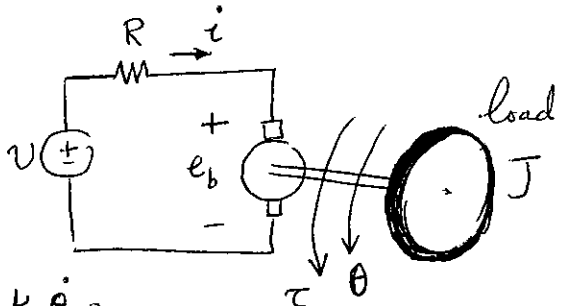
ENSC383: Feedback Control Systems, Fall 2007

School of Engineering Science, Simon Fraser University

Quiz#1: Time (10 minutes)

- Write the dynamic equations of a ~~brushless~~ DC motor driving an inertial load **J**. Assume no viscous friction and neglect the inductance of the rotor winding. Obtain the transfer function from shaft angle to input voltage.

$e_b = k\dot{\theta}$, $\tau = k i$ } Motor equations



$v = Ri + e_b \longrightarrow v = Ri + k\dot{\theta}$

$\tau = J\ddot{\theta} \longrightarrow \tau = J\ddot{\theta} = ki$

$\therefore V(s) = R\,I(s) + k s\,\theta(s)$ (**)

$\tau(s) = J s^2 \theta(s) = k\,I(s) \longrightarrow \boxed{I(s) = \frac{J}{k} s^2 \theta(s)}$ (*)

Substitute (*) into (**):

$$V(s) = \frac{RJ}{k} s^2 \theta(s) + k s\,\theta(s) = \left(\frac{RJ}{k} s^2 + k s\right)\theta(s)$$

$$\therefore \frac{\theta(s)}{V(s)} = \frac{1}{s\left(\frac{RJ}{k} s + k\right)} = \frac{k/(RJ)}{s\left(s + \frac{k^2}{RJ}\right)}$$

OR $\boxed{\frac{\theta(s)}{V(s)} = \frac{\frac{1}{k}}{s\left(\frac{RJ}{k^2} s + 1\right)}}$