3. Control

The main goal of modeling and simulation is to help the development of a control structure. In our application, we want to improve the response of the system by reducing/eliminating the overshoot and making the settling time as small as possible.

To determine the closed loop controller, we will use the Guillemin-Truxal method. To apply this method, our model of the system should be converted to a transfer function.

We must define our closed loop system performances: overshoot and settling time. From these, we can determine the transfer function of the closed loop system, using the following, well-known formulas:

Overshoot: σ =

Settling time: t_r =

Damping factor: $\xi = \frac{|\ln(\sigma|}{\sqrt{ln^2(\sigma)+\pi^2}} =$

Second order time constant: $\omega = \frac{4}{\xi * t_r} =$

The form of the closed loop system: $H_o = \frac{\omega^2}{s^2+2*\omega*\xi+\omega^2} =$

The controller transfer function: $H_c = \frac{1}{H_p} * \frac{H_o}{1-H_o} =$

The calculated controller is validated in closed loop simulation. **Attention**: the value of the control signal (duty cycle) should be between 0 and 1. Apply saturation block on the output of the controller. The output of the controller must be sampled with the multiple of the PWM signal period, for this we apply a Zero-Order Hold block on the control signal.

Task

Make the necessary calculations for the controller.

Set “Zero-Order Hold” block period to the (PWM period)/10. Make closed loop simulation, verify the previously defined settling time and overshoot on the output voltage graph.

Change “Zero-Order Hold” block period to PWM period. What happens with the output signal? Try to compensate for the sampling error by changing the performance indicators.

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