



# Robot nonlinear control

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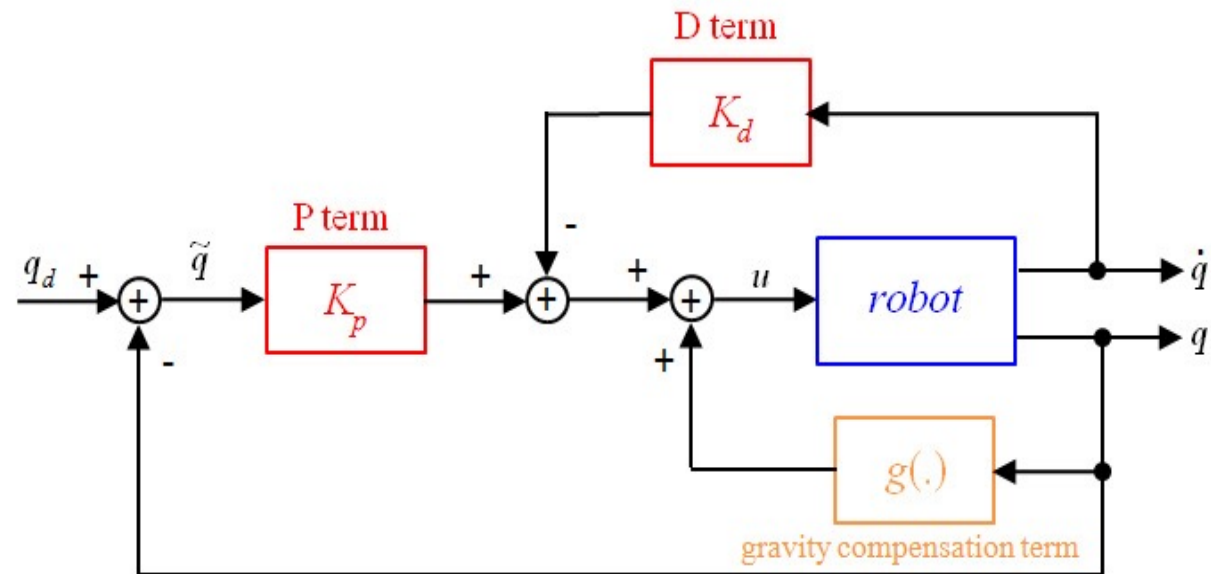
# Outline

- ♦ Nonlinear multivariable control
- ♦ Lyapunov stability
- ♦ PD control with gravity compensation
- ♦ Inverse dynamics
- ♦ Adaptive control

