comply with the conditions: $\overline{AB} = \overline{DC}$ and $\overline{AD} = \overline{BC}$. Thus, figure $ABCD$ is a parallel-crank linkage whose connecting rod BC mounts landing wheel a. Links *1* and *3* turn about fixed axis D of the aircraft frame member. Oil shock absorber *2* is mounted between points E and C. Hence, the whole system EDC turns about common axis D. Retracting cylinder *5* turns about fixed axis F of the aircraft frame and its piston rod *6* is connected by turning pair E to system EDC. When piston rod *6* moves into retracting cylinder *5*, links *1*, *3* and *4* are turned counterclockwise, and the landing gear is retracted as shown by the dash lines.

SystemNumber 2



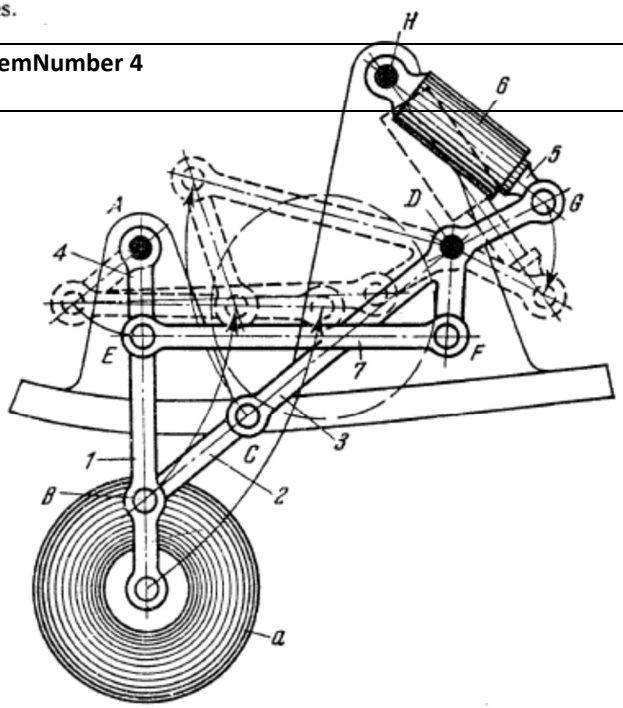
Link *1* with wheel *a* turns about fixed axis A of the aircraft frame member. Link *2* is connected by turning pairs B and C to links *1* and piston rod *4* of retracting cylinder *3*. Cylinder *3* turns about fixed axis D of the aircraft frame. Link *2* has roller *d* which slides freely along slot *e* of the aircraft frame. When piston rod *4* moves into retracting cylinder *3*, link *1* turns counterclockwise, and the landing gear is retracted as shown by the dash lines. At the extreme positions of link *2*, its roller *d* enters notches of slot *e* thereby relieving the load on the retracting cylinder.

SystemNumber 3



Link *2* turns about fixed axis *A* of the aircraft frame member. Link *1* with wheel *a* is connected by turning pairs *B* and *C* to links *2* and *3*. Link *3* turns about fixed axis *D* of the aircraft frame. Piston rod *5* of retracting cylinder *4* is connected by turning pair *E* to link *3*. Cylinder *4* is connected by turning pair *F* to link *2*. When piston rod *5* moves into retracting cylinder *4*, links *2* and *3* are turned clockwise, and the landing gear is retracted as shown by the dash lines.

SystemNumber 4



The lengths of the links comply with the conditions: $\overline{AE} = \overline{DF}$ and $\overline{EF} = \overline{AD}$, i.e. figure *AEFD* is a parallel-crank linkage. Links *4* and *3* turn about fixed axes *A* and *D* of the aircraft frame member. Link *1* with wheel *a* is connected by turning pairs *B*, and *E* to links *2* and *4*. Link *2* is connected by turning pair *C* to link *3*. Piston rod *5* of retracting cylinder *6* is connected by turning pair *G* to link *3*. Cylinder *6* turns about fixed axis *H* of the aircraft frame. When piston rod *5* moves out of retracting cylinder *6*, link *1* is turned counterclockwise and link *3* clockwise, and the landing gear is retracted as shown by the dash lines. When the landing gear is lowered, links *1* and *4*, and *2* and *3* are fixed in their extreme (dead centre) positions, forming a truss.