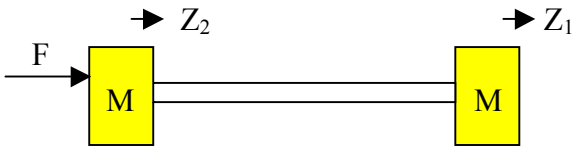
Feedforward Control

Short Course
HW 3

Consider the system of two masses (M) connected by a spring



The input u is force F and the output y is displacement Z_1. Note this is the non-collocated case.

1) Obtain a state space model with one FEM element for the rod. Find the poles and zeros of the system

2) Find the transfer function of the system (ss2tf) and verify the poles and zeros of the TF

3) The desired output acceleration d^2y/dt^2 is of the form Asin(wt). Choose A such that the output reaches 1 (y=1) after one period T = 10 s. The acceleration remains zero after the time period T. Obtain the velocity profile of the output as well as the position profile.

4) Find the internal dynamics of the system. Compare the poles of the internal dynamics with the zeros of the original system

5) Solve the internal dynamics; find the reference state trajectory X_{ref} and the inverse input U_{inv}.

6) Design your favorite feedback system. Simulate the output tracking of the system with this feedback (LSIM in MATLAB).

7) Add feedforward to feedback and simulate again.

8) Compare tracking results with and without feedforward (Steps 6 and 7).

9) Modify the system slightly before simulation (after finding feedforward and feedback controller to simulate parameter uncertainties). For example, change M by +- 1%. Repeat step 8.

10) Comparatively evaluate the feedforward and feedback inputs in Step 9.