ECE 580

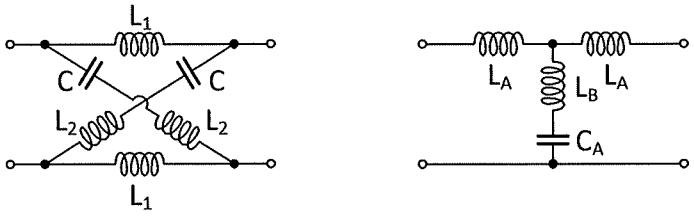
FINAL EXAMINATION

December 7, 2022, 2-4 pm

1. The two-ports shown have the same impedance parameters.

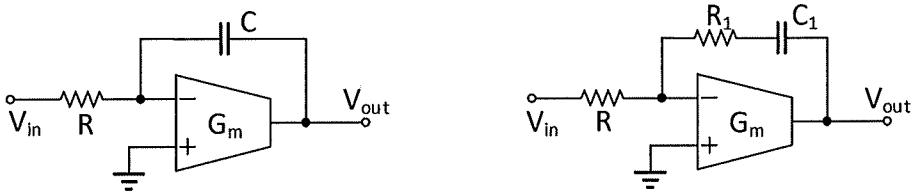
   (a) What are the element values of the bridged-T in terms of those of the lattices?

   (b) Is the bridged-T always realizable? What is the condition for it?



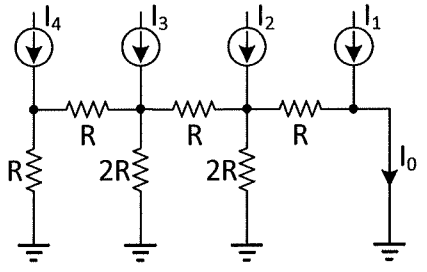
2. (a) Find the transfer function V_{out}/V_{in} of the first G_m-C stage shown.

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

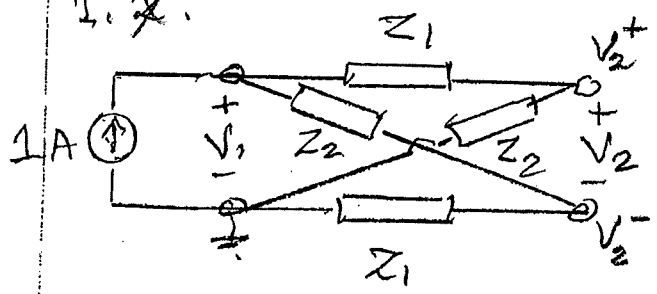


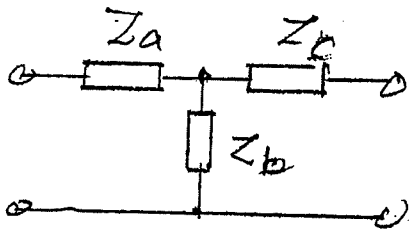
3. Find the transfer functions I_0/I_i, i = 1, 2, 3, 4 in the circuit shown.

   Hint: use inter-reciprocity.



1. 2.





$$Z_{11} = \frac{V_1}{1} = \frac{1}{2}(Z_1 + Z_2) = Z_a + Z_b$$

$$Z_{21} = V_2^+ - V_2^- = \frac{Z_2 - Z_1}{Z_2 + Z_1} V_1 = \frac{Z_2 - Z_1}{2} = Z_b$$

$$Z_b = s(L_2 - L_1)/2 + 1/(2sC)$$

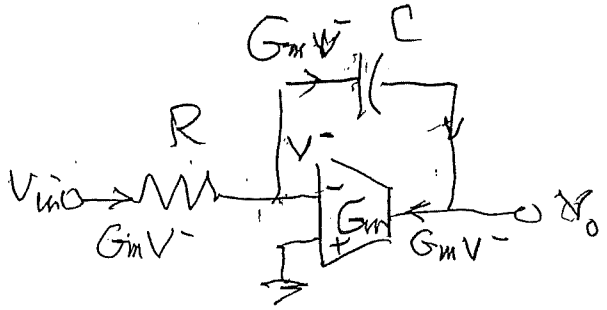
$$Z_a = Z_1 = sL_1 = Z_c$$

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)

