EENG307: Translational Mechanical Impedance[1] & Rotational Mechanical Impedance[2]

Lecture 8 & 9

Christopher Coulston, Kathryn Johnson and Hisham Sager[3]

Department of Electrical Engineering
Colorado School of Mines

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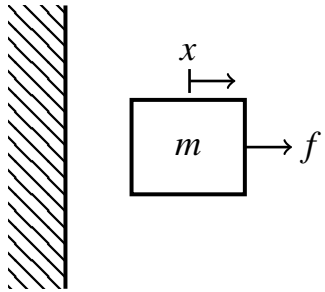
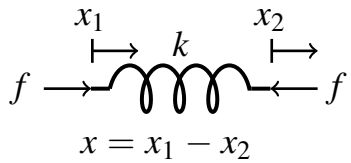
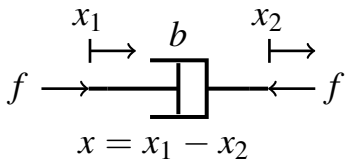
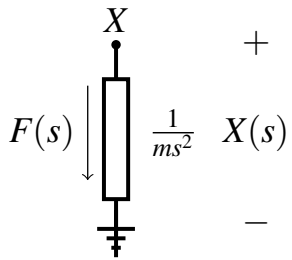
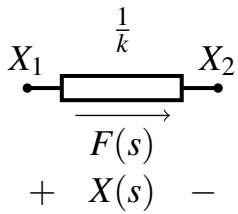
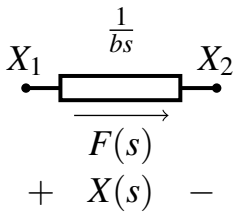
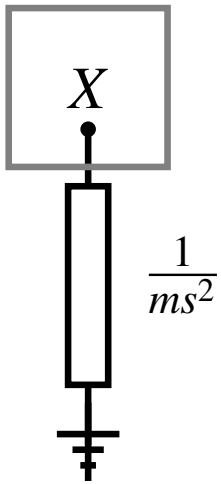
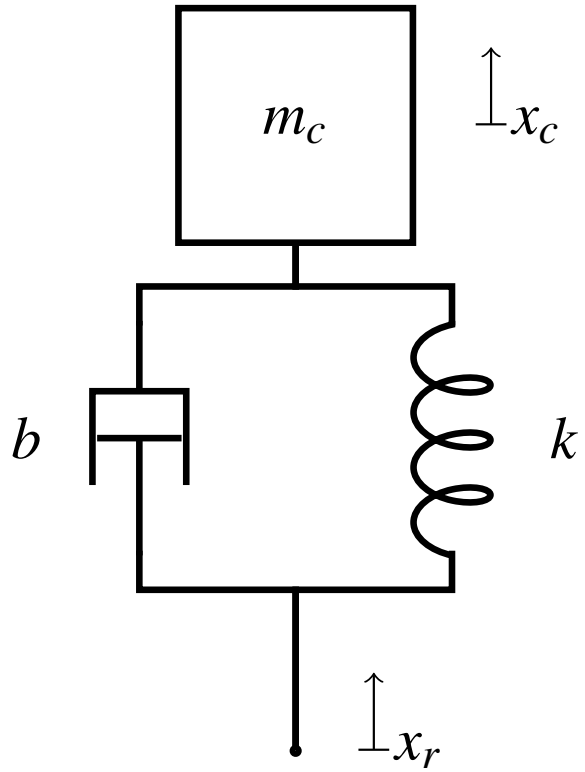
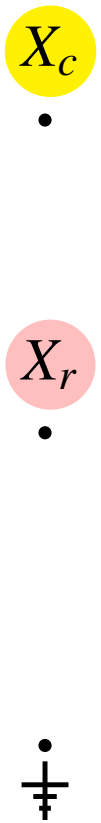
[3] Developed and edited by Tyrone Vincent and Kathryn Johnson, Colorado School of Mines, with contributions from Salman Mohagheghi, Chris Coulston, Kevin Moore, CSM and Matt Kupilik, University of Alaska, Anchorage

