

ENEE 303 Spring 2010 Final Exam Take Home Portion

Due in a separate exam book at the end of the final period.

Open book, open notes. Your signature is required and certifies that the work is solely your own. 100 points for the take home portion. Good Luck.

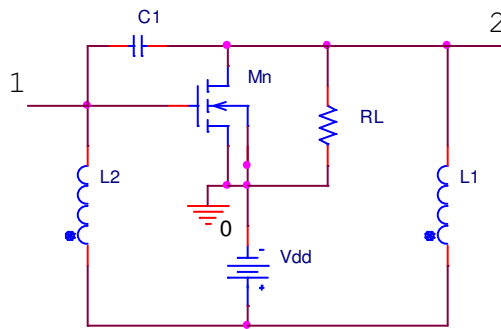
For numerical evaluations use the following for transistor model Spice parameters:

For BJTs: $\beta = 99$, $V_T = 0.026\text{V}$ = thermal voltage, $|V_{BE}| = 0.7\text{V}$

For CMOS:transistors: $V_{TOn} = -V_{TOp} = 1\text{V}$, $C_{gs} = 0$, $C_{gd} = 20\text{pF}$

$KP_n = KP_p = 10^{-4} \text{ A/V}^2$; $\lambda_n = \lambda_p = 0.01$

1. (100 pts) [Hartley circuit]



- a) Assume that the inductors are uncoupled,
 - a1) Draw the 2-port small signal equivalent circuit (voltages measured with respect to ground for both ports).
 - a2) Give the 2-port admittance matrix $Y(s)$ in literals. Use $C = C1 + Cgd$, $G = GL + go$ where $GL = 1/RL$ and go is the transistor Early effect conductance.
 - a3) Give the determinant of $Y(s)$, $\Delta Y(s)$, and show that there is a value of transconductance g_m such that this will oscillate when the ports are open circuited. Give, for this g_m (in literals)
 - a31) the resulting oscillation frequency and
 - a32) the s-domain factors of $\Delta Y(s)$.
 - a4) For the conditions of a3) find the transfer function $v2(s)/v1(s)$ when port 2 is open circuited (i.e. $i2=0$)
 - a5) When $V_{dd}=10$ and $I_D=4\text{mA}$, find for the numerical values of the given transistor W/L to properly bias the transistor .when the ports are open circuited.
 - a6) Calculate numerically the transistor g_m and output conductance go .
 - a7) If $RL=1\text{k}$ and $L1=3\text{mHy}$, find $L2$ for oscillations (when the ports are open circuited). In terms of C give the radian frequency, ω_o , of oscillation.
- b) Briefly mention what you would do differently when the coils are mutually coupled (you may assume a coefficient of coupling less than 1).