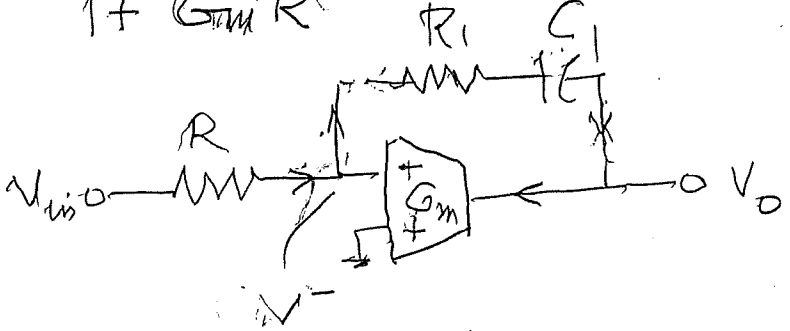


$$V^- = V_{in} - R G_m V^- \qquad V_o = V^- + \frac{1}{sC} G_m V^-$$

$$V^- = V_{in}/(1 + R G_m) \qquad V_- = V_o/(1 + G_m/sC)$$

$$\frac{V_o}{V_{in}} = \frac{1 + G_m/sC}{1 + G_m R}$$

(b)



$$V^- = V_{in} - R G_m V^- \qquad V_o = V_o + \left(R_1 + \frac{1}{sC_1}\right) G_m V^-$$

$$V^- = V_{in}/(1 + R G_m) \qquad V^- = V_o/\left[1 - G_m\left(R_1 + 1/sC_1\right)\right]$$

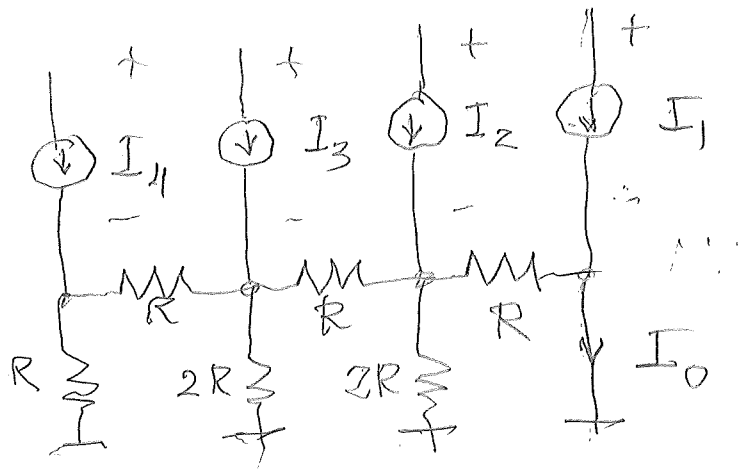
$$\frac{V_o}{V_{in}} = \frac{1 - G_m(R_1 + 1/sC_1)}{1 + G_m R} \simeq -\frac{1}{sRC}$$

$$-sRC + sG_m R_1 RC + G_m RC/C_1 = 1 + G_m R$$

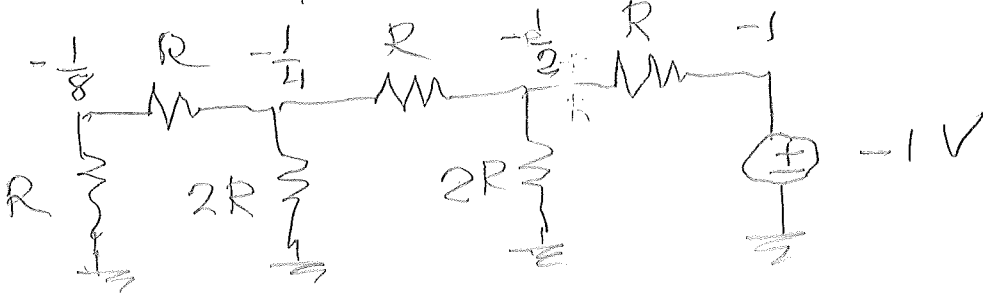
$$-1 + G_m R_1 = 0 \qquad C/C_1 = 1/G_m R + 1$$

$$R_1 = 1/G_m \qquad C_1 = C\,\frac{G_m R}{G_m R + 1}$$

3.



Inter-reciprocal



$$I_0 = *\left[I_1 + I_2/2 + I_3/4 + I_4/8\right]$$