Some useful identities for MOS IC design

SPG techteam – September 2011

MOS:

DC identities:

Transconductance (KP) = u0*Cox

u0	= surface mobility	(cm^2 /V – sec)
Cox	= Gate capacitance	(farad/unit area)

Cox	**= 0.0347/tox (um)**	**fF/um^2**

Vt	**= Vt0+ gamma[sqrt(Vbs+2phi) – sqrt(2phi)]**
Vt0	= Extrapolated MOSFET threshold voltage at Vbs=0
Vbs	= Bulk to source reverse bias voltage
Vt	= Threshold voltage
2Phi	**= Surface potential in strong inversion = 2*(KT/q)*ln(Na/ni);**
Na	= Substrate doping /cm^3
g Ni	= Intrinsic concentration = 1.45E10 /cm^3

GAMMA	**= sqrt[(2*e_s *q*Na)/Cox]**
e_s	= dielectric constant of silicon
GAMMA	= body effect constant.

*** Note: GAMMA can be used to find the substrate doping.**

LAMBDA	**= parameter for slope of the IDS/VDS curve**
Ro	**= output impedance of the saturated MOSFET = 1/(LAMBDA*IDS) (Ohms)**

AC Identities:

For a saturated MOSFET:

Cox*0.33 = gate to drain capacitance

Cox* 0.66 = gate to source capacitance

g_m = sqrt(2.0*KP*W/L*IDS)
Avol = gm*Ro

For a MOSFET in linear region:

Cox*0.5 = gate to drain capacitance
Cox*0.5 = gate to drain capacitance
gm = KP*W/L*VDS
Ro = 1/[KP*W/L*(Vgs-Vt)]

Note: Add the overlap capacitance to the gate to drain/source capacitance. In addition the drain/source to substrate capacitance should be added.

The drain /source capacitances are depletion capacitances that are defined by:

Cdep = sqrt(1.602E-19*8.85E-12*11.9*N*1E6)/sqrt(Vbi)

Here Vbi = built in voltage of the junction.

Vbi = KT/q * ln[NA*ND/1.9E20]

Note: The junction (drain or source) is assumed to be an abrupt junction.
NA and ND in all the above identities are hole densities and electron densities Sometimes called acceptor and donor densities.