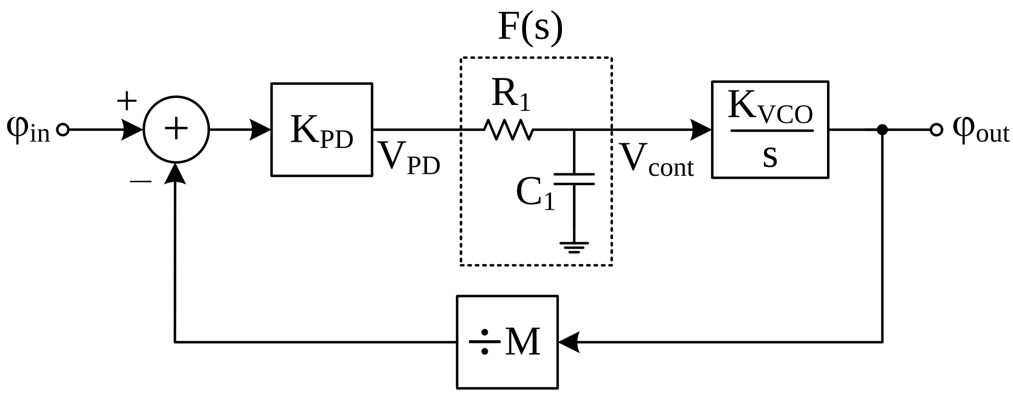
Tutorial 5: PLL

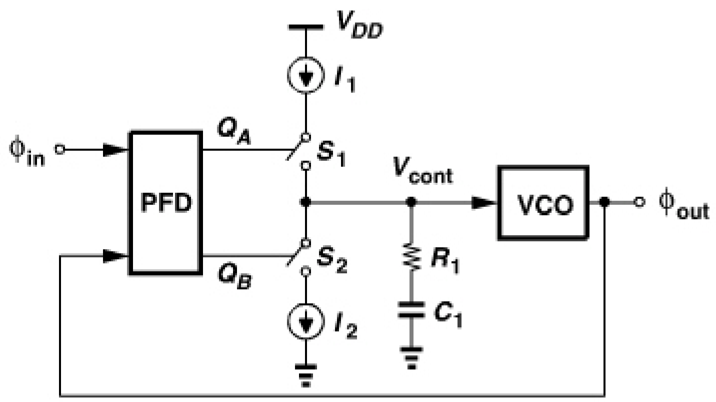
Problem 1 (9.2 Course book)

Determine the closed-loop transfer function, the damping factor ζ, and the natural frequency ω_n for the frequency-multiplying PLL shown below.

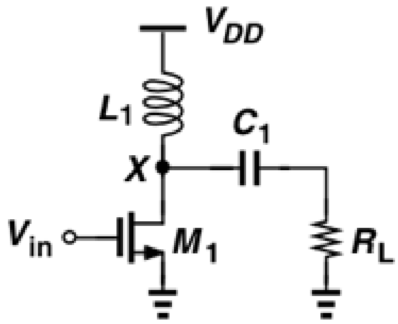


Problem 2 (9.3 Course book)

Suppose the charge-pump PLL shown below is designed with ζ = 1, and a loop bandwidth of $\omega_{in}/25$, and a tuning range of 10 %. Assume V_{cont} can vary from 0 to V_{DD}. Prove that the voltage drop across the loop filter resistor reaches roughly $1.6\pi V_{DD}$ if no second capacitor is used.



Problem 3



Let us consider designing a common source power amplifier for a battery-operated portable device. We assume the basic specifications:
- 30 dBm output power is to be delivered to the antenna (Z_L = 50 Ω), which corresponds to R_L in the figure.
- V_{DD}, the power supply voltage is 2.5 V. Depends on the battery and also is limited by the MOSFET breakdown voltage.

a) How much output power in dBm can we achieve without modifying the amplifier?

b) How high supply do we need to reach 30 dBm output power?

c) What load (R_L) can give 30 dBm output power?

d) Let us design a transformation network that transforms the 50 Ω load to the 3.1 Ω load the power amplifier wants to see to deliver 30 dBm to the load. Which network(s) from the book, below, can do the job? Which one is best suited for our existing amplifier?

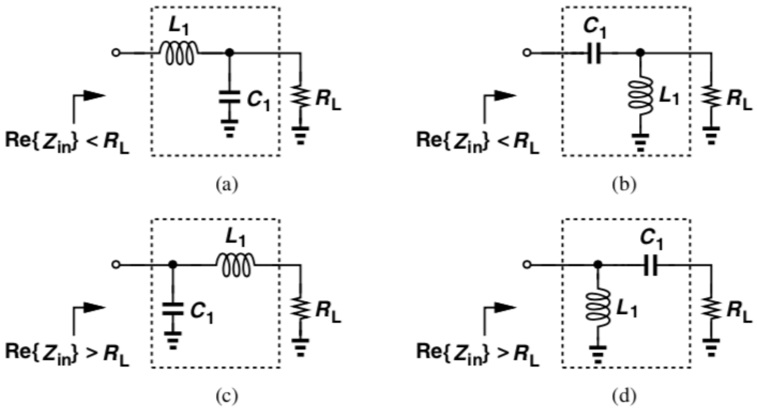
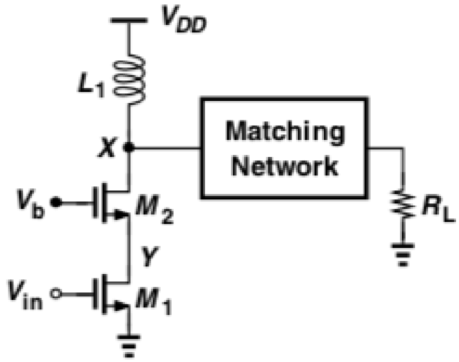


Figure 2.62 *Four L sections used for matching.*

e) Maybe we can use the bondwire at the output of the amplifier (out from the chip to the package), then network (a) is how it will look like. (But we need to add a large C also as the DC block somewhere before the load.)
Calculate L_1 and C_1 values for 2 GHz using transformation (a) above. Let Q of the transformation network be very high. Can we use a bondwire?

Problem 4

Compute the maximum efficiency of the cascode PA shown here. Assume *M*1 and *M*2 nearly turn off but their drain currents can be approximated by sinusoids.



Homework

In the PLL shown below, derive the output-to-noise $\left(\frac{\varphi_{out}}{V_{noise}}\right)$ transfer function.