University of British Columbia
Department of Mechanical Engineering

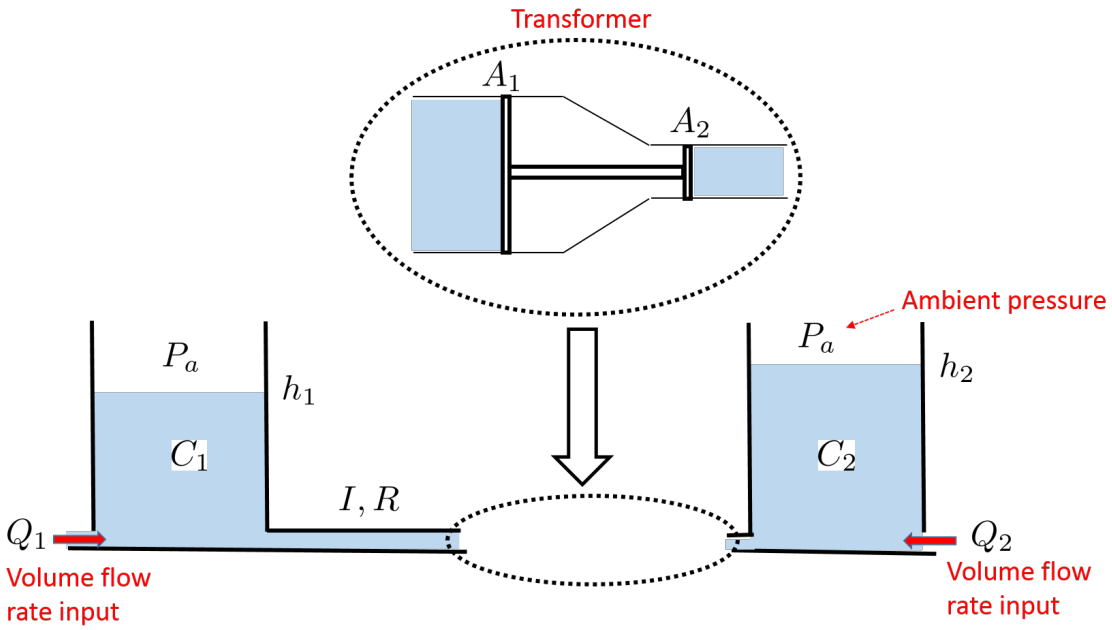
MECH366 Modeling of Mechatronic Systems
Homework 4

Due: October 28 (Monday), 2019, 3pm

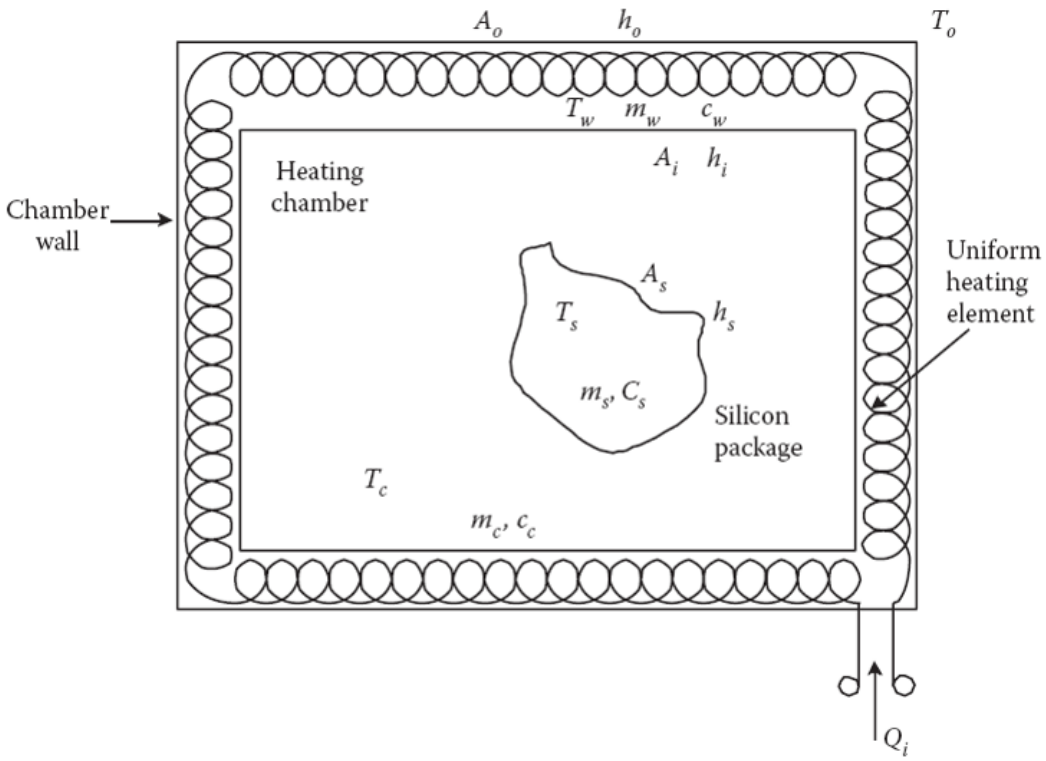
For each of the following systems, derive the state-space model by using the linear graph.

1. Two-tank system connected with a transformer. The notations are explained in the following table. What are not shown in the figure are assumed to be negligible. The inputs are the volume flow rates Q_1 and Q_2 [m^3/s], and the outputs are the heights h_1 and h_2 [m].

Notation	Unit	Meaning
C	$[m^5/N]$	Fluid capacitance
I	$[Ns^2/m^5]$	Fluid inertance
R	$[Ns/m^5]$	Fluid resistance
A	$[m^2]$	Section area
P_a	$[N/m^2]$	Ambient pressure



2. Semiconductor material in a heating chamber



- **Two input** are the heat transfer rate into the wall Q_i (control input), and the ambient temperature T_o (disturbance input).
- **One output** is the temperature T_s.
- Notations (see the figure)

	Mass	Specific heat	Temperature
Gas in the chamber	m_c	c_c	T_c
Silicon	m_s	c_s	T_s
Wall	m_w	c_w	T_w
Ambient			T_o

  - h_s and A_s: Convective heat transfer coefficient at the interface of silicon and gas inside the chamber, and the effective surface area
  - h_i and A_i: Convective heat transfer coefficient at the inside surface of the chamber wall, and the effective surface area
  - h_o and A_o: Convective heat transfer coefficient at the outside surface of the chamber wall, and the effective surface area