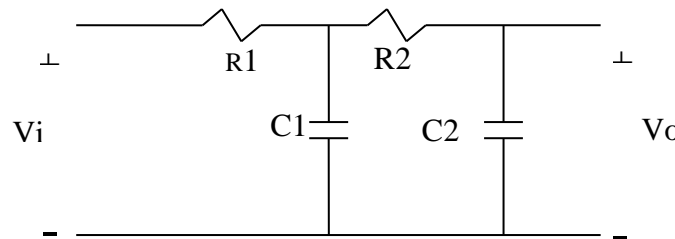


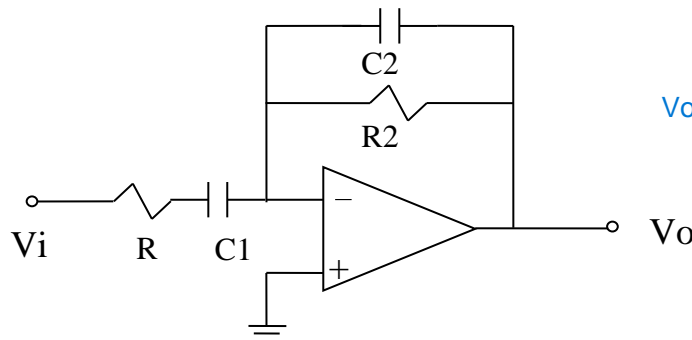
## Sheet 2 Mathematical Modeling

1. For the circuit shown, obtain the transfer function  $V_o(s)/V_i(s)$ .



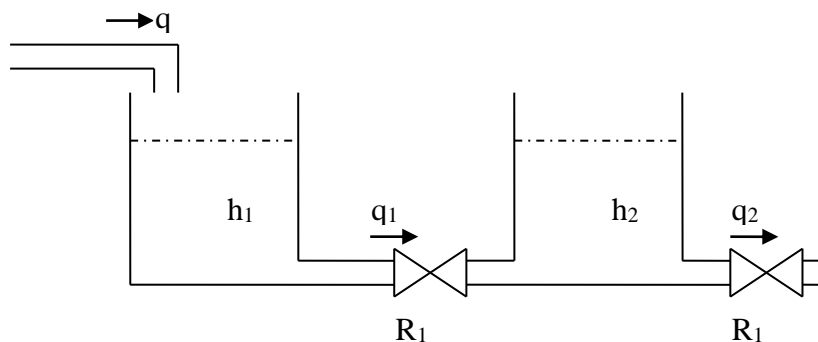
$$\begin{aligned} V_o &= I / (SC2) \\ I &= I_2 + I_3 \\ v_{in} &= IR_1 + I_2 / (SC1) \\ v_{in} &= IR_1 + I_3 (R_2 + 1/SC2) \\ \text{solve 3 equations simult} \\ \text{kirshoff law} \\ \text{get TF} \end{aligned}$$

2. For the Ideal Op-amp circuit shown, obtain the transfer function  $V_o(s)/V_i(s)$



$$V_{out}/v_{in} = -Z_2 / Z_1$$

3. The figure shows a process plant containing of two tanks of areas  $A_1$  and  $A_2$ . Derive the transfer function that relates  $q_2$  to  $q$ .



4. Derive the differential equations that represent the mechanical system shown, where  $U$  is a force that affects the mass  $M_1$  and hence derive the transfer functions  $X_1(s)/U(s)$  and  $X_2(s)/U(s)$ . If the force  $U$  has a value of 1 N find the steady state values of  $X_1$  and  $X_2$ .