# Independent-joint v.s. Multivariable control

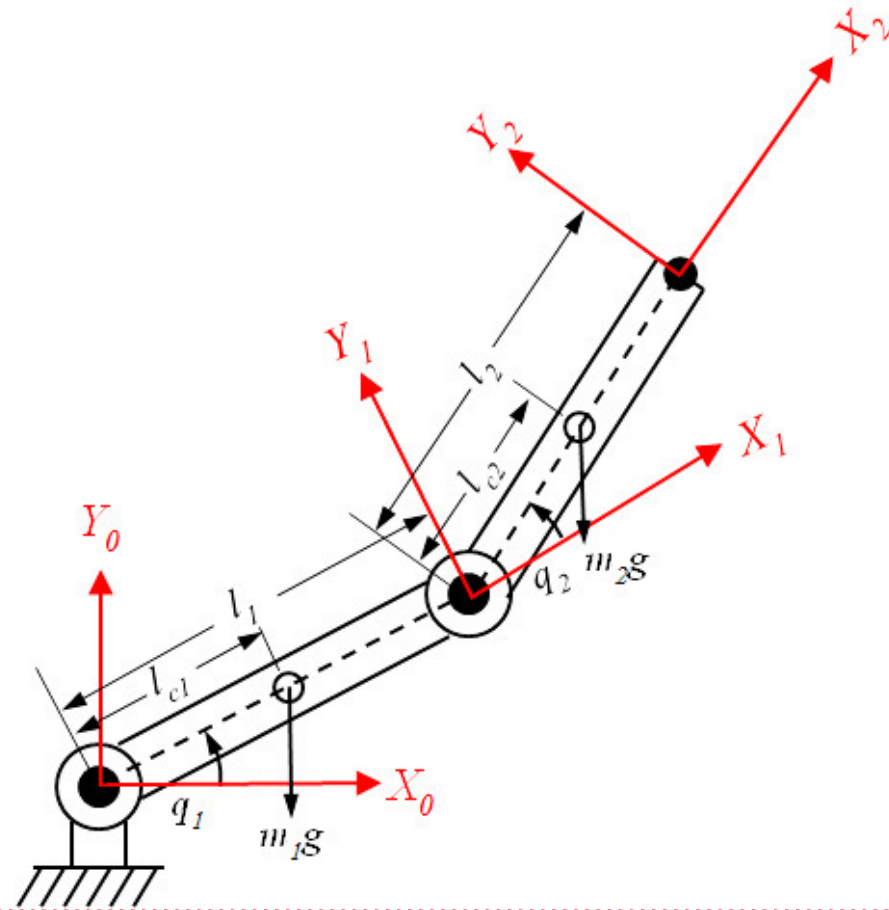
# Lyapunov stability

# PD control with gravity compensation



# Stability analysis

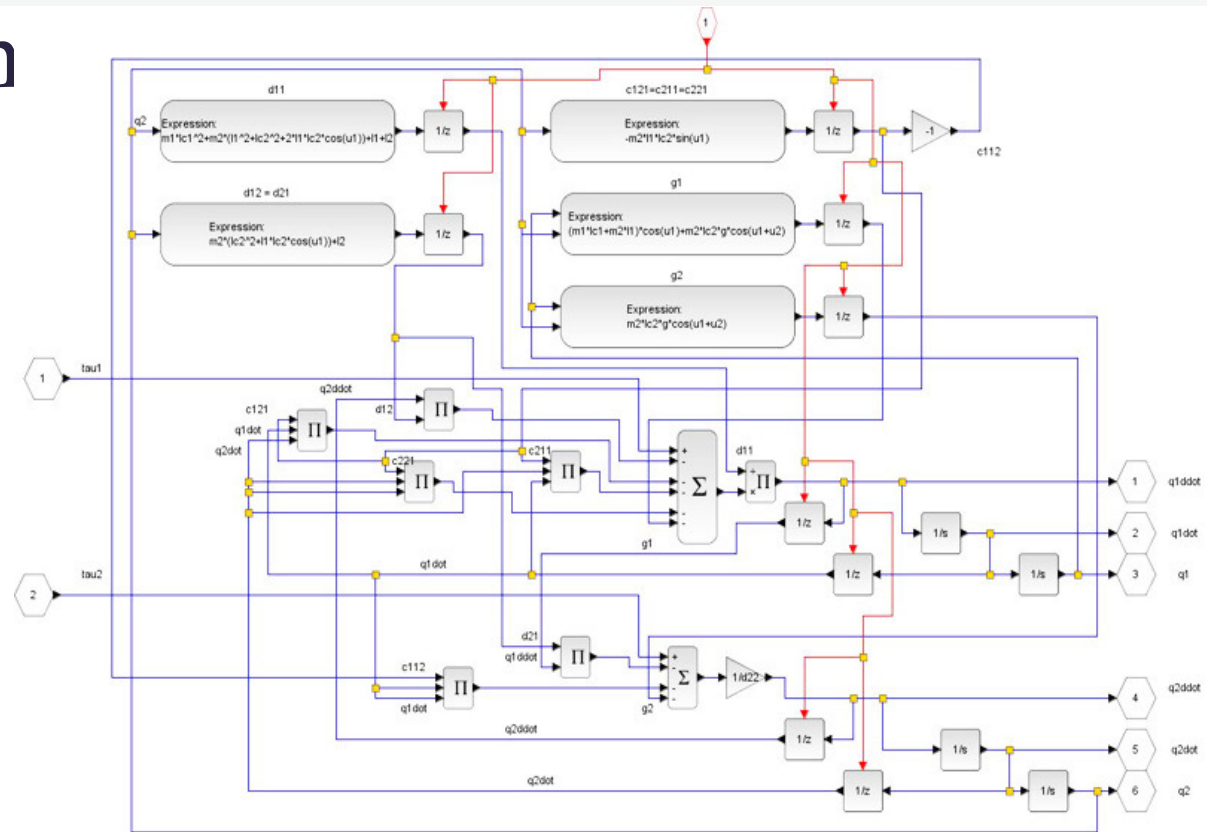
## 2-link manipulator



# Xcos diagram

`mdl_2link.zcos`

`/xcos/nonlinear_examples`

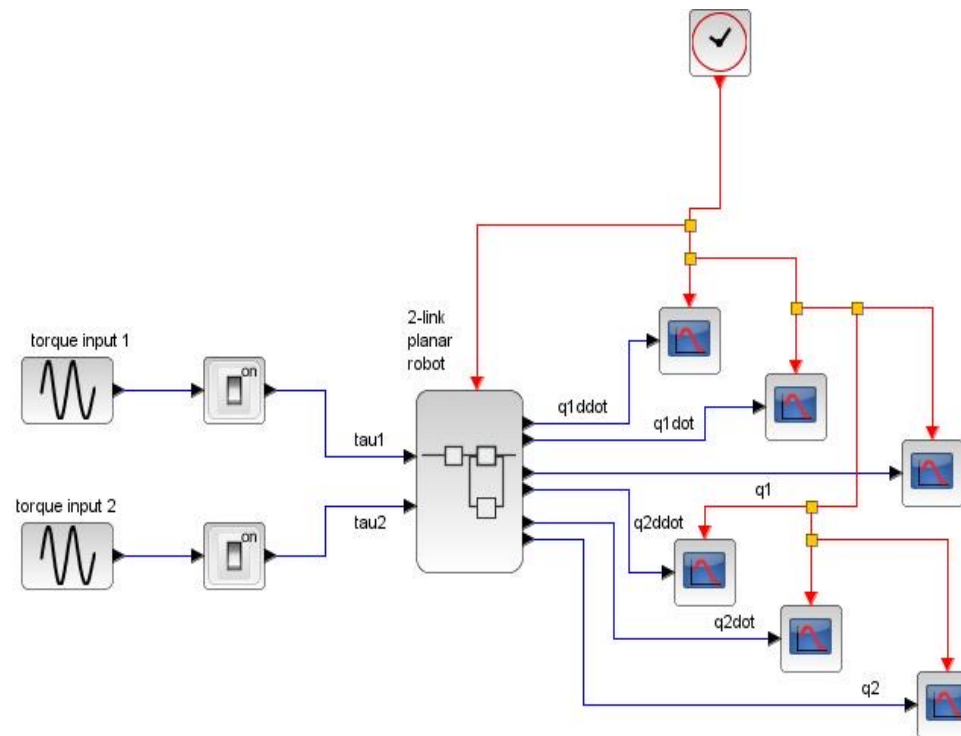


