

REPASO EXAMEN 2

INEL 4202 - Segundo semestre 2012-2013

TEMAS

- Análisis de amplificadores para obtener A_f , R_{if} y R_{of}
- Estabilidad
- Osciladores senoidales

Análisis de amplificadores para obtener A_f , R_{if} y R_{of}

TABLE 8.1 Summary of Relationships for the Four Feedback Amplifier Topologies

Feedback Amplifier	x_i	x_o	x_f	x_s	A	β	A_f	Source Form	Loading of Feedback Network Is Obtained		To Find β , Apply to Port 2 of Feedback Network	Z_{if}	Z_{of}	Refer to Figs.
									At Input	At Output				
Series-shunt (voltage amplifier)	V_i	V_o	V_f	V_s	$\frac{V_o}{V_i}$	$\frac{V_f}{V_o}$	$\frac{V_o}{V_s}$	Thévenin	By short-circuiting port 2 of feedback network	By open-circuiting port 1 of feedback network	a voltage, and find the open-circuit voltage at port 1	$Z_i(1 + A\beta)$	$\frac{Z_o}{1 + A\beta}$	8.4(a) 8.8 8.10 8.11
Shunt-series (current amplifier)	I_i	I_o	I_f	I_s	$\frac{I_o}{I_i}$	$\frac{I_f}{I_o}$	$\frac{I_o}{I_s}$	Norton	By open-circuiting port 2 of feedback network	By short-circuiting port 1 of feedback network	a current, and find the short-circuit current at port 1	$\frac{Z_i}{1 + A\beta}$	$Z_o(1 + A\beta)$	8.4(b) 8.22 8.23 8.24
Series-series (transconductance amplifier)	V_i	I_o	V_f	V_s	$\frac{I_o}{V_i}$	$\frac{V_f}{I_o}$	$\frac{I_o}{V_s}$	Thévenin	By open-circuiting port 2 of feedback network	By open-circuiting port 1 of feedback network	a current, and find the open-circuit voltage at port 1	$Z_i(1 + A\beta)$	$Z_o(1 + A\beta)$	8.4(c) 8.13 8.15 8.16
Shunt-shunt (transresistance amplifier)	I_i	V_o	I_f	I_s	$\frac{V_o}{I_i}$	$\frac{I_f}{V_o}$	$\frac{V_o}{I_s}$	Norton	By short-circuiting port 2 of feedback network	By short-circuiting port 1 of feedback network	a voltage, and find the short-circuit current at port 1	$\frac{Z_i}{1 + A\beta}$	$\frac{Z_o}{1 + A\beta}$	8.4(d) 8.18 8.19 8.20

Stability

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 ω_{180° be the frequency at which the loop gain's phase angle is -180° . 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 βA .

