Transconductance Amplifiers

- Input is a voltage, produces a current at the output.
- Common example is a MOSFET.

- To apply feedback, we must sample output current (in series) and apply to input as a voltage (in series). So we use series-series feedback.

Ideal case (no loading from feedback network, load) open resistance included at A circuit.

![Circuit Diagram]

Want to model as an equivalent circuit with the feedback effects included.

- Gain: as before, gain with feedback is $A_f = \frac{I_o}{V_{in}} = \frac{A}{1 + AB}$

Input Resistance:
- Want $R_{if}$ to be high, as with voltage amplifier.
- Using same methods as for series-shunt feedback, can write that:
  $R_{if} = R_i (1 + AB)$

Effect on input impedance is a function of how the feedback is applied:
- Series → increase $R_{in}$
- Shunt → decrease $R_{in}$

Output Resistance:
- Want $R_{of}$ to be high so all current is driven to the load.
  - to automate, apply test current source $I_o$ to output of circuit.
\[ V_i + AV_i \triangleq R_0 \rightarrow I_R = \frac{V_i}{I_X}, \text{ with input grounded, } V_i = 0 \]
\[ V_i = -V_f = -\beta I_X \]

\[ \text{KCL: } I_X = -A\beta I_X + \frac{V_X}{R_0} \]
\[ \Rightarrow I_X = \frac{V_X}{R_0} \Rightarrow V_X = R_0 (1 + \alpha A) \]

- Feedback increases output resistance by a factor of \((1 + \alpha A)\).
- Effect on output resistance is a function of how the output is sampled: series \(ightarrow\) increase \(R_o\),
  shunt \(ightarrow\) decrease \(R_o\).

Practical case - as with the series-shunt case, for any practical feedback network we must take loading effects into account.

- We can do this by again modeling the feedback network \((B)\) with 2-port network parameters and again incorporating the loading effects into the amplifier model \((A)\).

- Use 2-parameters this time, more convenient for this case.

\[ \text{\textbf{Raised Practical model:}} \]

\[ -Z_{in}, Z_{out} \text{ model loading effects, shift time to put them in the amplifier model.} \]

\[ -Z_{in} \text{ model reverse gain again assume it is small compared to forward gain of amplifier \((A)\) so neglect it.} \]

\[ \text{\textbf{A circuit}} \]

\[ -\text{So now we can again make use of the results that we derived for the ideal case.} \]