**THE DEPARTMENT OF MECHANICAL & AEROSPACE ENGINEERING**
**UNIVERSITY AT BUFFALO**
**MAE 340: Systems Analysis, Spring 2003**

**Homework 3**

**Put each of the following problems into State Space Form.**

**7.1.** The source in the circuit shown in Figure P7.1 undergoes a step change so that $e_s$ suddenly changes from 0 to 10 V at $t = 0$. Before the step change occurs, all variables are constant—i.e., $e_s$ has been zero for a long time.

**(a)** Find $e_{32}(0^-)$ and $e_{32}(0^+)$.

**(b)** Find $e_{1g}(0^-)$ and $e_{1g}(0^+)$.

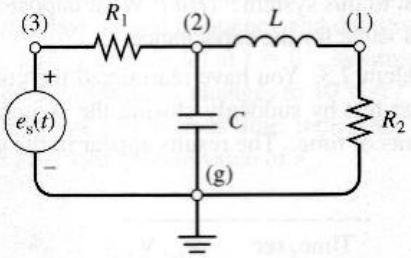


**Figure P7.1**

**7.2.** The circuit shown in Figure P7.2 is subjected to a step change in $e_s$ from 5.0 to 7.0 V at $t = 0$. Before the step change occurs, all variables are constant—i.e., $e_s$ has been 5.0 V for a very long time.

**(a)** Find $i_L(0^-)$, $i_L(0^+)$, and $i_L(\infty)$.

**(b)** Find $e_{3g}(0^-)$, $e_{3g}(0^+)$, and $e_{3g}(\infty)$.

**(c)** Find $e_{2g}(0^-)$, $e_{2g}(0^+)$, and $e_{2g}(\infty)$.

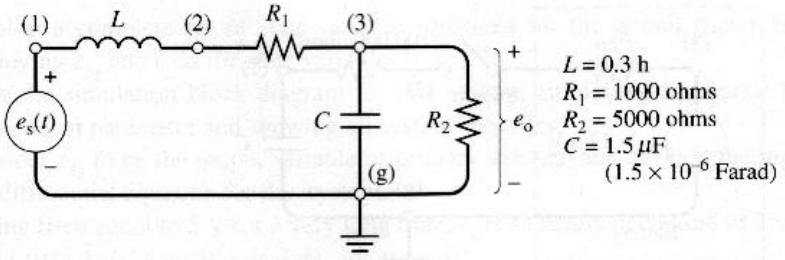


**Figure P7.2**

**9.1.** **(a)** Develop the system differential equation relating $P_{2r}$ to $P_s$ for the first-order low-pass hydraulic filter shown in Figure P9.1a.

**(b)** Write the expression for the system time constant, and sketch the response, $P_{2r}(t)$ versus $t$, for a step change $\Delta P_s$ from an initial value $P_s(0)$, which has been constant for a very long time. (Figure P9.1b)

**9.2.** **(a)** Develop the system differential equation relating $P_{3r}$ to $P_s$ for the second-order low-pass hydraulic filter shown in Figure P9.2a.

**(b)** Find expressions for the natural frequency $\omega_n$ and damping ratio $\zeta$, and sketch the response versus time for a step change $\Delta P_s$ from an initial value $P_s(0)$, which has been constant for a very long period of time, assuming that $\zeta = 0.3$. Show clearly the period of the oscillation, the per-cycle decay ratio, and the final steady-state value of $P_{3r}$ in Figure P9.2b.

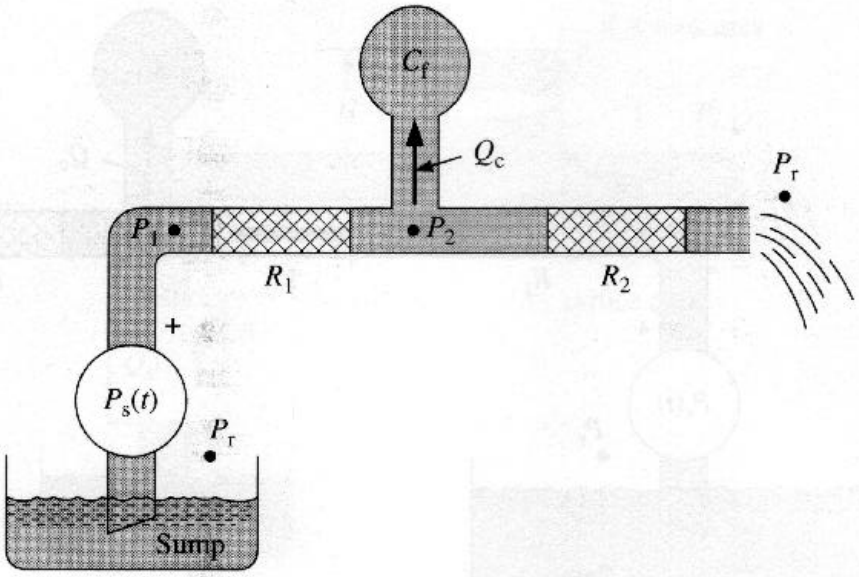


**Figure P9.1a** First-order low-pass hydraulic filter.

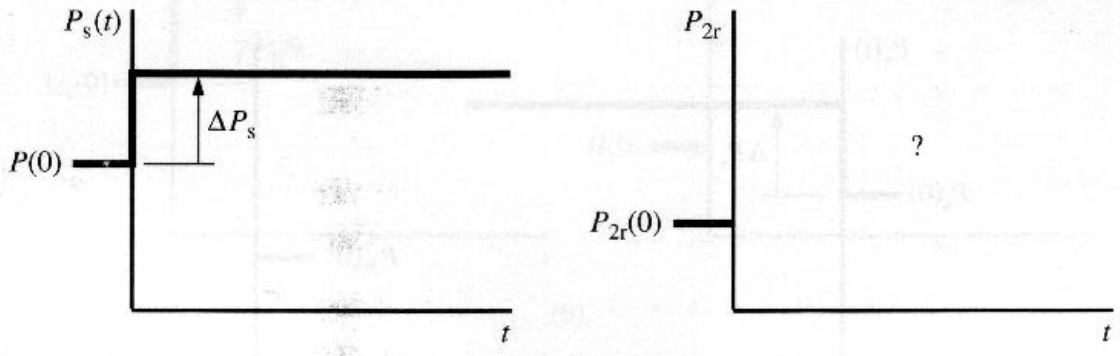


**Figure P9.1b** Input and output graphs.