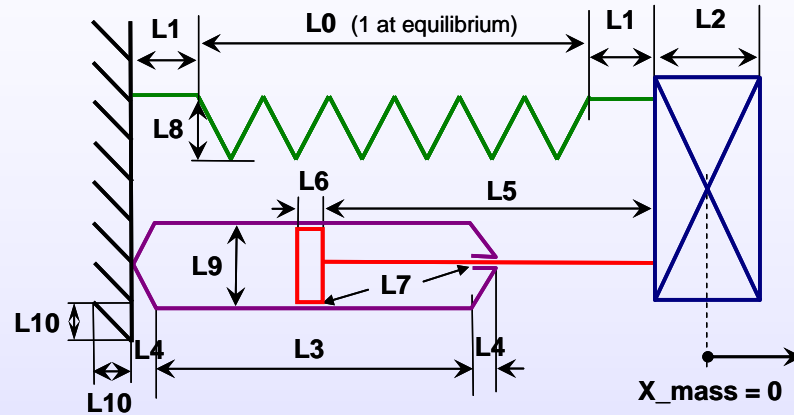


A casual approach to numerical modeling - part #4

a Spring-Mass-Damper-System - creating the animation



- We are trying to generate animation for the system sketched above knowing the deviation from the equilibrium function of time. This deviation is calculated dynamically by using a macro. The formulas and the VBA macros were presented in the previous tutorial.

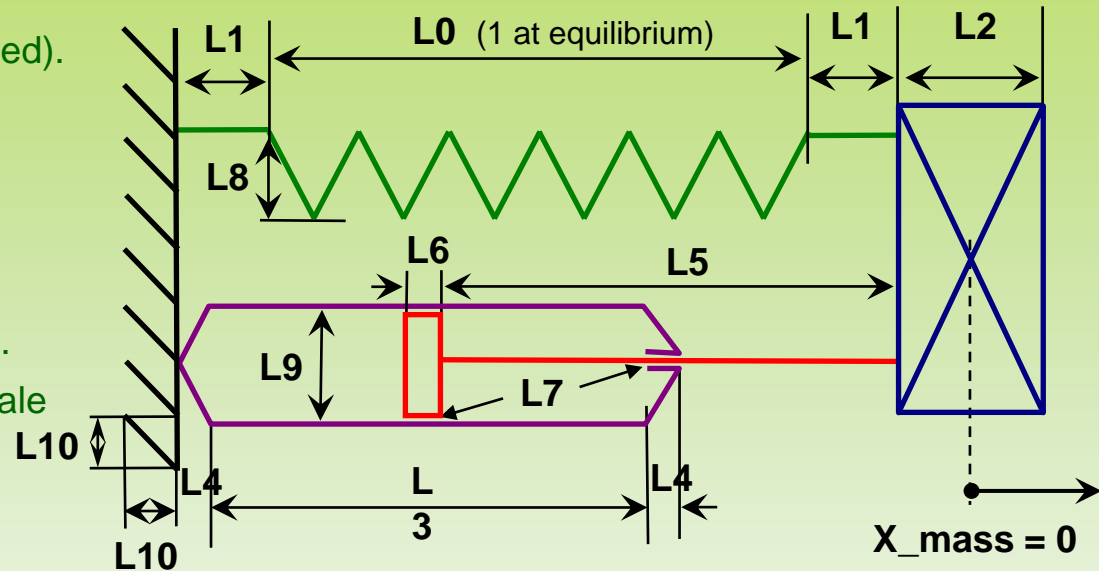


This is a sketch of the system:

- System shown in equilibrium (spring unstressed).
- The only value calculated by our system of equations is the coordinate "x_mass". This coordinate will change (will be animated) during the run of the simulation.

When x_mass is zero the spring is unstressed.

- This input parameters (K, m, DC) will also scale certain elements of the drawn system.

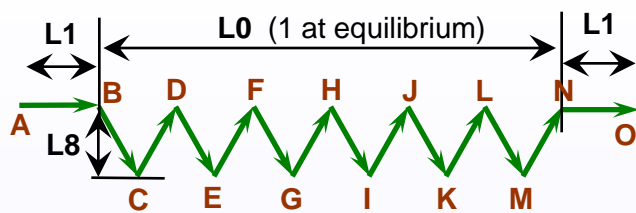


The master dimension table:

- This table contains all the dimensional information regarding the system
- The top range G25:H25) is the proof mass position (y=0 and x is taken from the table of coordinates, which is updated during the simulation run by the macro)
- The series L1, L3, L4, L5, L6, L7 and L10 are constants chosen by trial and error
- $L0 = 1 + X_mass$ (the free spring length is 1 meter, X_mass is the stretch)
- $L2 = 0.2 * \text{Mass}$ (the width of the mass is chosen proportional to the value of the mass – the proportionality factor (0.2) is arbitrary)
- $L8 = 0.15 / K$ (the width of spring is chosen inversely proportional to the spring constant K – again, the proportionality factor (0.15) is arbitrary)
- L9, the width of the damper is drawn proportional to the square root of the damping coefficient (see the formula in the worksheet) hence the cross sectional area of the damper is proportional to the damping coefficient