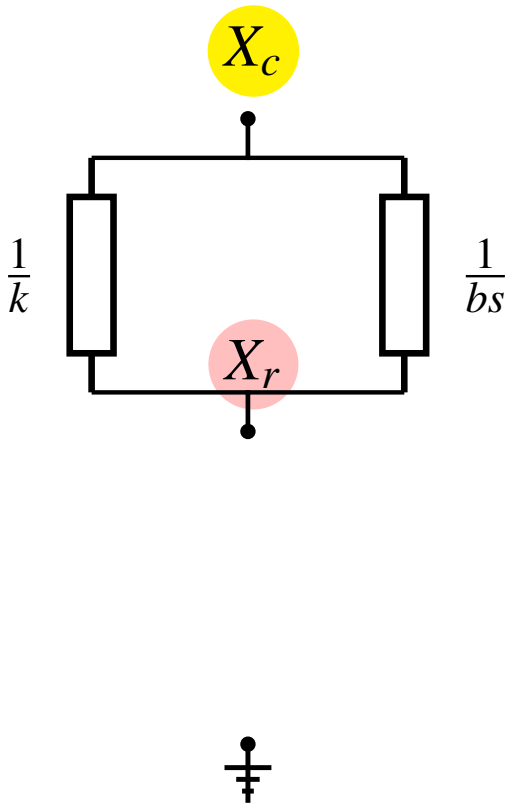
Mechanical Impedance

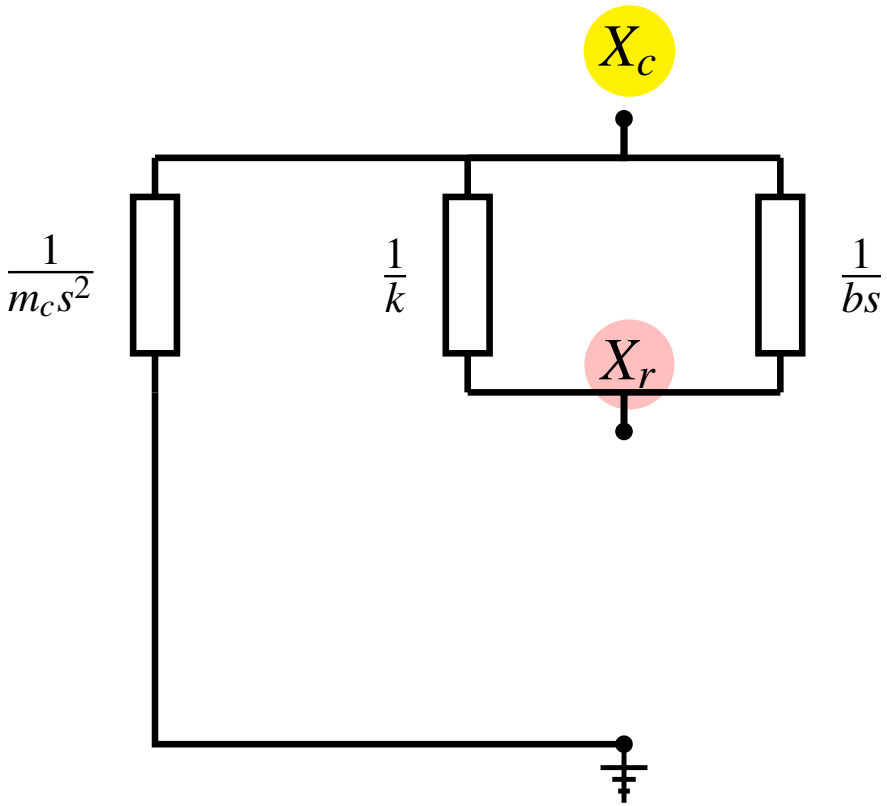
	mass	spring	damper
Component		 $x = x_1 - x_2$	 $x = x_1 - x_2$
Component law	$m\ddot{x} = f$	$f = kx$	$f = b\dot{x}$
Laplace Transform	$X(s) = \frac{1}{ms^2}F(s)$	$X(s) = \frac{1}{k}F(s)$	$X(s) = \frac{1}{bs}F(s)$
Impedance Component (positive f direction agrees with positive x direction)			

