Oct. 26,2010 5:30PM - 7:00PM   R. Mason
answer all questions on sheet provided, one 8.5 x 11 crib sheet allowed

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1.   (5 points)   Multiple Choice, Circle BEST answer
(a)   We can add impurities to the silicon substrate using:
                (i)   oxidation
                (ii)   photomasking
                (iii)   ion implantation
                (iv)   sputtering
(b)   Compared to a standard current mirror, a cascode current mirror generally has:
                (i)   smaller output swing
                (ii)   smaller output impedance
                (iii)   fewer transistors
                (iv)   smaller current
(c)   An advantage of thin film resistors compared to an implanted resistors is:
                (i)   higher yield
                (ii)   higher TEMPCOs
                (iii)   lower cost
                (iv)   wider range of values
(d)   The body effect is accounted for by what component in the small signal model:
                (i) g_{sb}
                (ii) $g_m v_{gs}$
                (iii) g_{ds}
                (iv) $g_s v_s$
(e)   A CMOS transistor is formed by the overlap of which two masks:
                (i)   polysilicon and contact
                (ii)   polysilicon and active
                (iii)   nplus and active
                (iv)   metal and polysilicon

2.   (10 points)   Short Answer
(a)   Draw the cross section of a CMOS inverter in an N-well process and show how a substrate
        PNP transistor could be formed.

(b)   Draw the cross section of a substrate contact? What are they used for?

(c)   Why do we specify integrated resistor using sheet resistance and not resistivity? What is the typical sheet resistance of a polysilicon resistor?

(d)   Why is matching tolerance better than absolute tolerance for integrated capacitors.

(e)   Draw the transistor schematic for a PMOS folded cascode gain stage with NMOS casocde load? What is the output impedance of this amplifier?

3. (5 points) For the following circuit assuming all transistors are in saturation and have $W/L = 100um/1.5um$, $u_nC_{ox} = 80$ uA/V^2, $u_pC_{ox} = 40uA/V^2$, $I_D = 100uA$, r_{ds-n} (ohms) = r_{ds-p} (ohms) = 6,000L (um)/I_d (mA), Ignoring the body effect, what is the gain of this stage?
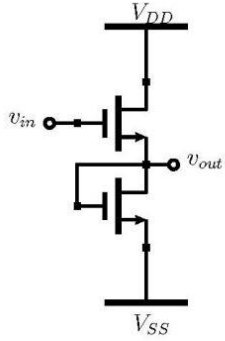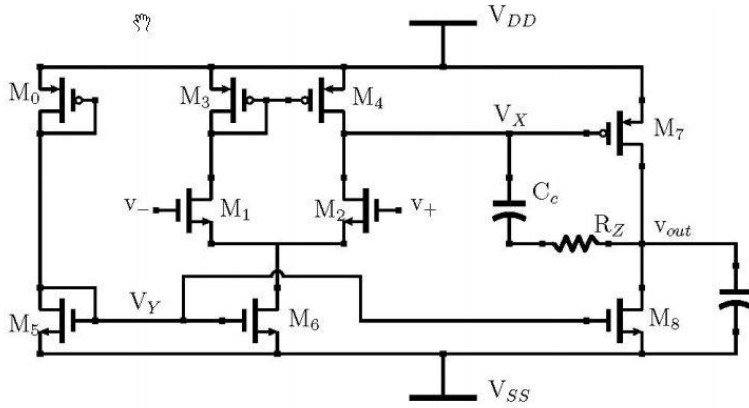

4. (4 points) What is this circuit? Draw the DC transfer curve of v_o vs. (v_1-v_2).
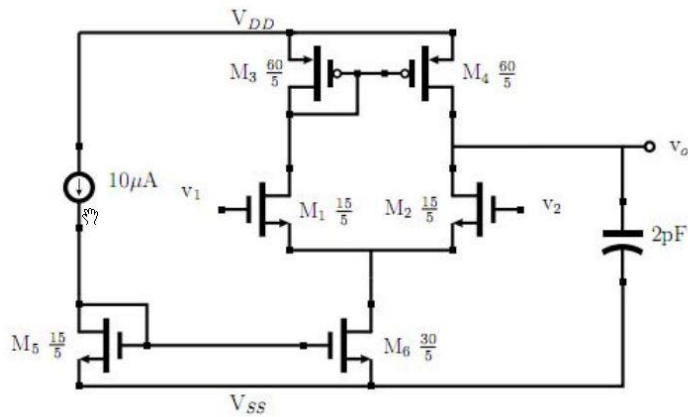
5. (6 points)   What are the following circuits? Explain the purpose of each transistor in the circuits.

(a)

(b)