Note : use Scilab 5.5 for best result

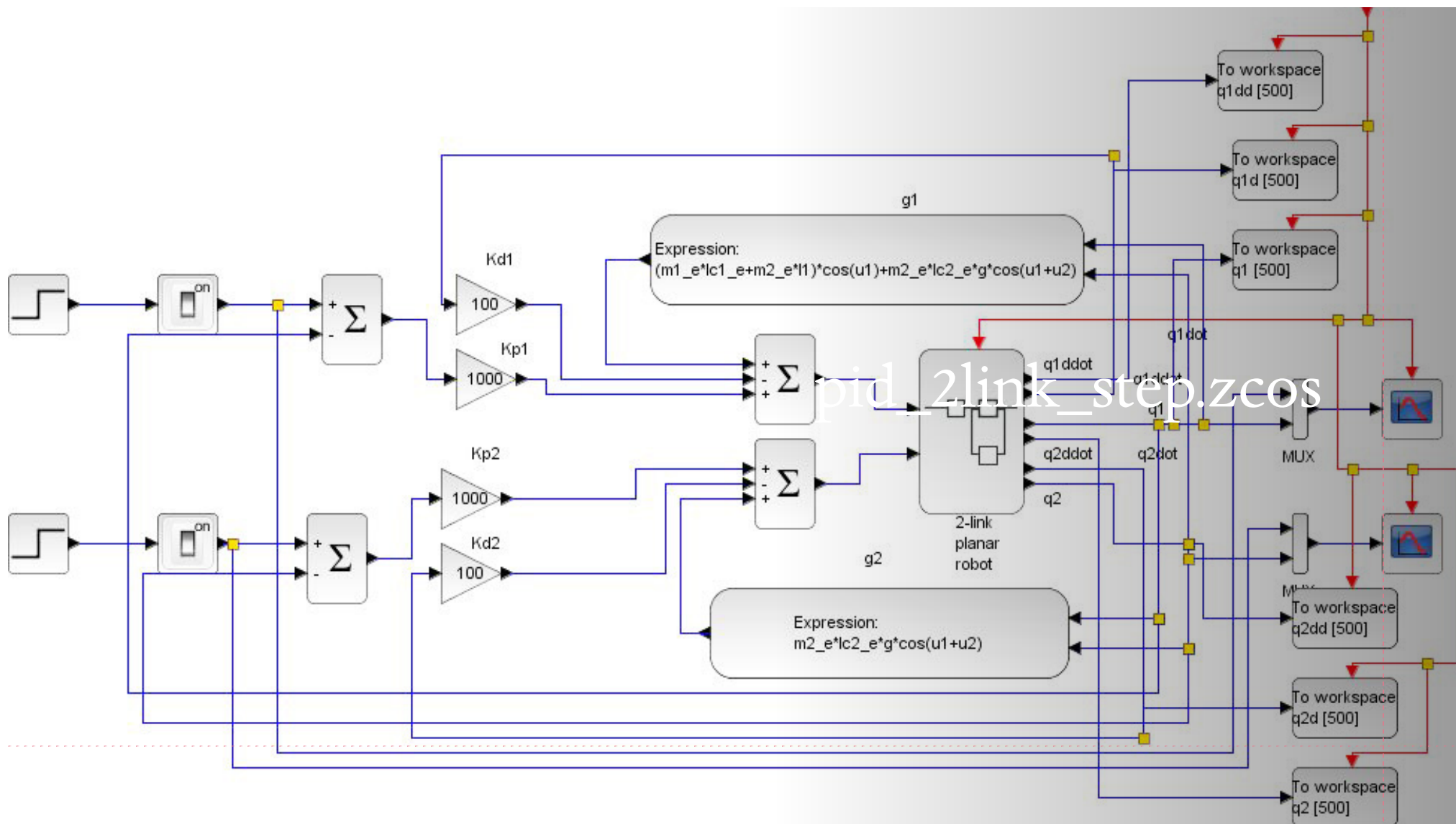


# mdl\_2link.zcos

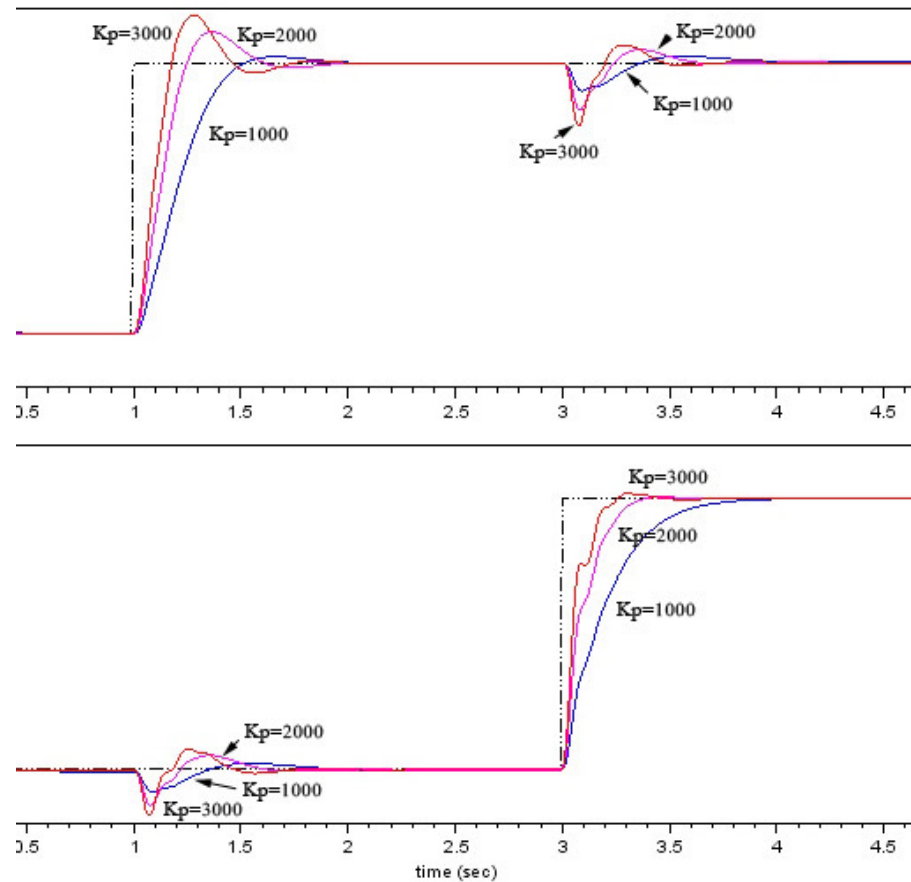
open-loop  
simulation



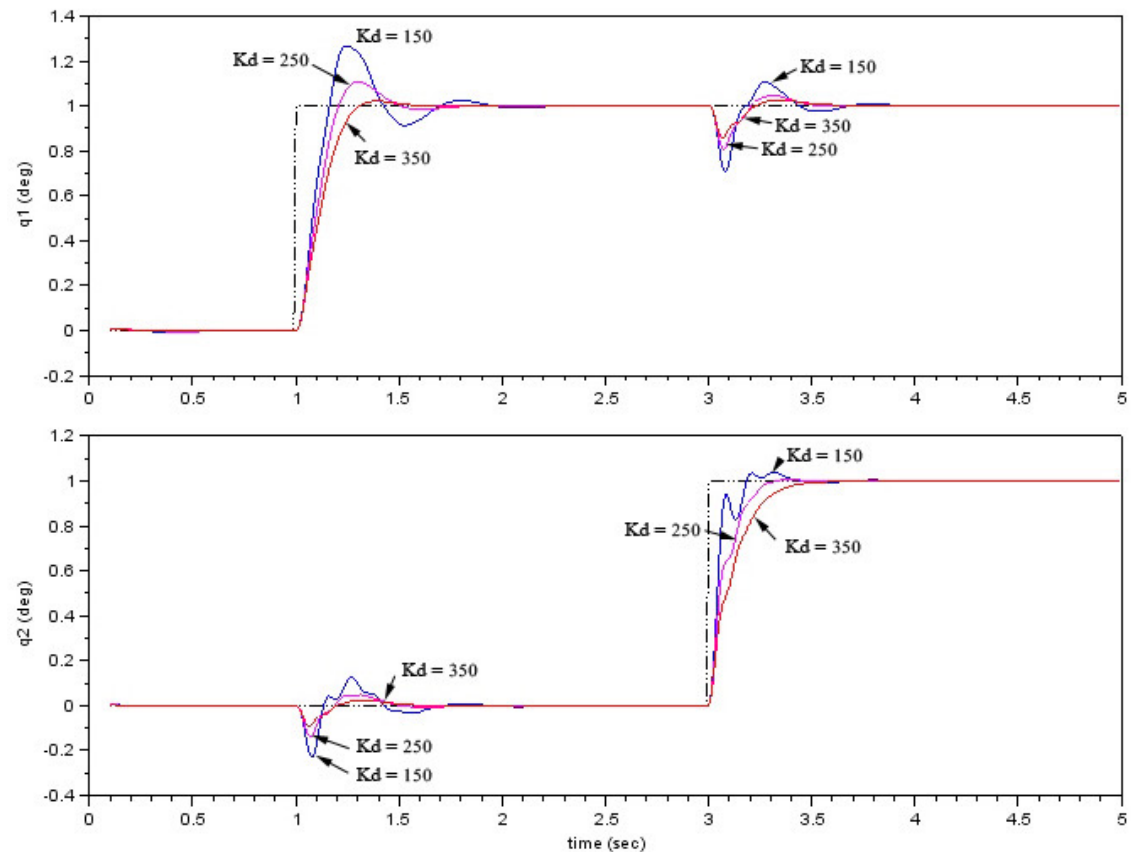
initialize variables with setup2link.sce



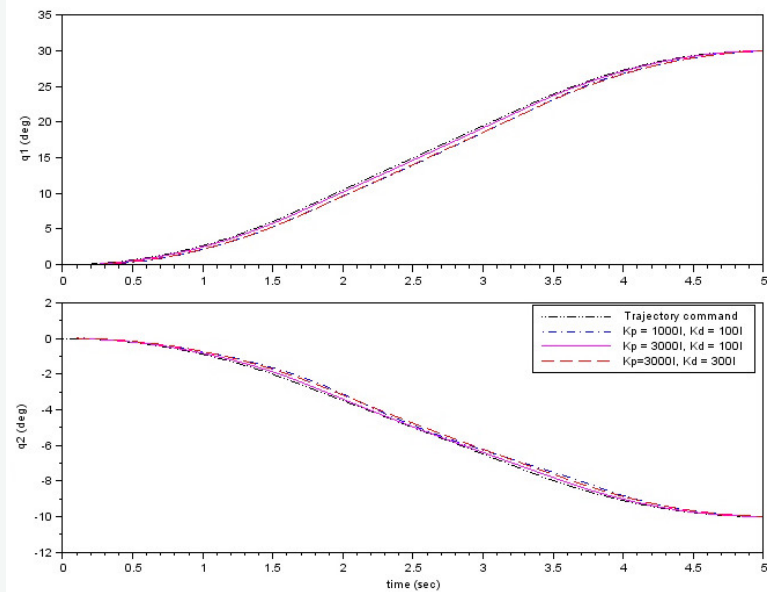
# Step response when $K_d$ fixed and $K_p$ varied