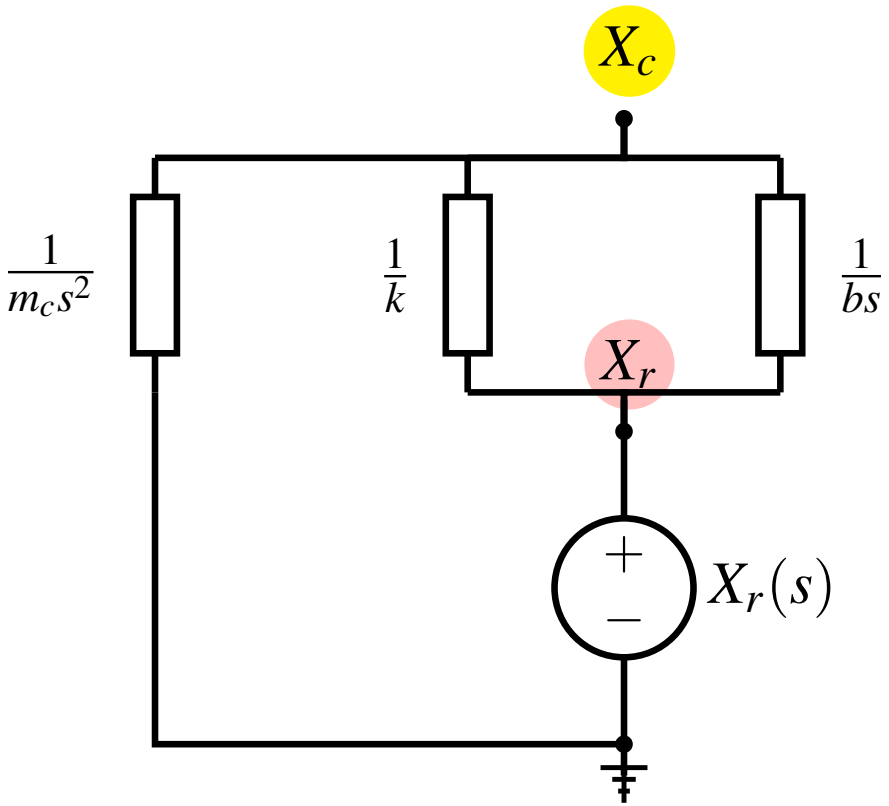

X
$\frac{1}{ms^2}$


m_c
x_c
b
k
x_r

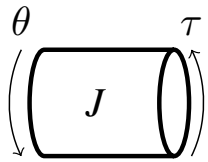
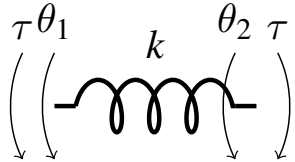
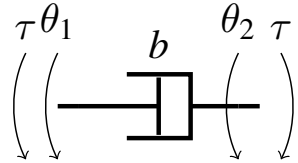
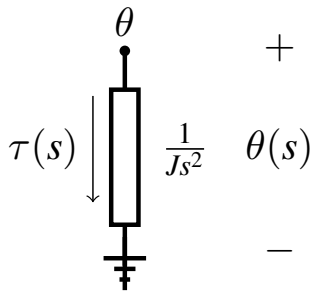
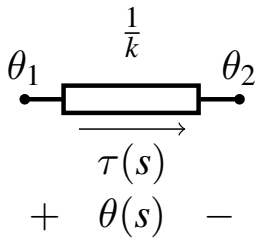
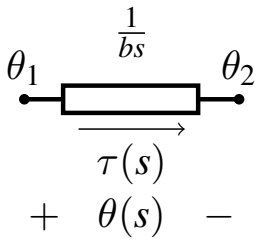

