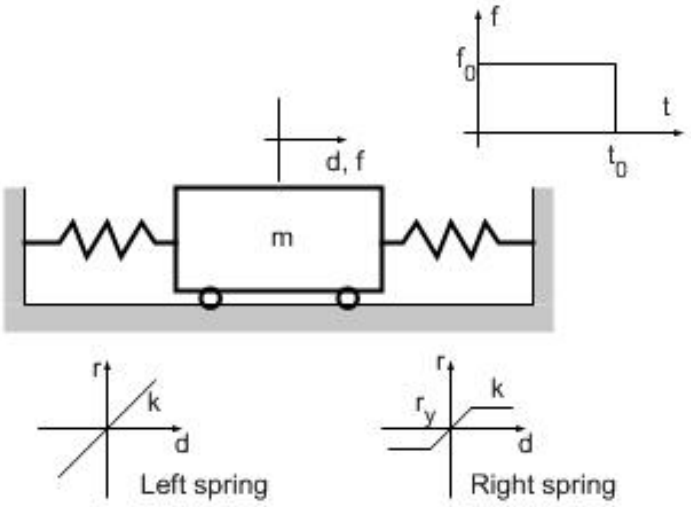
nees@berkeley Hybrid Simulation Workshop:

SDOF Example

Compute the response of a SDOF system shown below using "hybrid simulation". Form four-person teams and divide the roles as follows:

- First member: Left spring
- Second member: Right spring
- Third member: Given resistance and force, compute target displacement
- Fourth member: Compute initial conditions, then, in each step assemble spring forces, request displacement target, disseminate displacement target to springs



System properties:

- Natural period 1 sec; damping ratio 5%:
  - Mass m=0.0761 kips-sec^2/in
  - Stiffness k=1.5 kips/in (for each spring)
  - Damping coefficient c=0.0478 kips-sec/in
- Spring yield force r_y=0.5 kip.

Excitation properties:

- Duration t0=0.5 sec
- Intensity f0=1.5 kips

Complete system state (force and displacement) for 10 time-steps with $\Delta t = 0.1\text{sec}$

Pre-compute:

$a_0 = \frac{1}{m}(f_0 - cv_0 - r_0)$	
$d_{-1} = d_0 - \Delta t v_0 - \frac{\Delta t^2}{2} a_0$	
$\frac{m}{\Delta t^2}$	
$\frac{c}{2\Delta t}$	

Iterate:

$$d_{i+1} = \frac{1}{\frac{m}{\Delta t^2} + \frac{c}{2\Delta t}} \left[\frac{2m}{\Delta t^2} d_i - \left(\frac{m}{\Delta t^2} - \frac{c}{2\Delta t} \right) d_{i-1} - r_i + f_i \right]$$

Results:

Time (sec)	Excitation f (kips)	Total resistance r (kips)	Mass displacement d (in)
0	1.5		
0.1	1.5		
0.2	1.5		
0.3	1.5		
0.4	1.5		
0.5	1.5		
0.6	0		
0.7	0		
0.8	0		
0.9	0		
1.0	0		