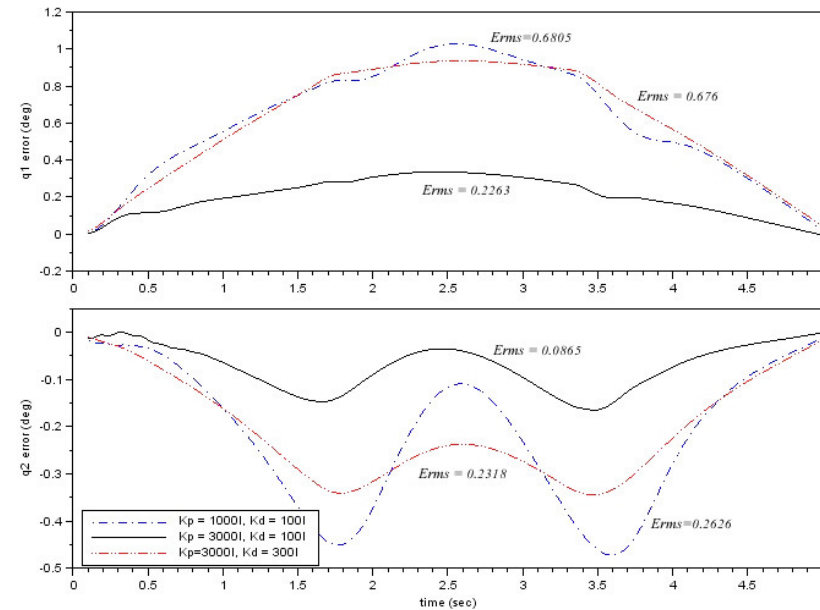
Step response  
when  $K_p$  fixed  
and  $K_d$  varied