	F	G	H	I
24		X_mass	Y_mass	
25		0.02543	0	
26				
27		L0	1.02543	
28		L1	0.2	
29		L2	0.08	
30		L3	0.9	
31		L4	0.05	
32		L5	0.85	
33		L6	0.1	
34		L7	0.017	
35		L8	0.15	
36		L9	0.05844	
37		L10	0.08	
38				

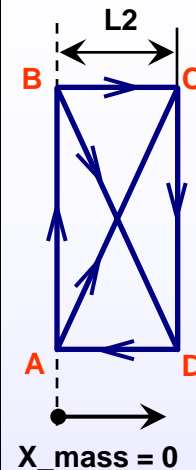
----- Drawing the spring -----



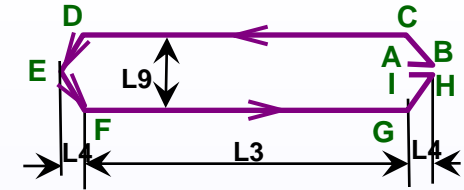
A	$-2*L1-1$	$3*L10$
B	$-L1-1$	$3*L10$
C	$-L1-1+L0/12$	$3*L10-L8$
D	$-L1-1+2*L0/12$	$3*L10$
E	$-L1-1+3*L0/12$	$3*L10-L8$
F	$-L1-1+4*L0/12$	$3*L10$
G	$-L1-1+5*L0/12$	$3*L10-L8$
H	$-L1-1+6*L0/12$	$3*L10$
I	$-L1-1+7*L0/12$	$3*L10-L8$
J	$-L1-1+8*L0/12$	$3*L10$
K	$-L1-1+9*L0/12$	$3*L10-L8$
L	$-L1-1+10*L0/12$	$3*L10$
M	$-L1-1+11*L0/12$	$3*L10-L8$
N	$-L1-1+L0$	$3*L10$
O	$-1+L0$	$3*L10$

--- Drawing the proof mass ---

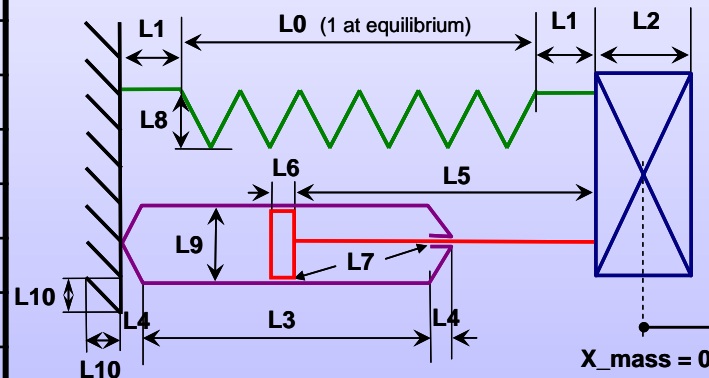
A	X_mass	$-5*L10$
B	X_mass	$5*L10$
C	X_mass+L2	$5*L10$
D	X_mass+L2	$-5*L10$
A	X_mass	$-5*L10$
C	X_mass+L2	$5*L10$
--- data gap needed here ---		
B	X_mass	$5*L10$
D	X_mass+L2	$-5*L10$



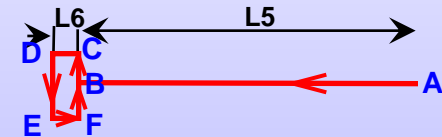
--- The damper body ---



A	$-2*L1-1+L3+L4$	$-3*L10+L7$
B	$-2*L1-1+L3+2*L4$	$-3*L10+L7$
C	$-2*L1-1+L3+L4$	$-3*L10+L9/2+L7$
D	$-2*L1-1+L4$	$-3*L10+L9/2+L7$
E	$-2*L1-1$	$-3*L10$
F	$-2*L1-1+L4$	$-3*L10-L9/2-L7$
G	$-2*L1-1+L3+L4$	$-3*L10-L9/2-L7$
H	$-2*L1-1+L3+2*L4$	$-3*L10-L7$
I	$-2*L1-1+L3+L4$	$-3*L10-L7$



----- The damper piston -----



A	X_mass	$-3*L10$
B	X_mass-L5	$-3*L10$
C	X_mass-L5	$-3*L10+L9/2$
D	X_mass-L5-L6	$-3*L10+L9/2$
E	X_mass-L5-L6	$-3*L10-L9/2$
F	X_mass-L5	$-3*L10-L9/2$
G	X_mass-L5	$-3*L10$

- All this animation is created from pieces of various colors using the path and coordinates shown in each table in order: **A=>B=>C=>D=>E=>**

- Creating the base plate is left as an exercise to the reader (if you encounter major problems you could cheat and look in the worksheet)