

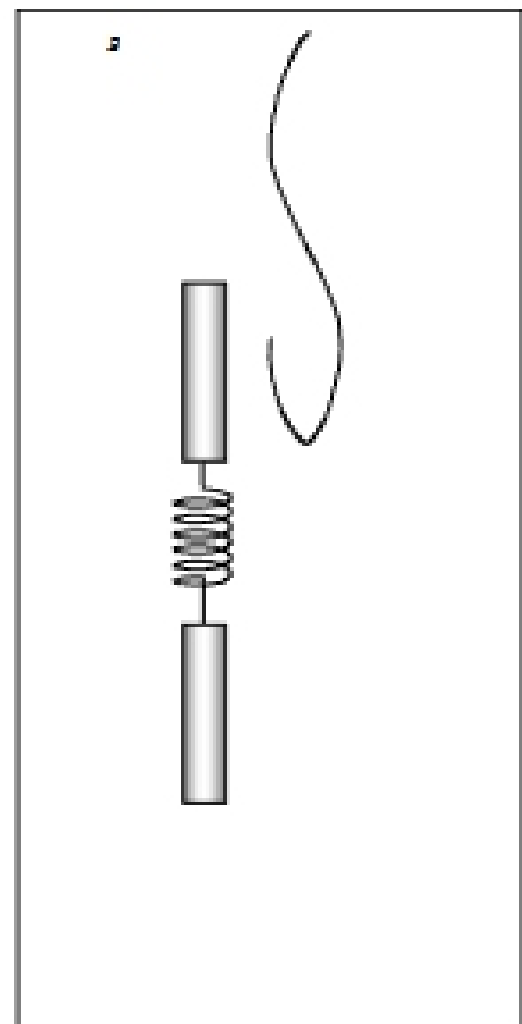
## ME 451: Control Systems Laboratory

Department of Mechanical Engineering  
Michigan State University  
East Lansing, MI 48824-1226

### ME451 Laboratory

# TORSIONAL CONTROL DESIGN PROJECT WEEK 2

**Bring the course textbook to the Lab**  
**'C.L.Philips and R.D.Harbor, Feedback Control Systems'**



This equation of motion generates the same transfer function form as that used to describe the dynamics of the torsional vibration experiment you have used in the laboratory

$$G(s) = \frac{\theta(s)}{T(s)} = \frac{1}{Js^2 + bs + k} \quad (2)$$

Because the *WindDrive* and torsional vibration apparatus have models of the same form, the research team will use the torsional vibration apparatus to investigate vibration control designs for our new2 product.

## Objective:

The objective of this project is to design a PD (Proportional-Derivative) controller for improving the transient response of a second order system. The second order system in this case is the Mass Spring Damper system used in experiments 2 and 5. This system will be used to model the support dynamics of the *WindDrive* system. The concept of root locus described in the controls textbook is an effective method for designing the PID class of controllers. In this project we will focus on the PD controller.

## Torsional MSD System and the PD Controller:

The torsional control system has the block diagram

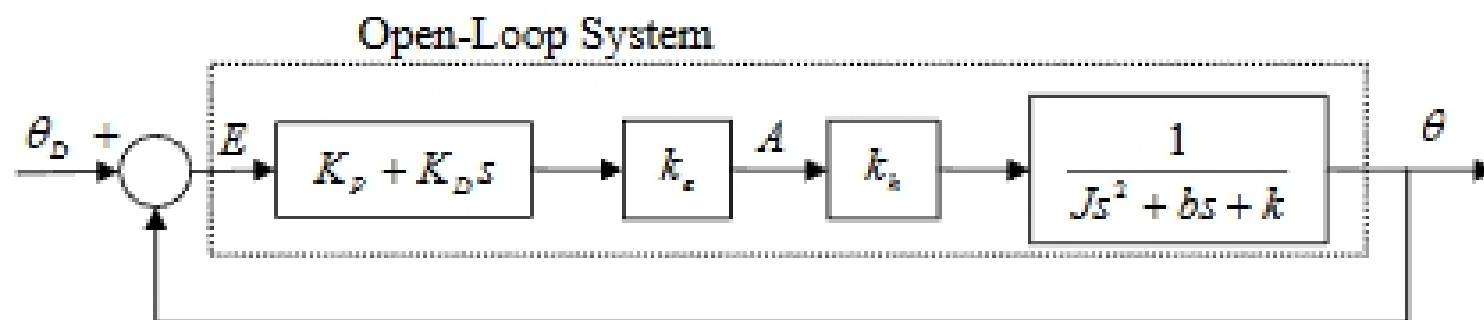


Figure 4: Closed-Loop Torsional Control Block Diagram showing the Open-Loop System Blocks as a Subsystem of the Closed-Loop System Block Diagram.

The parameters in the system are:

Table 1: Torsional Vibration System Parameters

Parameter	Value (Units)
$J$	$0.008 \pm 0.002$ (kg-m <sup>2</sup> )
$b$	$0.025 \pm 0.015$ (N-m-sec.)
$k$	$1.6 \pm 0.2$ (N-m/rad)
$k_e$	25 (volt/rad)
$k_s$	0.8 (N-m/volt)

The design of a controller for systems like the one above (Fig. 4) is discussed in Section 7.10 of the Phillips and Harbor *Feedback Control Systems* text. In this section, control design is performed on the open-loop transfer function defined when the comparator