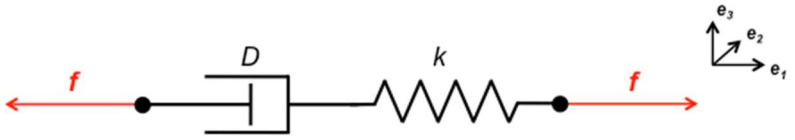
Introduction to Biomechanics VU 317.043

Tutorial 1

12.10.2021

1 Mechanical elements - Maxwell body

Consider the following lumped parameter model of the Maxwell body:



Hint: The extension in the dashpot and spring is different, whereas their force is the same.

Assuming the extension to jump to instantaneously rise to a magnitude x_0 (relaxation experiment):

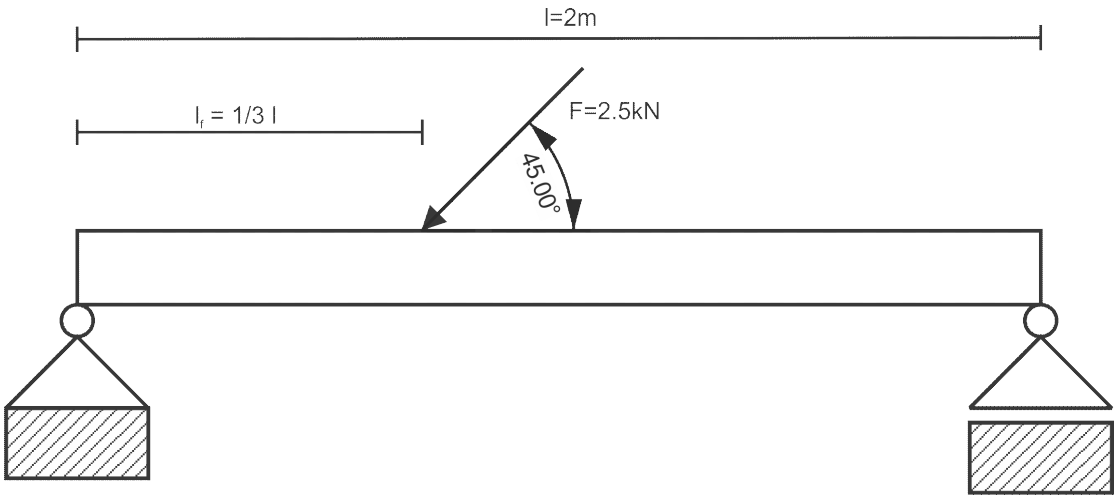
- derive an expression for the force $f_1(t)$ of the body
- sketch the progression of $f_1(t)$ qualitatively

Now assume the force to jump to instantaneously rise to a magnitude f_0 (creep experiment):

- derive an expression for the extension $x_1(t)$ of the body
- sketch the progression of $x_1(t)$ qualitatively

2 Statics- Beams

Determine required reaction forces and moments of the weightless beam. Sketch the internal forces n*(x) (normal force) and v(x) (shear force),* and the moment curve *M(x)*.



3 Dynamics

3.1 Jump

A person with a mass of 80kg is performing a jump from rest in a crouched position. The duration of the take of phase is τ = 180 ms and the vertical ground reaction force f_3 [N] can be described by:

$$f_3(t) = 2400\sin\left(\frac{\pi t}{\tau}\right) + 800\left(1 - \frac{t}{\tau}\right)$$

Calculate the peak height *h*, that the center of mass (COM) raises above its initial position.

3.2 Inertia

A slender, circular rod with cross-section $A = \frac{d^2\pi}{4}$ length *l* and density ρ is located with one end at the origin and oriented parallel to axis e_1. For a rotation around axis e_1, with the rotation centre located at the centre of mass calculate the moment of inertia.

Calculate the moment of inertia around axis e_3 with the rotation centre located at the centre of mass and at the origin. Further, calculate the radius of gyration, with the assumption that *d* is much smaller than *l*.

Hint: Use the parallel axis theorem to calculate the moment of inertia with respect to a new axis. $I = I_{cm} + md^2$, where I_{cm} is the moment of inertia at the centre of mass, *m* is the mass and *d* is the perpendicular distance to the new axis.