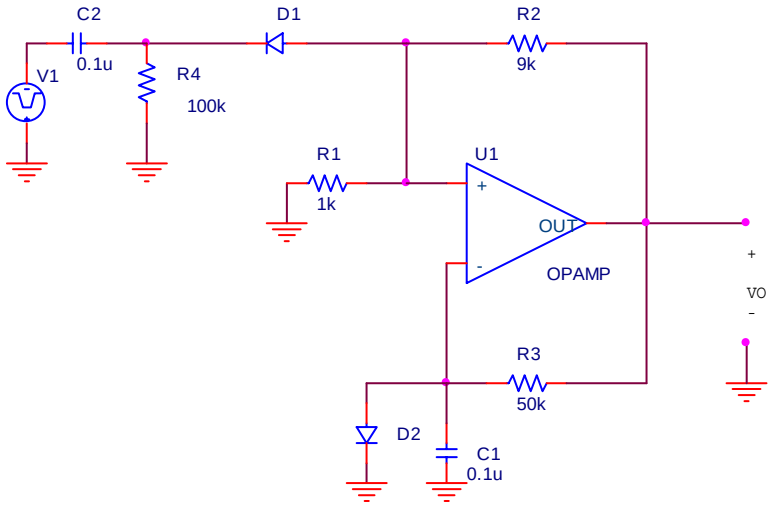
Introduction

You are currently working as an electronic circuit designer. Your boss calls you one day and asks you to design a module that can be used in one of their products. You do not really know in detail the theory of this module but you think that the basic concepts were covered in one of the 2nd year electronic courses (2EI4). You realize as well that developing a design requires both science and creativity. In most cases, there is no unique answer. You were given up to April 1st to come up with a design that can be verified with PSpice.

Sections L01, L10



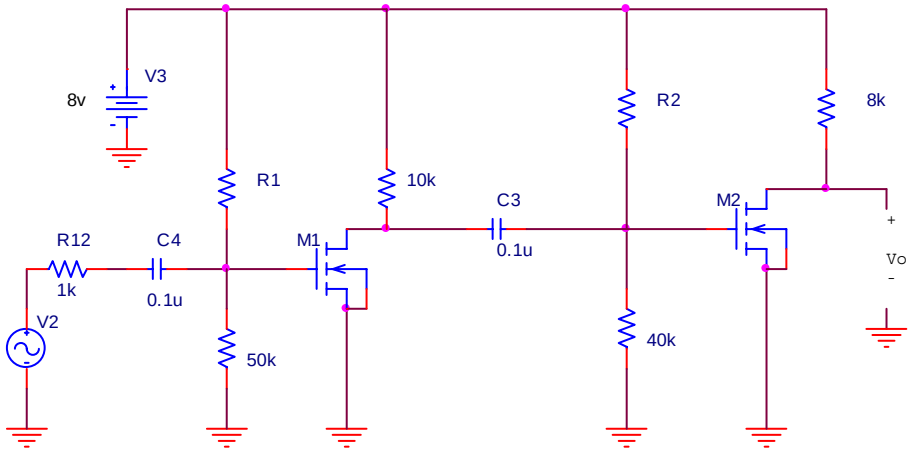
A monstable circuit is a circuit that generates a pulse of fixed duration in response to a trigger signal of any duration. The OpAmp in the above circuit is connected to a dual supply of +15 V and -15V.

a) If the steady value of V_1=15 volts, determine the steady state currents and voltages everywhere in the circuit. Confirm your answers using PSpice

b) At time t=1.0 msec a negative-going (from 15v to 0 volts) pulse of duration 10 μsec appears at V_1. What is the duration of the pulse appearing at V_o. Confirm your answer using PSpice.

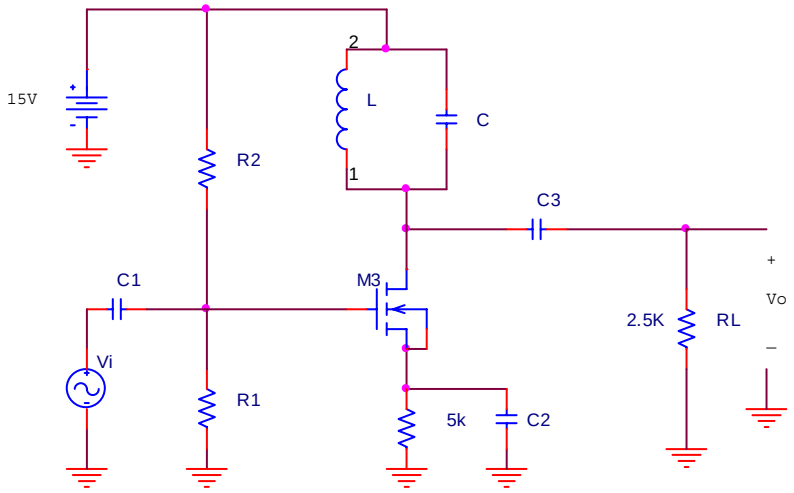
c) Redesign the values of the capacitor C_1 and Resistor R_3 so that the duration of the output pulse is 3 msec. Check your design using PSpice.

