## Small Signal Models of the MOSFET Transistor 6.301 — Spring 2002 Copyright 2002 by Michael H, Perrott

## General Thevenin Resistance View with D-G Feedback



Figure 1 Definition of Thevenin Resistances.

Thevenin resistance at drain:

$$Z'_{th_d} \approx R_{th_d} || \frac{Z_f}{1 + (Z_f || R_G)(G_m - 1/Z_f)}$$

Thevenin resistance at gate:

$$Z'_{th_g} \approx R_{th_g} || \frac{Z_f}{1 + (Z_f || R_{th_d} || R_D)(G_m - 1/Z_f)}$$

Thevenin resistance at source:

$$Z'_{th_s} \approx \frac{1}{g_m} + \frac{1}{1+\beta_o} (R_B || \frac{Z_f}{1+(Z_f || R_{th_c} || R_C) (G_m - 1/Z_f)})$$

Where:

$$\begin{aligned} R_{th_c} &\approx (1 + g_m(r_\pi || R_E)) r_o \quad \text{for } R_B \ll r_\pi, R_E \\ R_{th_b} &\approx r_\pi + (\beta_o + 1) R_E \quad \text{for } R_C \ll r_o, R_E \ll r_o \\ G_m &= \frac{1}{1/g_m + R_E} \end{aligned}$$

Note: for small signal two-port models, simply replace the non-feedback Thevenin resistances with the Z' Thevenin impedances above, and keep the same  $G_m$  and  $A_v$  values as before.