Phase and Gain Margin

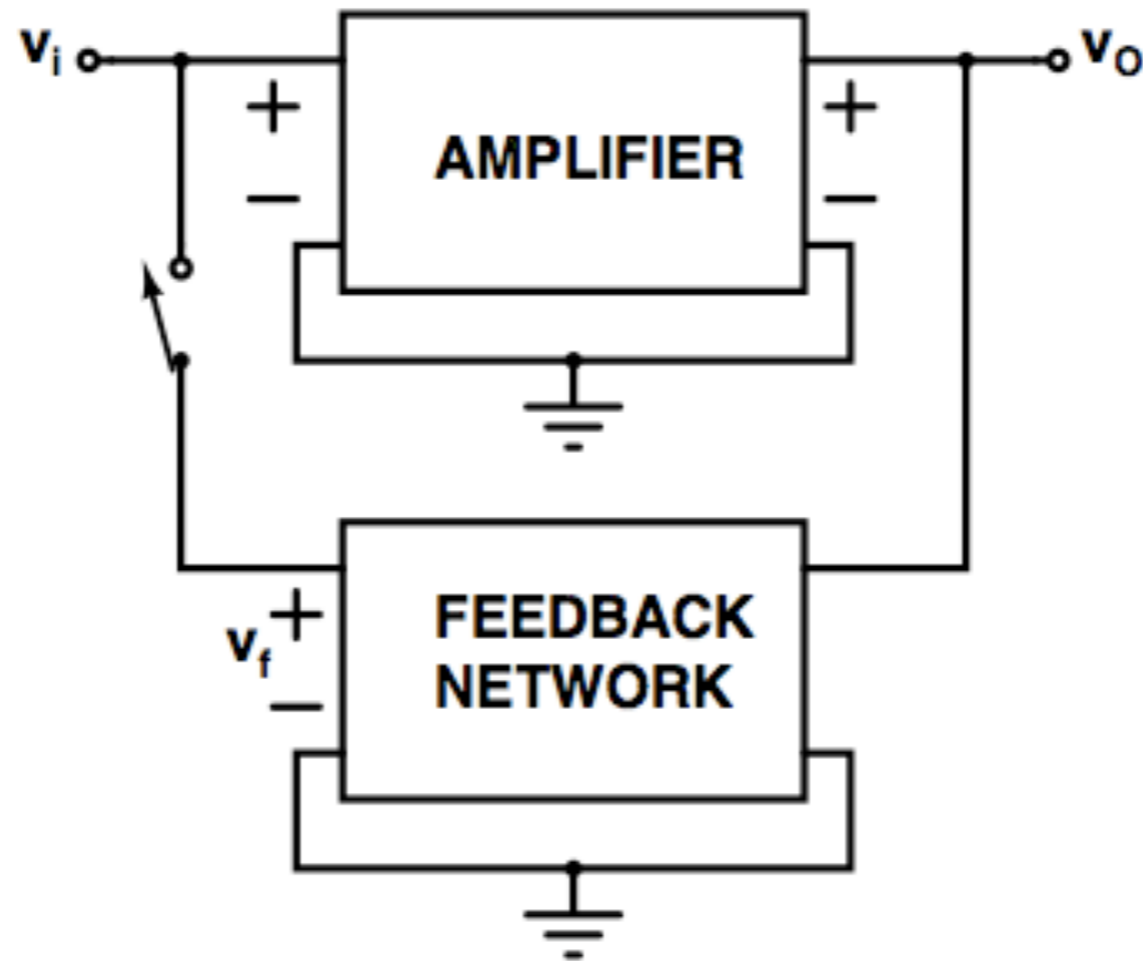
- Gain margin: decibels below zero of $|T(j\omega_{180^\circ})|$.
- Phase margin: degrees above -180° at the frequency ω_{0dB} at which $|T(j\omega_{0dB})| = 1$, or 0 db.

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

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.

