Repaso Examen II
INEL 4202 - Segundo semestre 2009-2010
Temas

- Análisis de amplificadores para obtener $Af$, $Rif$ y $Rof$
- Estabilidad
- Osciladores senoidales
• Análisis de amplificadores para obtener $A_f$, $R_{if}$ y $R_{oif}$

<table>
<thead>
<tr>
<th>Feedback amplifier</th>
<th>Source signal</th>
<th>Output signal</th>
<th>Transfer function</th>
<th>Input resistance</th>
<th>Output resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series–shunt (voltage amplifier)</td>
<td>Voltage</td>
<td>Voltage</td>
<td>$A_{vf} = \frac{V_o}{V_i} = \frac{A_v}{(1 + \beta_v A_v)}$</td>
<td>$R_i (1 + \beta_v A_v)$</td>
<td>$\frac{R_o}{(1 + \beta_v A_v)}$</td>
</tr>
<tr>
<td>Shunt–series (current amplifier)</td>
<td>Current</td>
<td>Current</td>
<td>$A_{if} = \frac{I_o}{I_i} = \frac{A_i}{(1 + \beta_i A_i)}$</td>
<td>$R_i (1 + \beta_i A_i)$</td>
<td>$R_o (1 + \beta_i A_i)$</td>
</tr>
<tr>
<td>Series–series (transconductance amplifier)</td>
<td>Voltage</td>
<td>Current</td>
<td>$A_{gf} = \frac{I_o}{V_i} = \frac{A_g}{(1 + \beta_z A_g)}$</td>
<td>$R_i (1 + \beta_z A_g)$</td>
<td>$R_o (1 + \beta_z A_g)$</td>
</tr>
<tr>
<td>Shunt–shunt (transresistance amplifier)</td>
<td>Current</td>
<td>Voltage</td>
<td>$A_{zf} = \frac{V_o}{I_i} = \frac{A_z}{(1 + \beta_g A_z)}$</td>
<td>$R_i (1 + \beta_g A_z)$</td>
<td>$\frac{R_o}{(1 + \beta_g A_z)}$</td>
</tr>
<tr>
<td>input source</td>
<td>series-shunt</td>
<td>series-series</td>
<td>shunt-series</td>
<td>shunt-shunt</td>
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<tr>
<td>output source</td>
<td>Thevenin</td>
<td>Thevenin</td>
<td>Norton</td>
<td>Norton</td>
<td></td>
</tr>
<tr>
<td>$R_{11}$</td>
<td>$\frac{u_1}{i_1}$</td>
<td>$\frac{u_1}{i_1}$</td>
<td>$\frac{u_1}{i_1}$</td>
<td>$\frac{u_1}{i_1}$</td>
<td></td>
</tr>
<tr>
<td>$\beta$</td>
<td>$\frac{v_1}{v_2}$</td>
<td>$\frac{v_1}{i_2}$</td>
<td>$\frac{i_1}{i_2}$</td>
<td>$\frac{i_1}{v_2}$</td>
<td></td>
</tr>
<tr>
<td>$R_{22}$</td>
<td>$\frac{v_2}{i_2}$</td>
<td>$\frac{v_2}{i_2}$</td>
<td>$\frac{v_2}{i_2}$</td>
<td>$\frac{v_2}{i_2}$</td>
<td></td>
</tr>
</tbody>
</table>
• Estabilidad

Basics

• Basic feedback equation:

\[ A_f(s) = \frac{a(s)}{1 + \beta(s)a(s)} \]

Thus, feedback moves the poles of the amplifier’s transfer function.

• Poles of \( A_f \) are roots of \( 1 + \beta a \). Thus, feedback moves the poles of the amplifier’s transfer function.

• The idea is to determine information about the stability of \( A_f \) from the loop gain \( T(s) = \beta(s)a(s) \).
Nyquist Theorem

Let \( \omega_{180^\circ} \) be the frequency at which the loop gain’s phase angle is \(-180^\circ\). If

\[
| T(j\omega_{180^\circ}) | = | \beta(j\omega_{180^\circ})A(j\omega_{180^\circ}) | > 1
\]

then the amplifier is unstable. Otherwise, it is stable.

Nyquist theorem allows us to answer questions about the stability of \( A_f \) by analyzing the loop gain \( \beta A \).
Phase and Gain Margin

- Gain margin: decibels below zero of $|T(j\omega_{180})|$.

- Phase margin: degrees above $-180^\circ$ at the frequency $\omega_{0dB}$ at which $|T(j\omega_{0dB})| = 1$, or 0 db.

$$\phi_m = 180 + \angle T(j\omega_{0dB})$$

Note that $\angle T(j\omega_{0dB})$ is usually negative.

- The amplifier is unstable if the gain and phase margins are negative. If the margins are positive or zero the amplifier is stable or marginally stable, respectively.
If the loop gain $L = A(\omega) \beta(\omega)$ is real and larger than one at a frequency $\omega_0$, the circuit will produce a sinusoidal output voltage with frequency $\omega_0$. 
\[
\frac{v_f}{v_i} = A(\omega_0)\beta(\omega_0) = M(\omega_0)\angle \phi(\omega_0) = +1
\]

This means that the magnitude \( M(\omega_0) \) must be unity and the phase angle \( \angle \phi(\omega_0) = 0^\circ \).

Strategy:

- find loop gain \( L = A(\omega)\beta(\omega) \)
- find frequency \( \omega_0 \) at which the loop gain is real; the imaginary part is zero
- determine the amplifier gain required to make the loop gain larger than 1
- the criterion must be satisfied at a single, well defined \( \omega_0 \)
- the amplifier gain \( A \) will depend on the input impedance of the feedback network. unless the amplifier’s output impedance is zero (i.e. op amps)