1. The two-ports shown have the same impedance parameters.
   
   (a) What are the element values of the bridged-T in terms of those of the lattices?
   
   (b) Is the bridged-T always realizable? What is the condition for it?

2. (a) Find the transfer function $V_{out}/V_{in}$ of the first $G_m$-C stage shown.

   (b) Find the element values of the second stage to make $V_{out}/V_{in} = -1/sRC$.

3. Find the transfer functions $I_0/I_i$, $i = 1, 2, 3, 4$ in the circuit shown.

   Hint: use inter-reciprocity.
\[ Z_{11} = \frac{V_1}{I} = \frac{1}{2} (Z_1 + Z_2) = Z_a + Z_b \]

\[ Z_{21} = V_2^+ - V_2^- = \frac{Z_2 - Z_1}{Z_2 + Z_1}, \quad V_1 = \frac{Z_2 - Z_1}{2} = Z_b \]

\[ Z_b = s \left( \frac{L_2 - L_1}{2} + 1/(2sC) \right) \]

\[ Z_a = Z_1 = sL_1 = Z_c \]

a. So \( L_a = L_c = L_1 \), \( C' = 2C \)

\[ L_b = (L_2 - L_1)/2 \geq 0 \]

b. \( L_2 \geq L_1 \) for realizability
2. (a)

\[ V^- = V_{in} - R G_m V^- \]
\[ V_0 = -V^- + \frac{1}{s C} G_m V^- \]
\[ V^- = V_{in}' / (1 + R G_m) \]
\[ V_0 = V_0 / (1 + G_m / s C) \]
\[ \frac{V_0}{V_{in}} = \frac{1 + G_m / s C}{1 + G_m R} \]

(b)

\[ V^- = V_{in} - R G_m V^- \]
\[ V^- = V_{in} / (1 + R G_m) \]
\[ V_0 = V_0 + \left( R_1 + \frac{1}{s C_1} \right) G_m V^- \]
\[ V^- = V_0 / \left[ 1 - G_m (R_1 + 1 / s C_1) \right] \]
\[ \frac{V_0}{V_{in}} = \frac{1 - G_m (R_1 + 1 / s C_1)}{1 + G_m R} \]
\[ -s R C + s G_m R_1 R C + G_m R C / C_1 = 1 + G_m R \]
\[ -1 + G_m R_1 = 0 \]
\[ \frac{C_1}{C_1} = 1 / G_m R \]
\[ R_1 = 1 / G_m \]
\[ C_1 = C / (G_m R + 1) \]
\[ I_0 = \frac{1}{8} \left[ I_1 + \frac{I_2}{2} + \frac{I_3}{4} + \frac{I_4}{8} \right] \]