# pid\_2link\_track.zcos

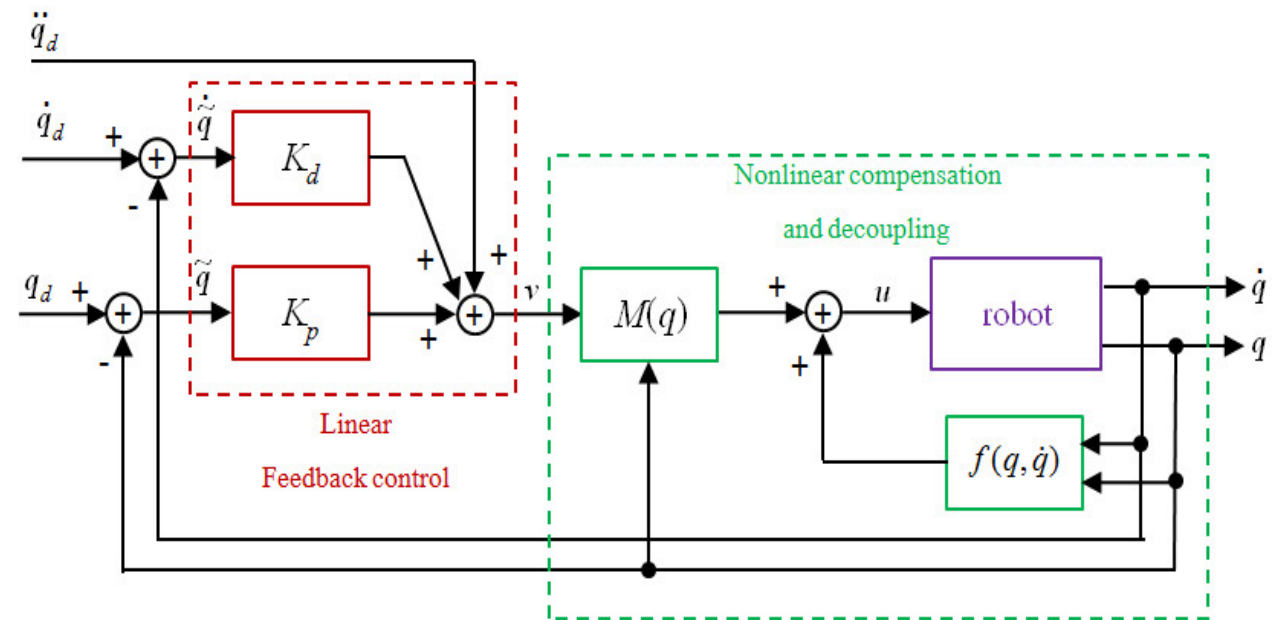


tracking response

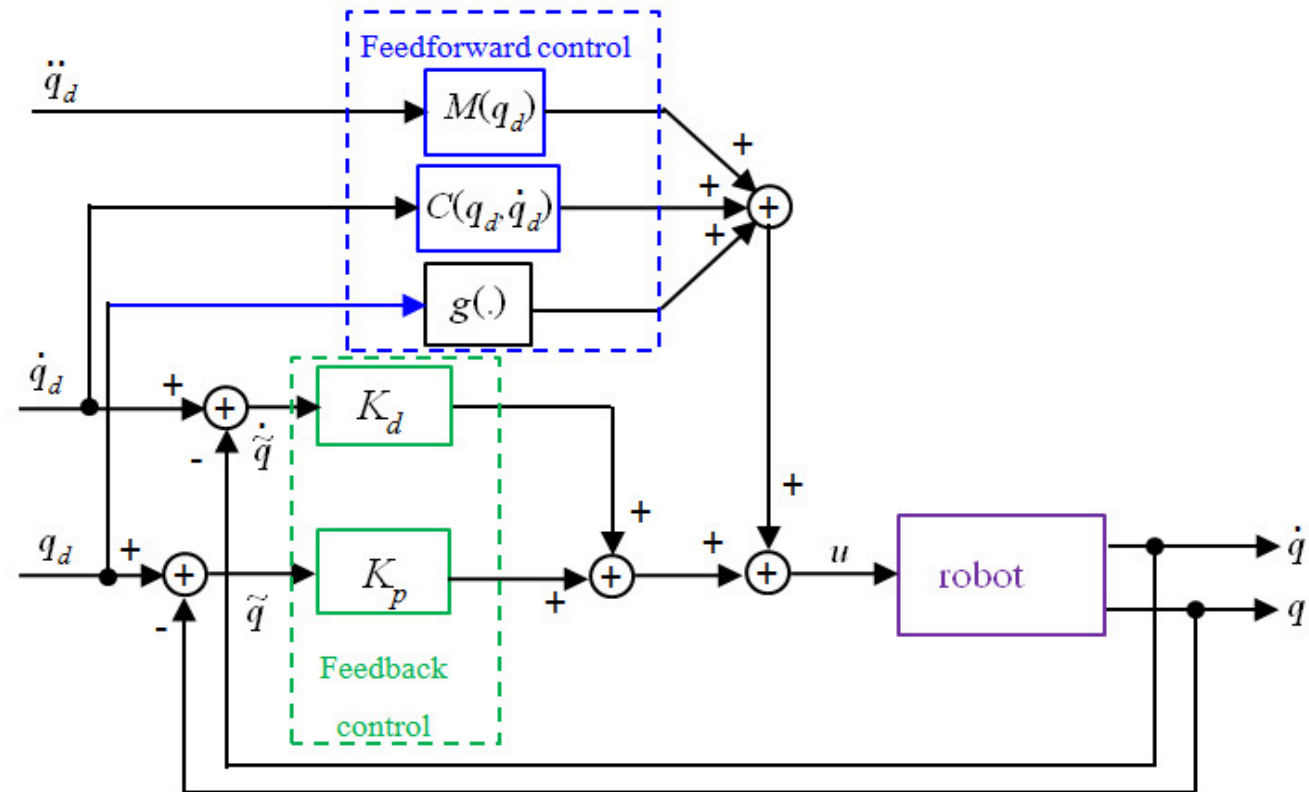


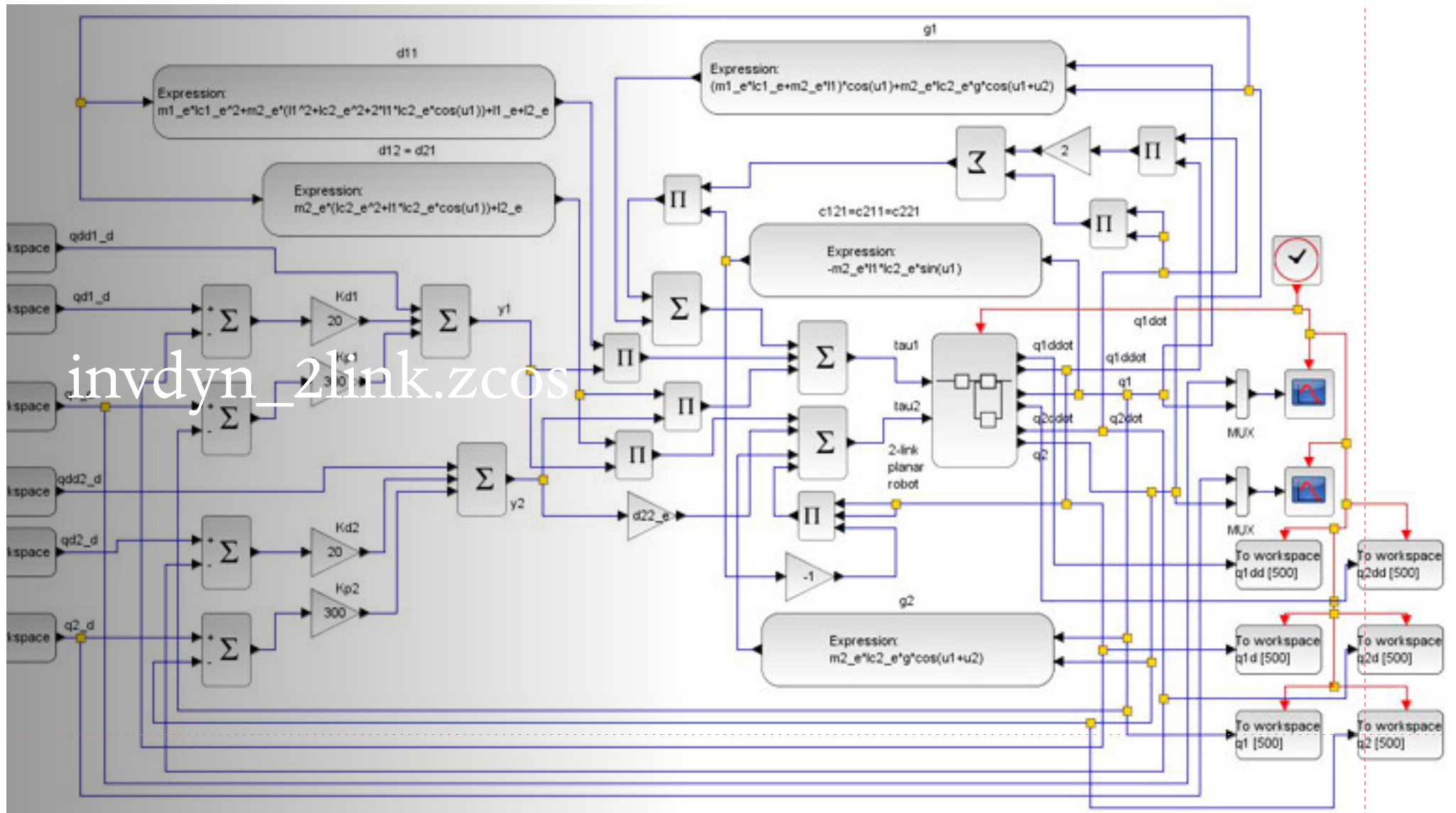
tracking error

# Inverse dynamics



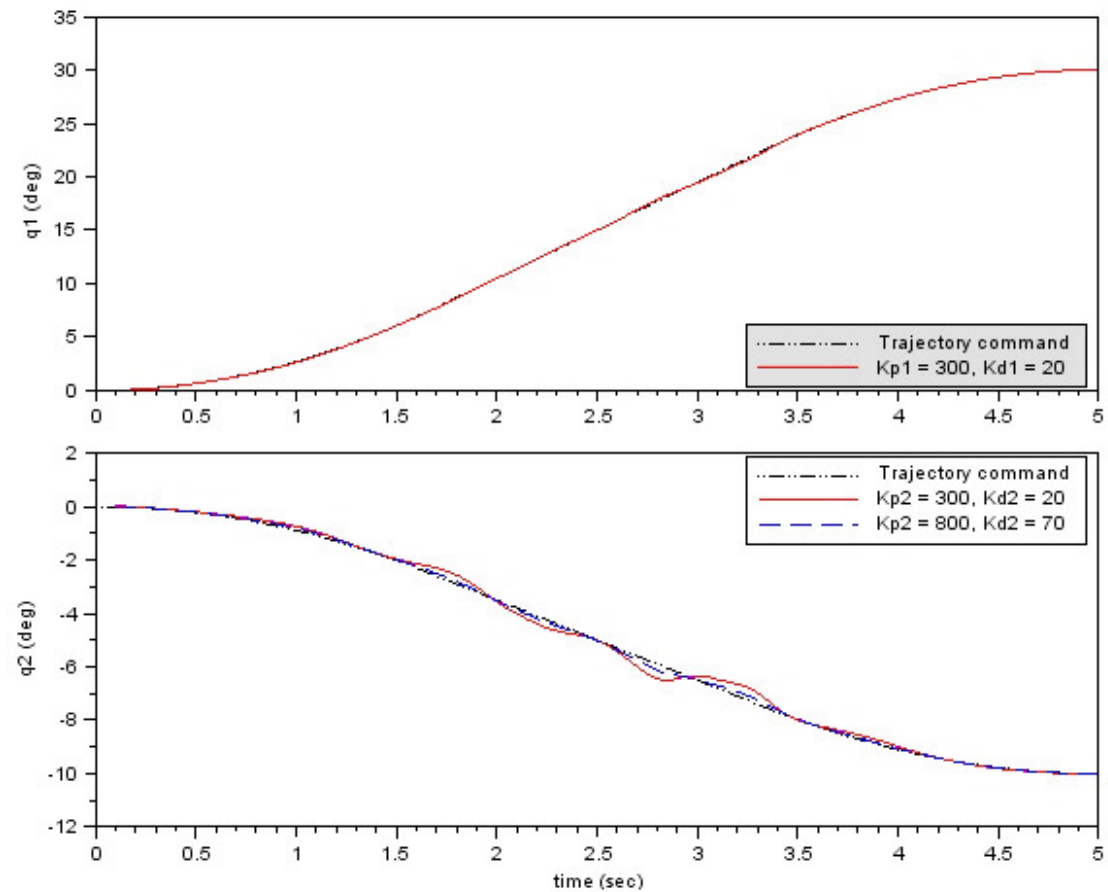