X_c
X_r


X_c
$\frac{1}{k}$
$\frac{1}{bs}$
X_r


X_c
$\frac{1}{m_c s^2}$
$\frac{1}{k}$
$\frac{1}{bs}$
X_r

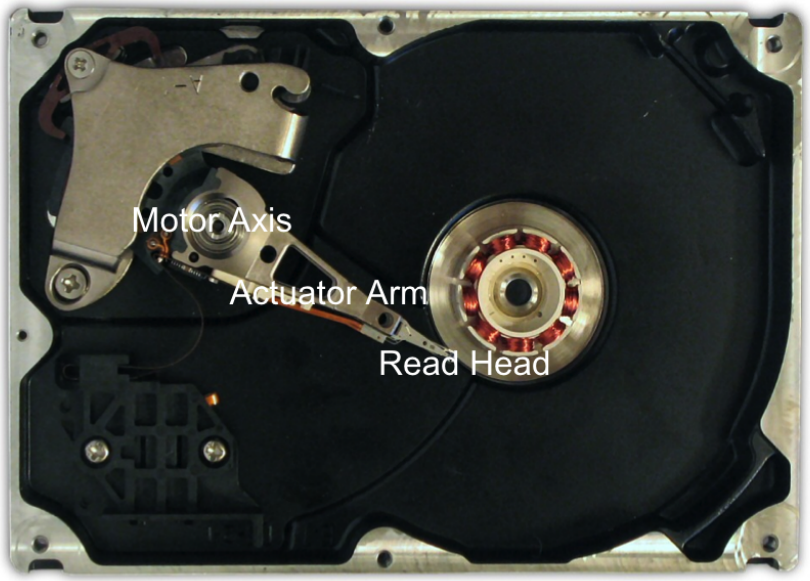

X_c
$\frac{1}{m_c s^2}$
$\frac{1}{k}$
$\frac{1}{bs}$
X_r
+
−
$X_r(s)$

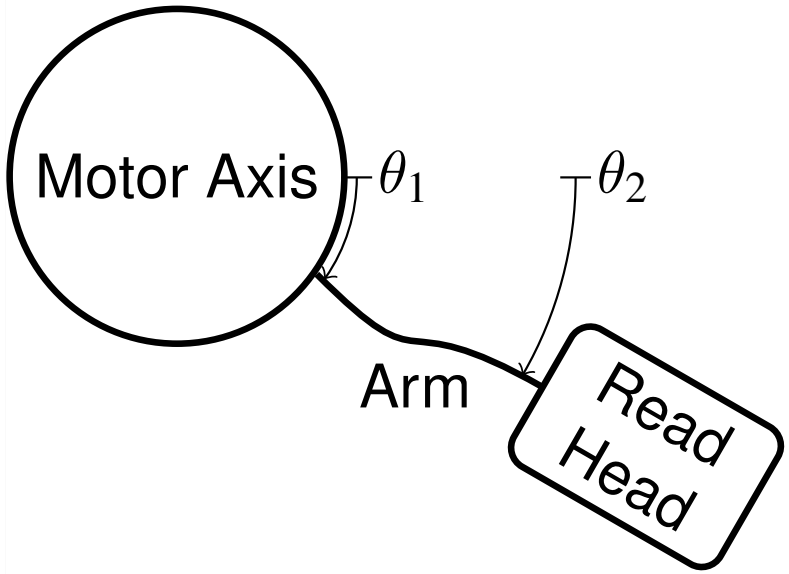
Rotational Impedance

	mass	spring	damper
Component		 $\theta = \theta_1 - \theta_2$	 $\dot{\theta} = \dot{\theta}_1 - \dot{\theta}_2$
Laplace Transform	$\theta(s) = \frac{1}{Js^2}\tau(s)$	$\theta(s) = \frac{1}{k}\tau(s)$	$\theta(s) = \frac{1}{bs}\tau(s)$
Impedance Component (force direction agrees with positive direction)			

Hard Disk Drive Read Head

In order to move the read head to the correct track and hold it there, we need to be able to predict the relationship between the motor torque τ and the angular position of the read head θ_2. First, find the equivalent impedance model. Then, find the transfer function $\frac{\theta_2}{\tau}$.





