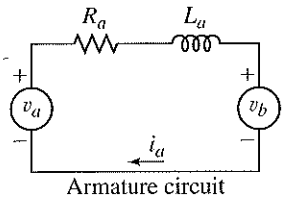
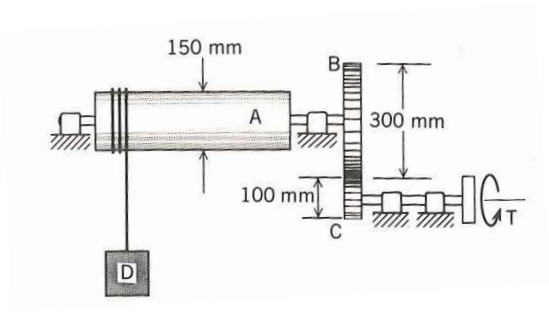
Dynamics Candidacy Jan 2014

1. A mechanically powered windlass is shown. A motor (circuit shown) drives gear C, which in turn drives gear B and drum A. A mass D of 800 kg is being raised by the windlass. Write the governing differential equation/s for the system. The combined radius of gyration of drum A, gear B, and the shaft connecting them is 300 mm, and the combined mass if 100kg. The radius of gyration of gear C and associated shaft is 80mm, with corresponding mass of 10kg. Assume $K_b = K_T$. (Note: The back EMF is $v_b = K_b\omega$, and the torque $T = K_t i$.)





2. Use the FRF to write the steady-state response for each system:

   (a) $5\ddot{y} + 18y = f(t)$
   - i. $f(t) = 1\cos(t)$
   - ii. $f(t) = 5\cos(t)$
   - iii. $f(t) = 1\cos(10t)$
   - iv. $f(t) = 5\cos(10t)$

   (b) $5\ddot{y} + 18y = f(t) + \dot{f}(t)$
   - i. $f(t) = 1\cos(t)$
   - ii. $f(t) = 5\cos(t)$
   - iii. $f(t) = 1\cos(10t)$
   - iv. $f(t) = 5\cos(10t)$

   (c) $12\dddot{y} + 4\ddot{y} + 6\dot{y} + 18y = f(t) + \dot{f}(t)$
   - i. $f(t) = 1\cos(t)$
   - ii. $f(t) = 5\cos(t)$

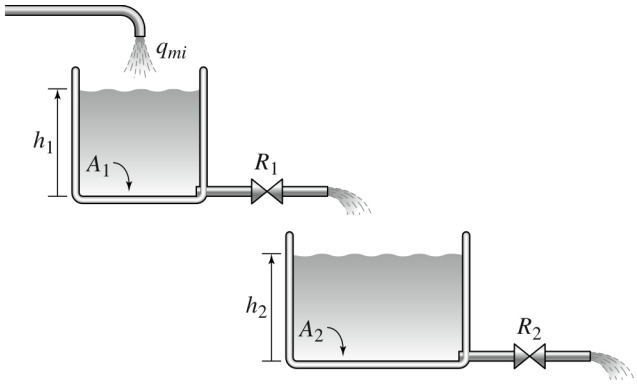
3. Draw a block diagram for the following system.

$$\begin{aligned} \ddot{x} + \dot{x} + x - y &= f_1(t) \\ \ddot{y} + (y - x) &= f_2(t) \end{aligned}$$

4. Develop a model of the two liquid heights in the system shown in the figure below. The inflow rate $q_{mi}(t)$ is a mass flow rate. Using the values $R_1 = R$, $R_2 = 3R$, $A_1 = A$ and $A_2 = 4A$, determine

   (a) The transfer function $\frac{H_2(s)}{Q_{mi}(s)}$

   (b) The state space model presuming outputs h_1, h_2, and q_{mo}.



$F(s)$	$F(t)$
$sX(s) - x(0)$	$\dot{x}(t)$
$s^2X(s) - sx(0) - v(0)$	$\ddot{x}(t)$
$\frac{a}{s^2+a^2}$	$\sin(at)$
$\frac{s}{s^2+a^2}$	$\cos(at)$
1	$\delta(t)$
$\frac{1}{s}$	$u(t)$
$\frac{1}{s^2}$	t
$\frac{1}{s-a}$	e^{at}
$\frac{1}{s^n}$	$\frac{t^{n-1}}{(n-1)!}$