# Feedforward control



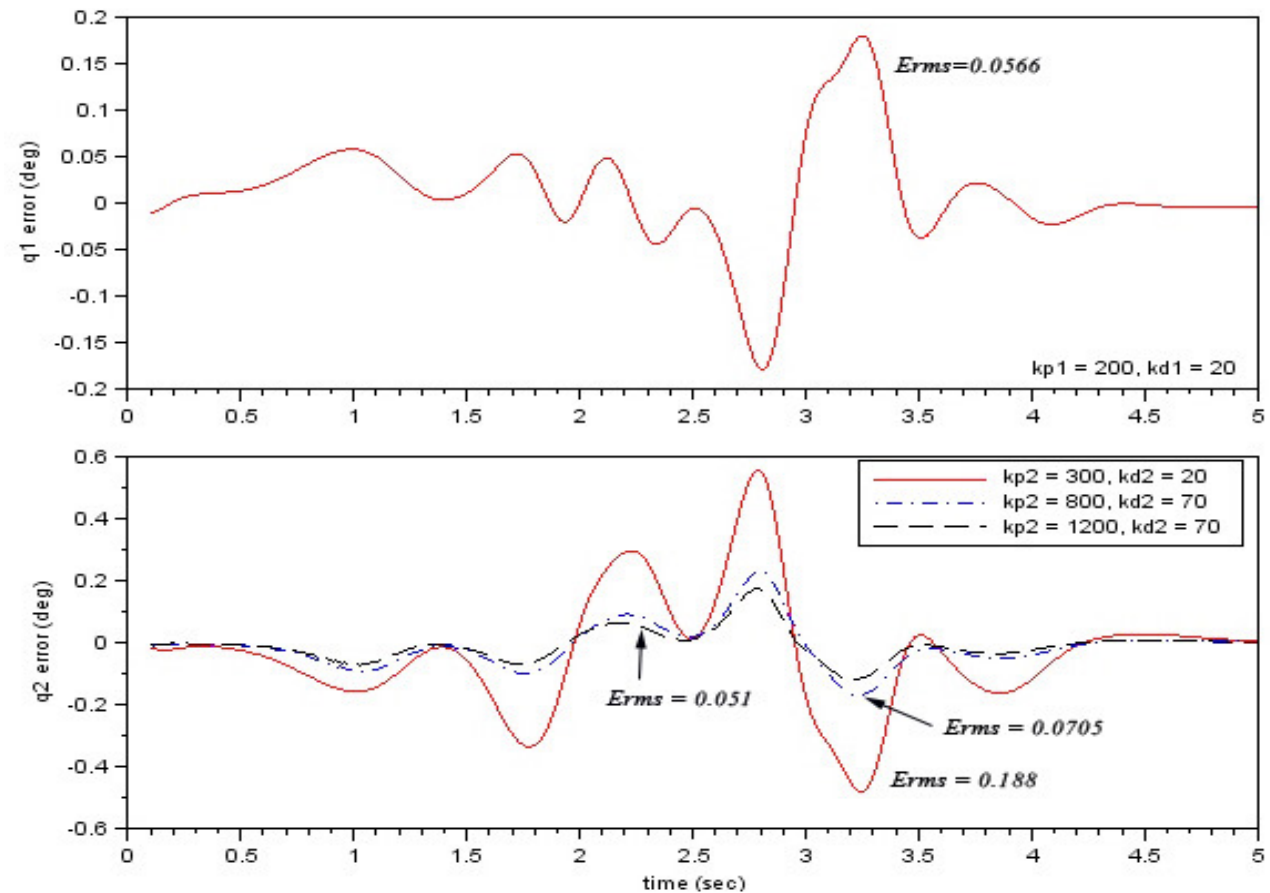




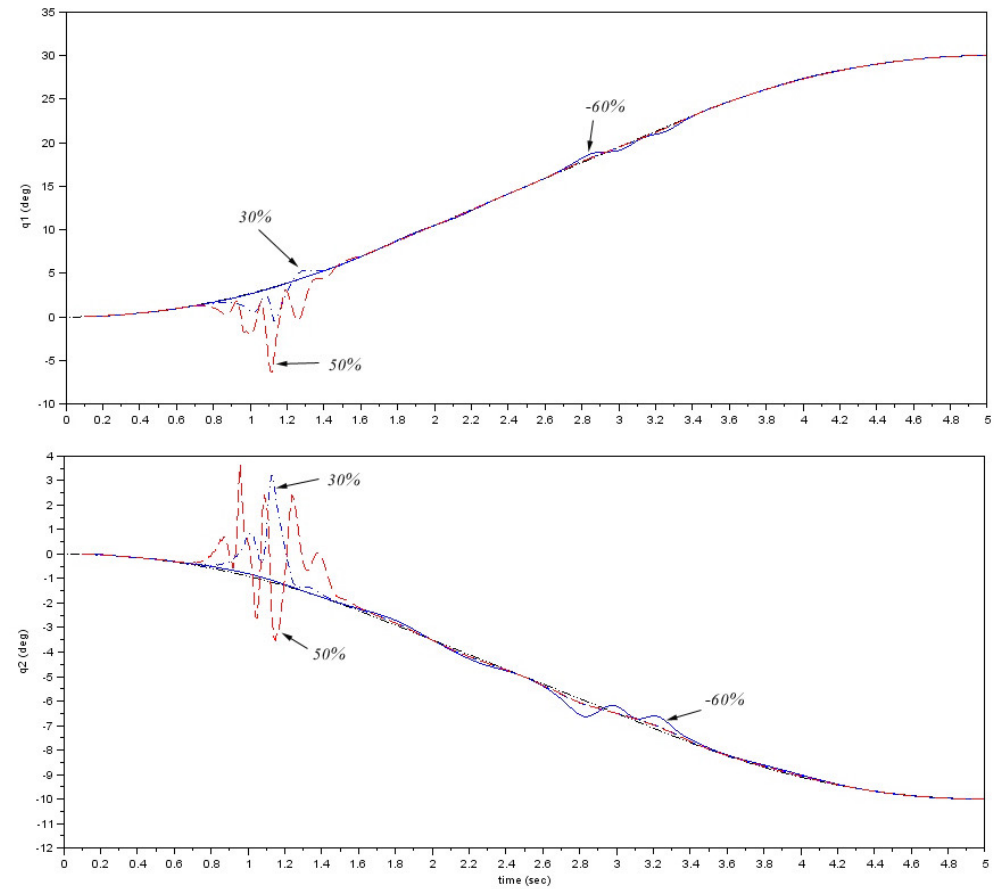
# Tracking performance



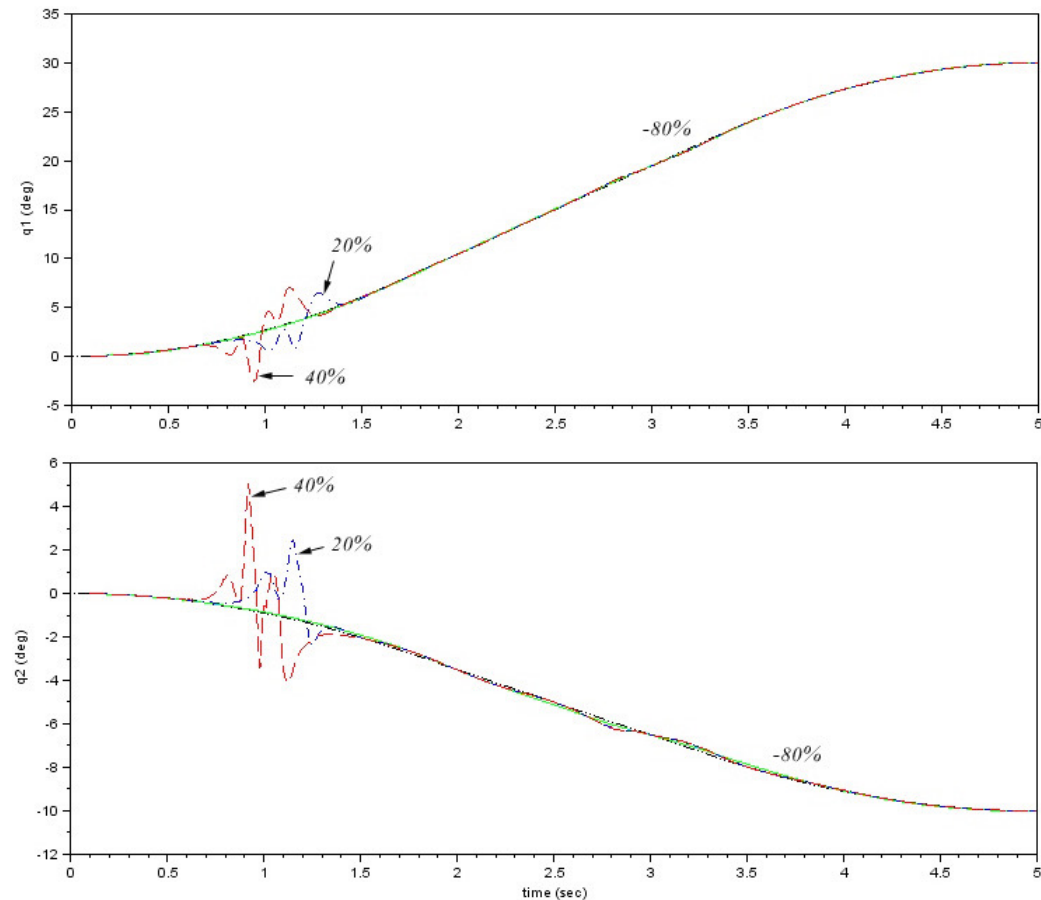