Sections L02, L09



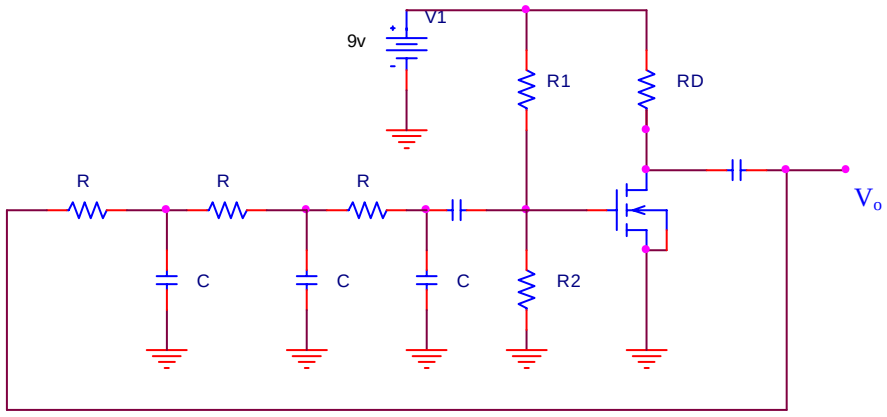
The MOSFETS in the above circuit are identical with K_n=1.6 mA/V^2, V_{TN}=0.8 V and λ=0.018 V^{-1}. Design the values of the resistors R_1 and R_2 so that the total gain of this two-stage amplifier is 110. Verify your design using PSpice.

Sections L03, L08



The shown NMOS transistor has the following properties: V_{TN}=2.0V, λ=0.1 V^{-1}, $\mu_n C_{ox}$=100 μA/V^2, L=10 μm and W=1250 μm. Design the values of R_1, R_2, C and L so that this tunable amplifier has a midband gain of magnitude 15 at 2.0 MHz with a bandwidth of 20 KHz. Verify your design using PSpice. Select values of the coupling and bypass capacitors C_1, C_2 and C_3 such that their impedance is neglected at the frequency band of interest.

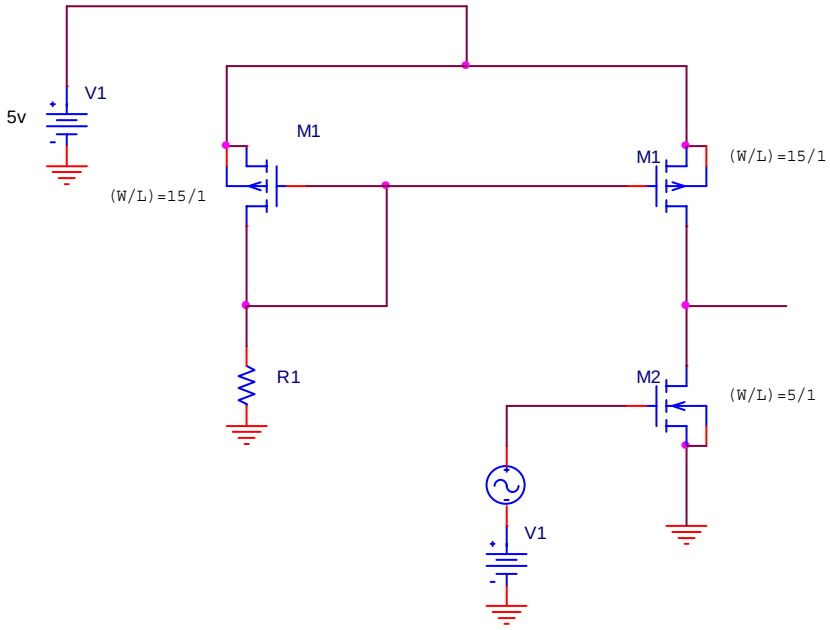
Sections L04, L07



The above figure shows a sinusoidal oscillator utilizing an NMOS transistor. The transistor has the following parameters: V_{TN}=1.0V and K_n=1.0 mA/V^2

a) Explain in simple words the theory of operation of this circuit
b) Derive an expression for the phase shift presented by the RC network
c) Design this circuit (determine R, C, R_1, R_2 and R_D) so that it oscillates at 100 KHz
d) Verify your design using PSpice

Sections L05, L06



For the shown circuit we have V_{TN}=1.0 V, V_{TP}=-1.0 V, K_n=0.36 mA/V^2 , K_p=25 e-6 A/V^2

a) Explain the theory of operation of the shown amplifier

b) Design the values of R_1 and V_1 such that the midband gain is -64 V/V

c) Verify your design using PSpice