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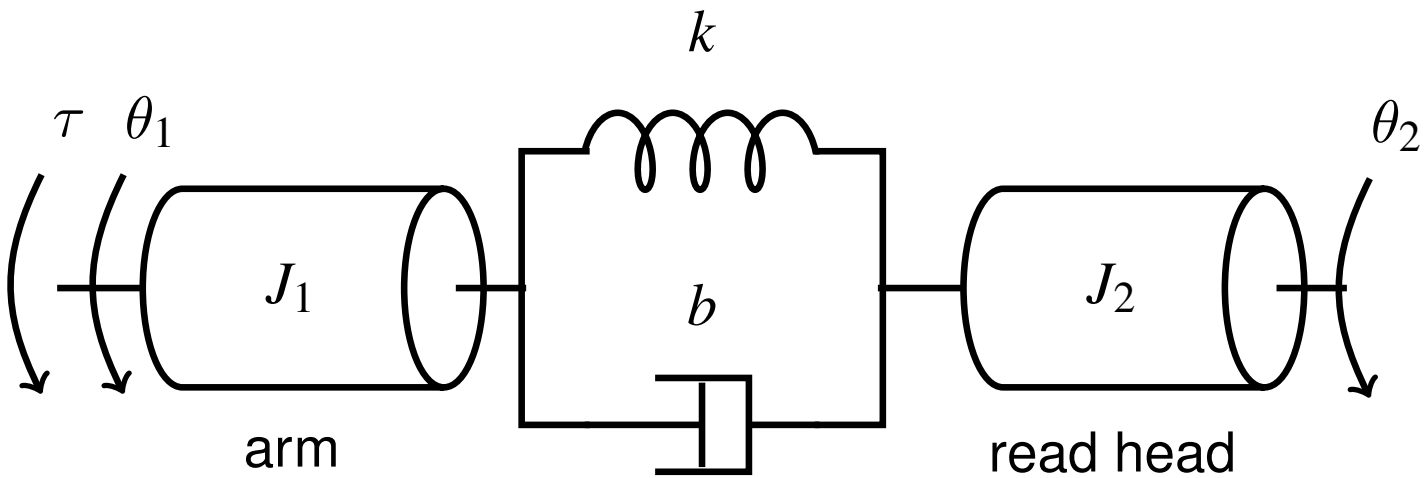
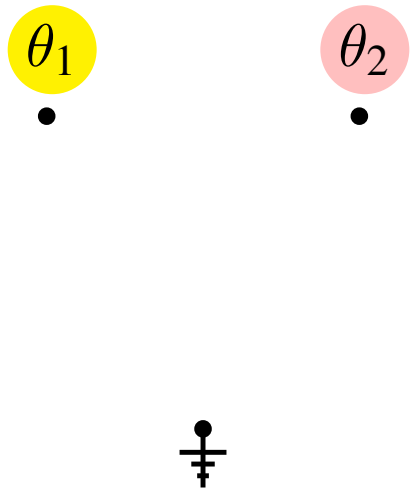
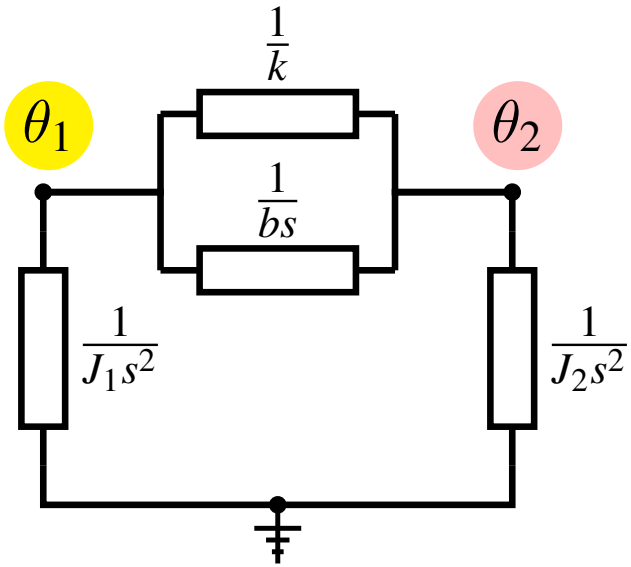
Hard Disk Drive Ideal Elements



Nodes



Disk Drive Impedance Network



Disk Drive Complete Circuit