# Tracking error



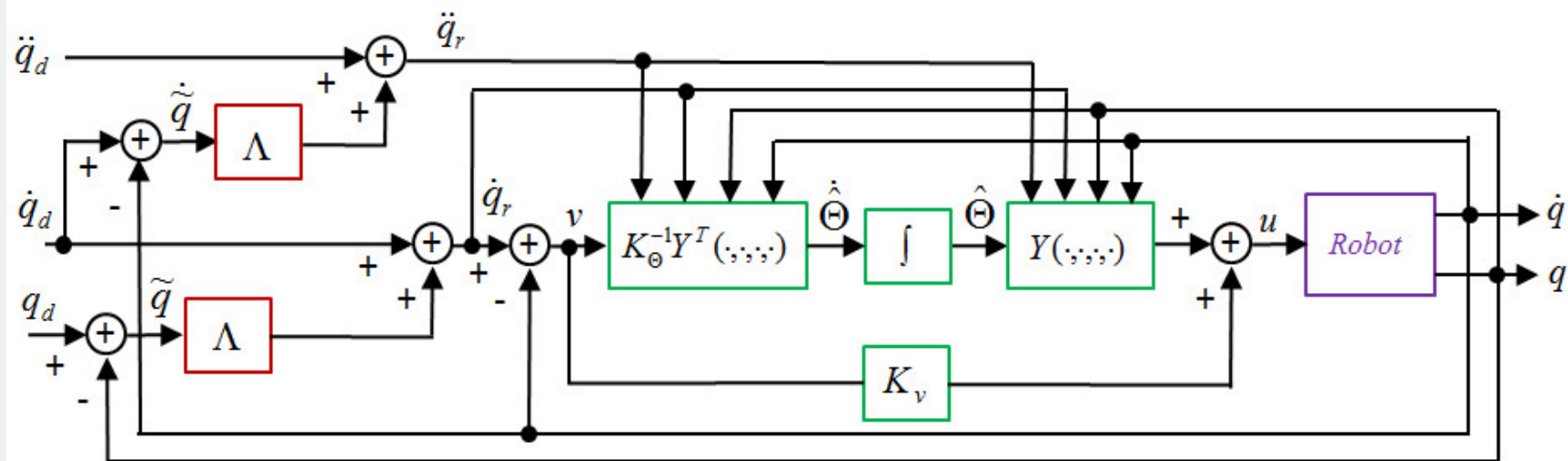
# Effect of inertia variation

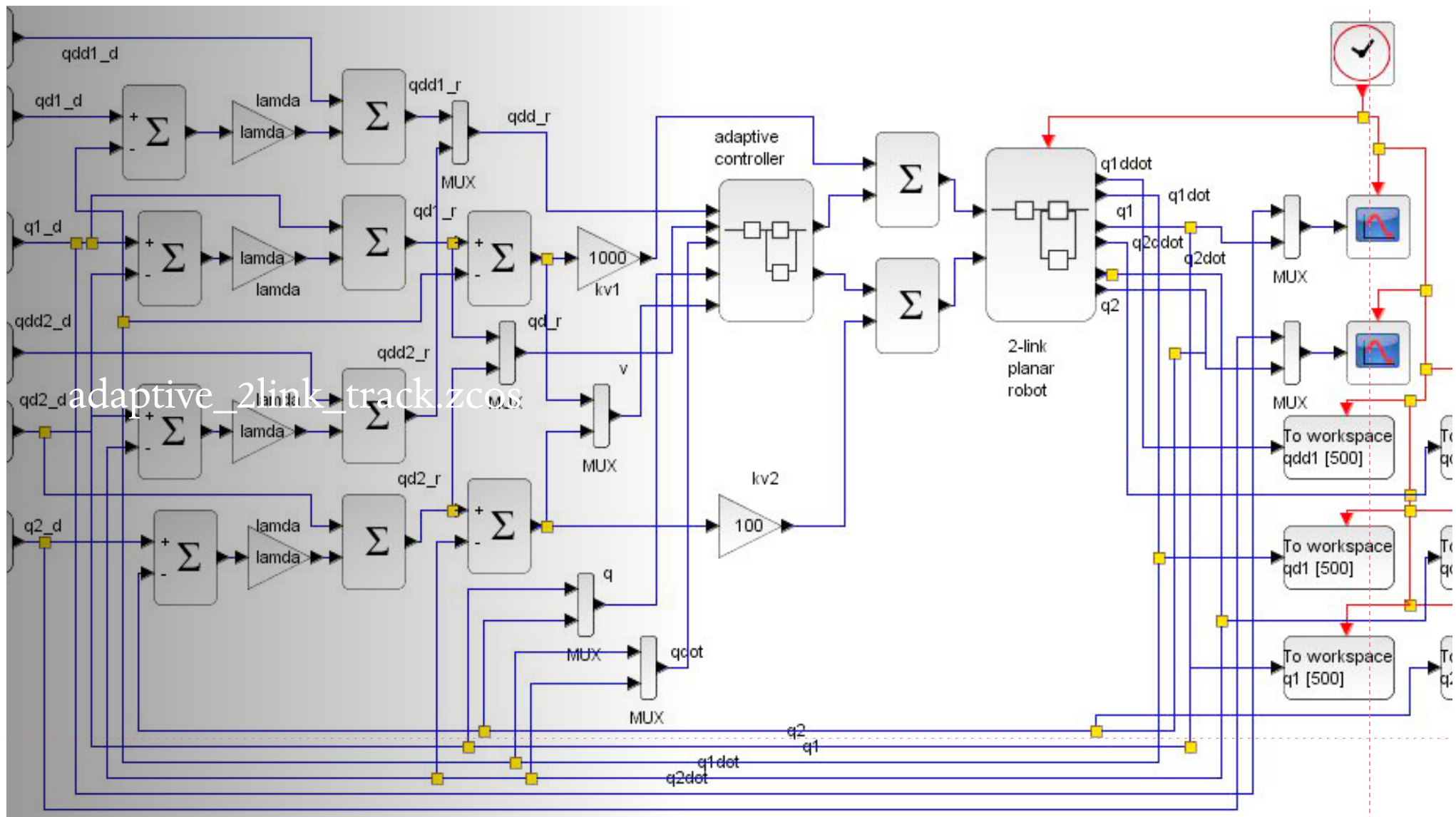


# Effect of link mass variation

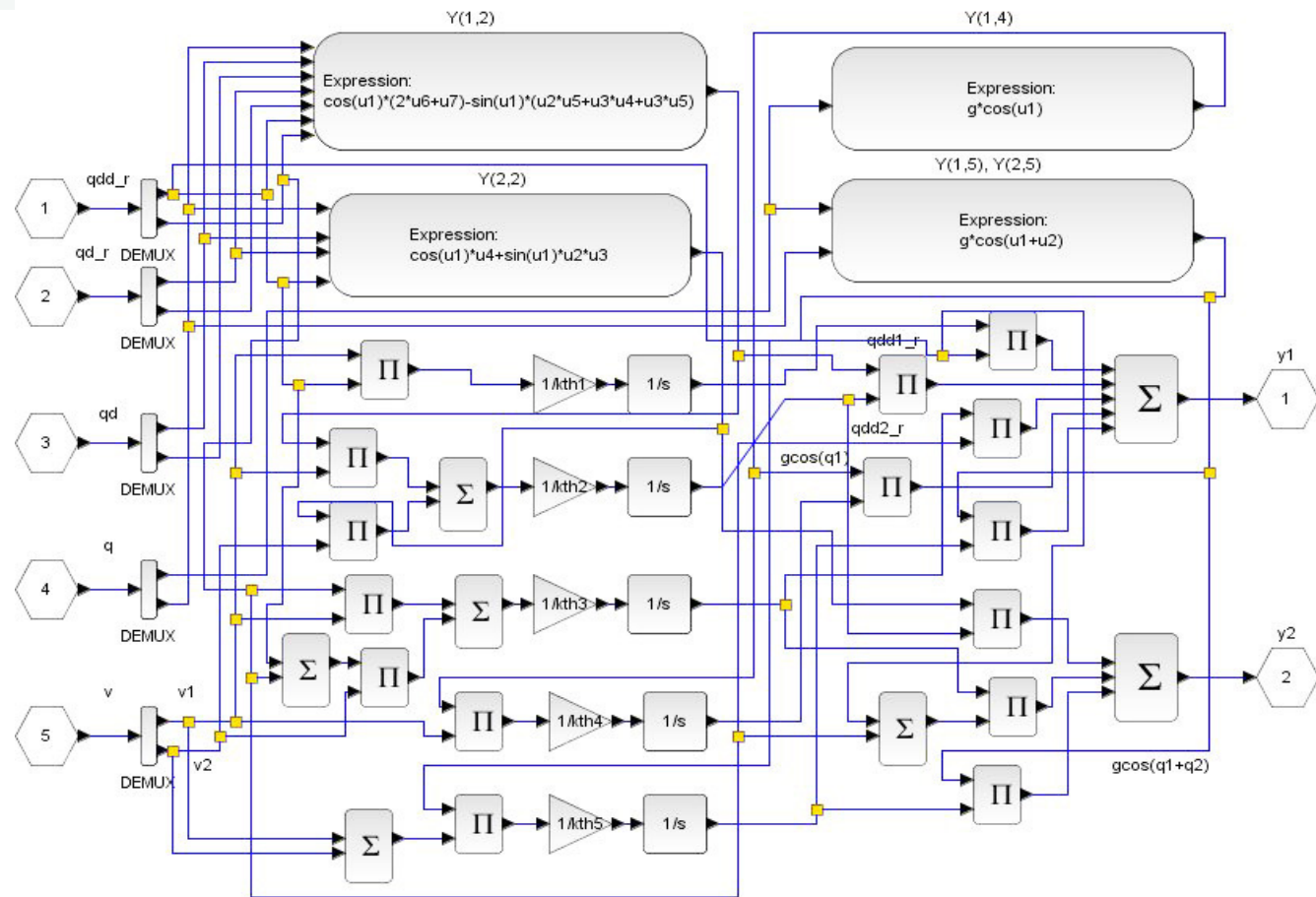


