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EE 610 Final – Fall2004

100 points, 120 minutes, work all problems; if stuck go on to next part

1. 30 points (30 minutes)

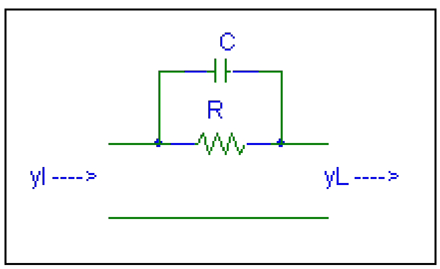
For the polynomial

$$P(s)=s^6+3s^5+4s^4+6s^3+5s^2+3s+2$$

a) Form $z(s)=EvP(s)/OdP(s)$
b) Determine if $z(s)$ is a reactance function (= positive-real & lossless)
c) If $z(s)$ is a reactance function give a First Cauer synthesis while if it is not give the reason why it is not.
d) Using $z(s)$ determine if $P(s)$ is a Hurwitz polynomial (no zeros in $\operatorname{Re}s>0$ and only simple ones on $\operatorname{Re}s=0$).

2. 35 points (30 minutes)

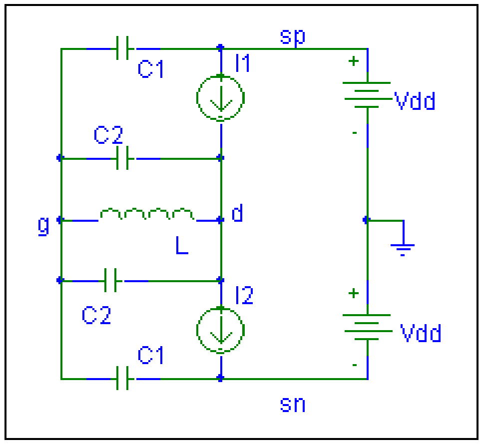
For the following 2-port



a) Find the 2-port admittance matrix $Y(s)$ and give its determinant $\Delta(s)$
b) Find the load admittance $y_L(s)$ in terms of $\Delta(s)$, the entries of $Y(s)$, and the loaded input admittance $y_I(s)$.
c) Determine necessary and sufficient conditions on a rational positive-real $yI(s)$ such that $y_L(s)$ is positive-real and one degree lower than $y_I(s)$.

3. 35 points (30 minutes)

For one of the Colpitts oscillators presented in class the following is an equivalent circuit.



Here the voltages v_g, v_d, v_{sp}=Vdd, v_{sn}=-Vdd (for gate, drain, source_p and source_n) are measured with respect to ground. Using $\beta = \frac{KP}{2}\frac{W}{L}$, assume the drain current source values are given by

$$-i_{Dp} = i1 = \beta(v_g - v_{sp} - VTO)^2$$

$$i_{Dn} = i2 = \beta(v_g - v_{sn} - VTO)^2$$

a) Let i_L and $v_L=v_g-v_d$ be inductor current and voltage. Set up state variable equation using $x=[i_L, v_g, v_L]^T$ as the state variable.
b) Linearize the state variable equations and find the characteristic polynomial [= det($s1_3$-A)]. From this find the natural frequencies.
c) Show that this circuit can be an oscillator and find the oscillation frequency in terms of the circuit parameters.