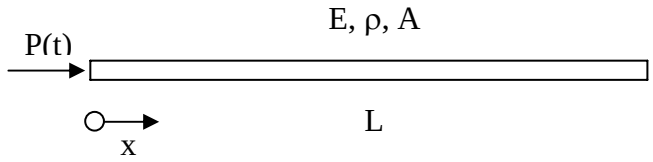
Finite element analysis of solid structures (FEM för mekanisk analys), M7009T

Task 2

Create a FEM-program that solves the dynamic 1-D bar problem with explicit integration.

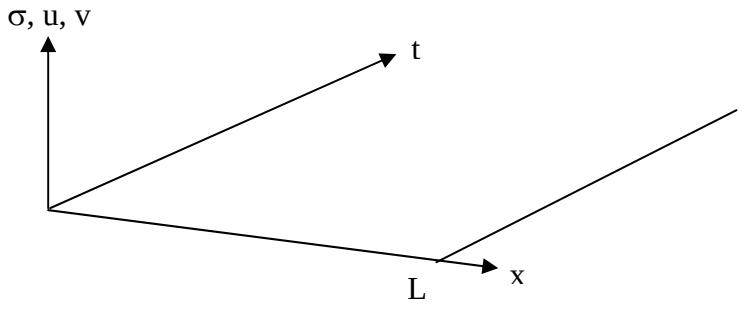


Examples on input data:

L: The bar's length
E: The material 's E-modulus
ρ : The material's density
A: The bar 's cross-section area
P(t): Load as function of time, can be given as a list where the load is stated for each time step or via a function in the programme
N: Number of elements
T: End time
Δt: Time step

Expected result presentation

Stress, displacement and velocity along the bar are presented in different diagrams at any given time. Can also be plotted in a certain position along the bar as function of time.
Plot also stress, displacement and velocity and present the results in 3-D according to the figure below.



The task can be carried out individually or in groups of two, a survey according to the list below is done by each group. The survey information is distributed among the groups.

Surveys

The boundary condition is normally a completely free bar. L is the entire bar's length.

1. Study and describe the difference in the results then P(t) is a square pulse with the wavelength L/3 and the bar's right end is free or clamped, respectively.

2. Compare the result when P(t) is a square pulse as well as a sinusoidal formed pulse with the wavelength L/3 having the same amplitude. For the sinusoidal pulse, assume a period that begins at ¾ *2*pi and add 1 to the function value (=> P(0)=0). Both ends are free.

3. Use sinusoidal pulse according to 2, wavelength L/3. Study the result when $\Delta t/\Delta t_{cr}$ is 0.5, 0.95, 1.05 respective 1.5.

4. Let P(t) be a step load from t=0. Plot the right end's velocity and the bar's average velocity (the mean of all node velocities) as function of the time.

5. Let the right half of the bar have the cross-section area 2A. Let the load be a sinusoidal pulse according to 2, wavelength L/3 (choose an even number of elements).

6. According to 5, but let the right half of the bar have half as long elements instead of varying the cross-section area.

7. According to 5, but let the right half of the bar have E-modulus E/2 instead of changing the cross-section area.

8. Let the right end of the bar be clamped and the rest of nodes having an initial velocity v_o, study the results.

The results + an analysis of the results should be presented during the last lecture, the last week (we have only time with a few minutes/group!).

Report

Front-page with names.

Describe your task, present and discuss the results.

The FEM-code is put in appendix.