# Adaptive control (joint-space)

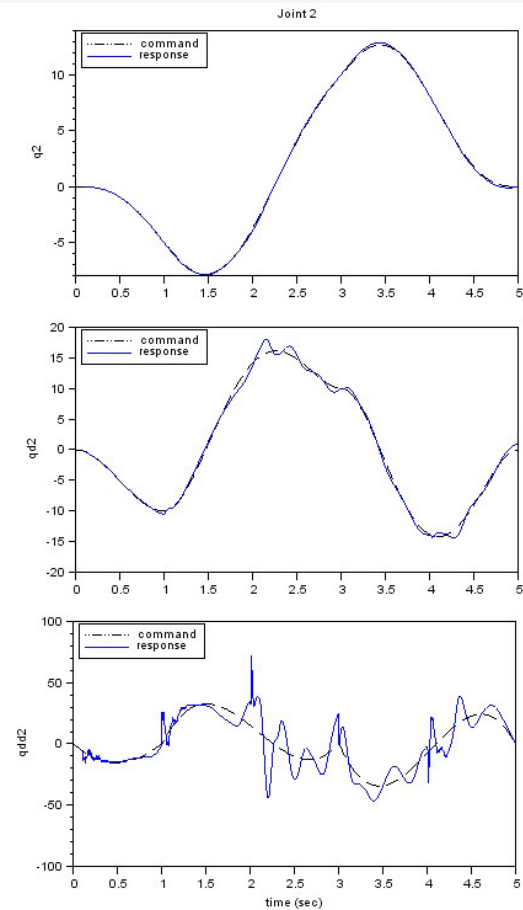
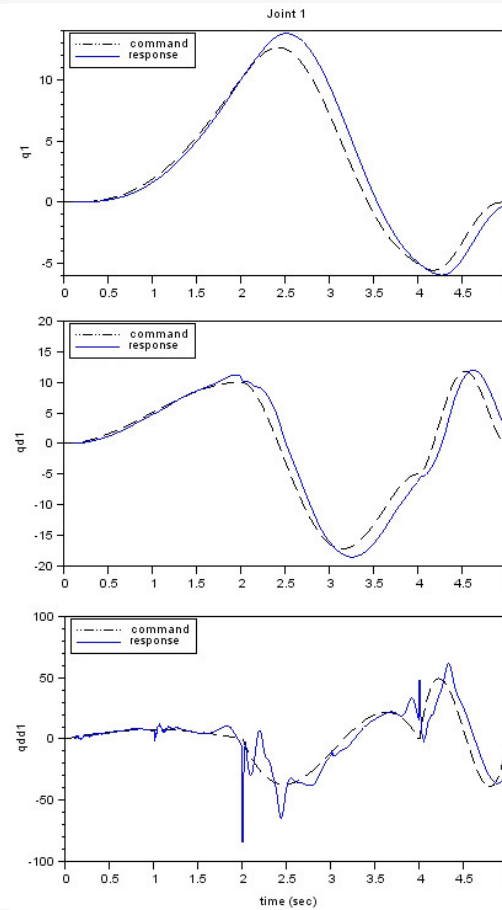




# details of adaptive controller block



# Tracking performance ( $\Lambda=10I$ )





# Tracking performance ( $\Lambda=60I$ )

