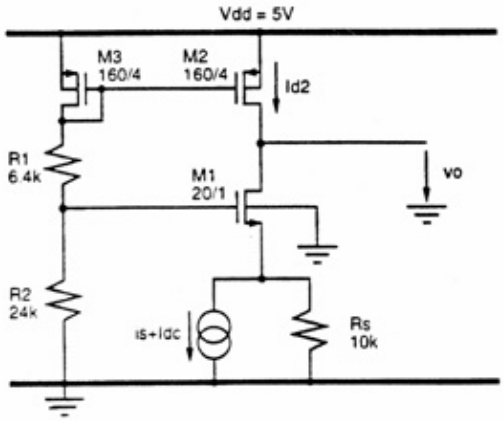
EE 140, Spring 1995
Midterm 1
Prof. Boser

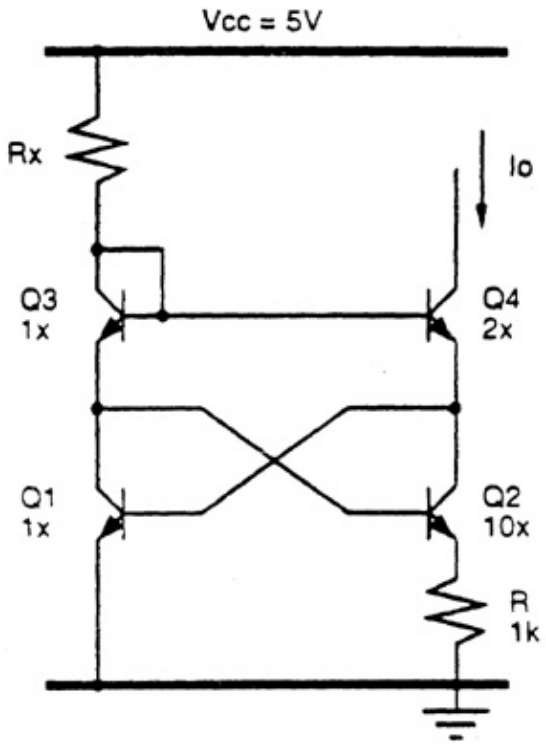
Problem #1

In the amplifier shown below the dc bias Idc is adjusted such that all devices operate in the forward active region.
(a) Find Id2, the drain current in M2.
(b) Find the transresistance Rx = vo/is. Don't neglect the body effect and beware that lambda depends on channel length.
(c) What are the minimum and maximum output voltages that keep all devices in saturation?



Problem #2

Assume that the all npn reference shown below has a stable operating point without startup problem and that all devices are in the forward active region. Neglect base currents and device output impedance.
(a) Find Io at 300K.
Hint: find a loop around which all voltages sum to zero.
(b) Find the value of the fractional temperature coefficient(TCF) of Io.
(c) What type of reference is this? (e.g. band-gap, Vt-referenced, etc).
(d) What is the minimum voltage required at the output to keep Q4 forward active?



Problem #3

Shown below is a simplified schematic of the input stage of an operational amplifier. Notice that Q1 and Q2 are not an emitter coupled pair.

(a) Find the input common-mode voltage vic = (vi1 + vi2)/2 for which Ic1 = Ic2 = 10 microAmps.

For this condition (i.e. Ic1 = Ic2 = 10 microAmps),

(b) Find the differential transconductance Gm = i0/vid (vid = vi1 - vi2), output impedance Ro = vo / io, and the differential voltage gain vo/vid of the circuit.

(c) What are the minimum and maximum values of Vo for which all devices remain in the forward active region?