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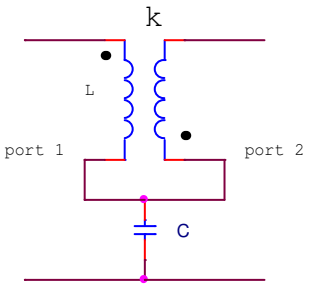
610 Fall 2009 – Homework ~~2~~ 3 Due Th 10/01/09

1. [60 points] [coupled coils and circuit solutions]

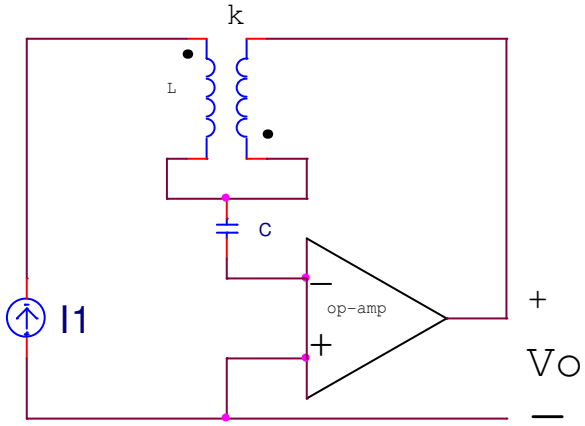
a) For the following circuit the top 2-port is a set of perfectly coupled coils with the impedance matrix description with k>0.

$$Z_{cc}(s)=sL[1 \quad -k; -k \quad k^2]$$

Show that these coupled coils have no admittance matrix. Find the impedance matrix, $Z_c(s)$, for the capacitor submatrix and add it to $Z_{cc}(s)$ to get the impedance matrix, Z(s), of the full 2-port. Find the admittance matrix, Y(s), for the full 2-port and interpret it as a parallel connection of two 2-ports each having an admittance matrix; comment on their nature.



b) Connect that 2-port with an ideal op-amp as per the following circuit. Set up circuit equations using a graph and admittances where possible and from your equations find Vo(s) given I1(s) and the circuit components.



2. [40 points] [2-port pi-equivalents & power]

a) For the ideal 2-port OTA, having Y=[0 0; g_m 0], give the 2-port pi-equivalent circuit. Repeat for the OTA turned around, that is with Y=[0 g_m; 0 0].

b) The gyrator can be made of two such OTAs by adding their Y matrices. Draw this OTA equivalent for the gyrator and give its 2-port pi-equivalent circuit.

c) From this gyrator pi-equivalent calculate the power in each of its branches as well as their sum. Compare with the input power, $V^T_{port}I_{port}$ commenting on the result.