1 Barkhausen Criterion



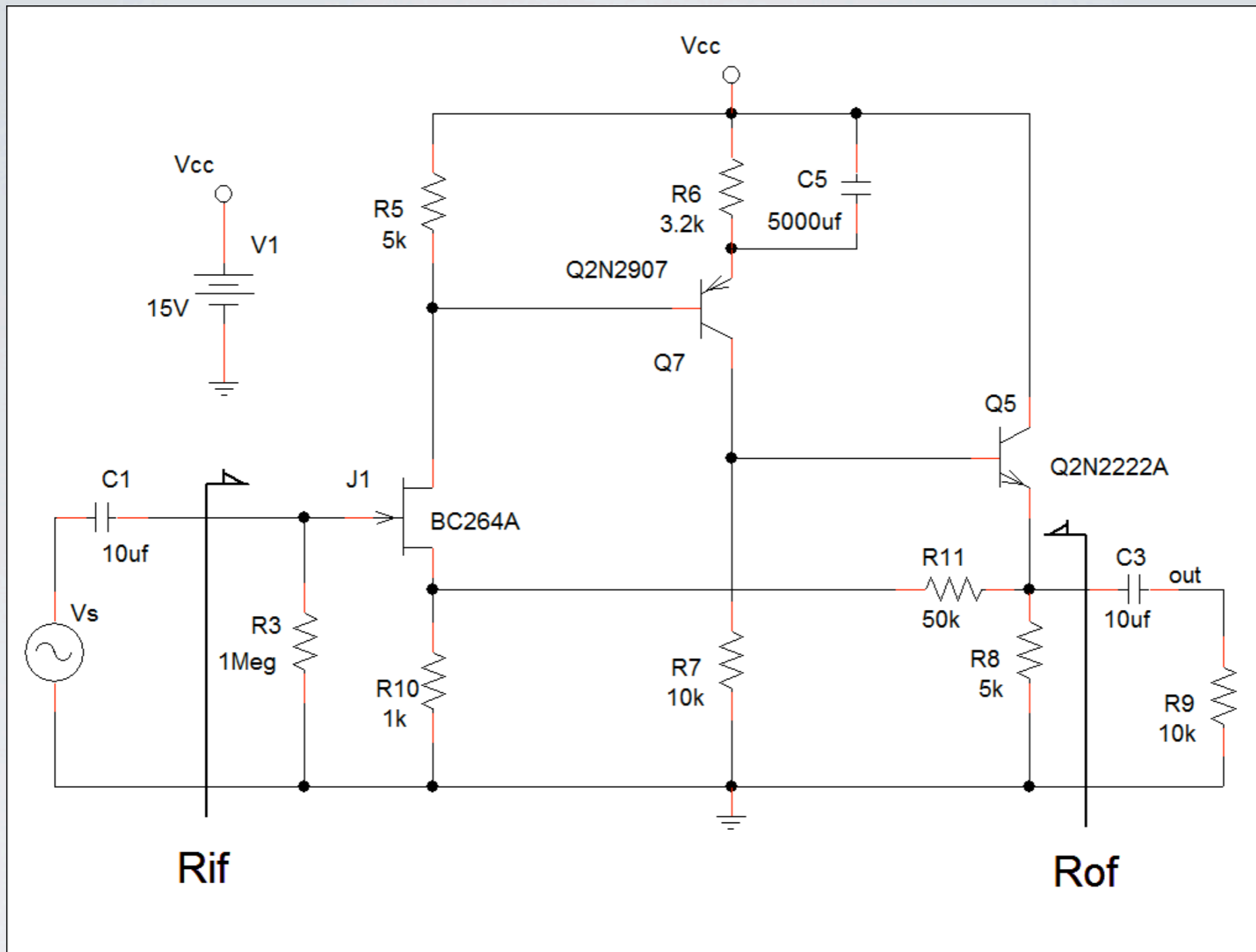
If the loop gain $L = A(\omega)\beta(\omega)$ is real and larger than one at a frequency ω_0 , the circuit will produce a sinusoidal output voltage with frequency ω_0 .

$$\frac{v_f}{v_i} = A(\omega_0)\beta(\omega_0) = M(\omega_0)\angle\phi(\omega_0) = +1$$

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 ω_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 ω_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)



- Assuming $h_{fe}=200$, $g_m=40\text{mA/v}$, $r_o=\infty$ for all BJTs, and $g_m=2\text{mA/v}$, $r_o=\infty$ for the FET.
- Determine the type of feedback employed, and find the feedback factor β .
 - Find the open loop-gain A_{ol}
 - Find the voltage gain V_{out}/V_s
 - Determine R_{if} and R_{of}

The loop gain of a feedback amplifier is given by

$$L(s) = \frac{10^{19}}{(s + 10^4)(s + 10^6)(s + 10^7)}$$

Assuming the amplifier is used in a negative feedback configuration with $\beta=0.1$,

- a) Determine the closed-loop gain of the feedback amplifier at low freqs. ($f \ll f_{\text{poles}}$).
- b) Determine the high frequency corner (f_h) of the feedback amplifier.
- c) Is the system stable? Justify your answer.

For the following circuit, $g_m=2\text{mA/V}$, $r_o=100\text{k}\Omega$. RFC (Radio Frequency Choke- a big inductor) is an open circuit for AC signals and a short circuit for DC. C2 is a coupling cap and can be assumed a short circuit at the frequency of oscillation.

- Find an expression for the loop gain
- Find the frequency of oscillation.

