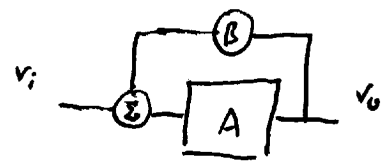
Folha de problemas 6 Electrónica II

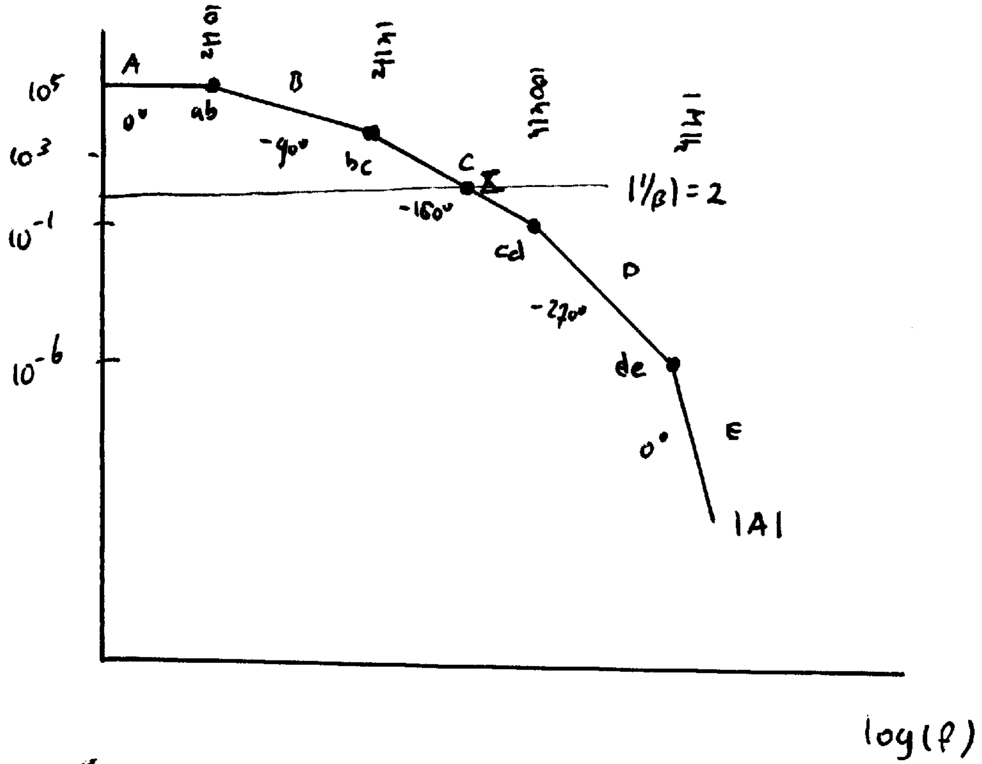
a)



$$\frac{v_o}{v_i} = \frac{A}{1+A\beta}$$

b) $A = 10^5$, $\beta = 0.5$, $\Rightarrow \frac{V_o}{V_i} = \frac{10^5}{1+10^5 \cdot 0.5} = \frac{10^5}{50001} \approx 2$

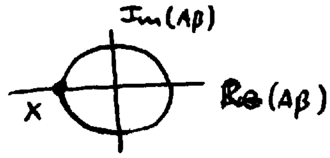
c)



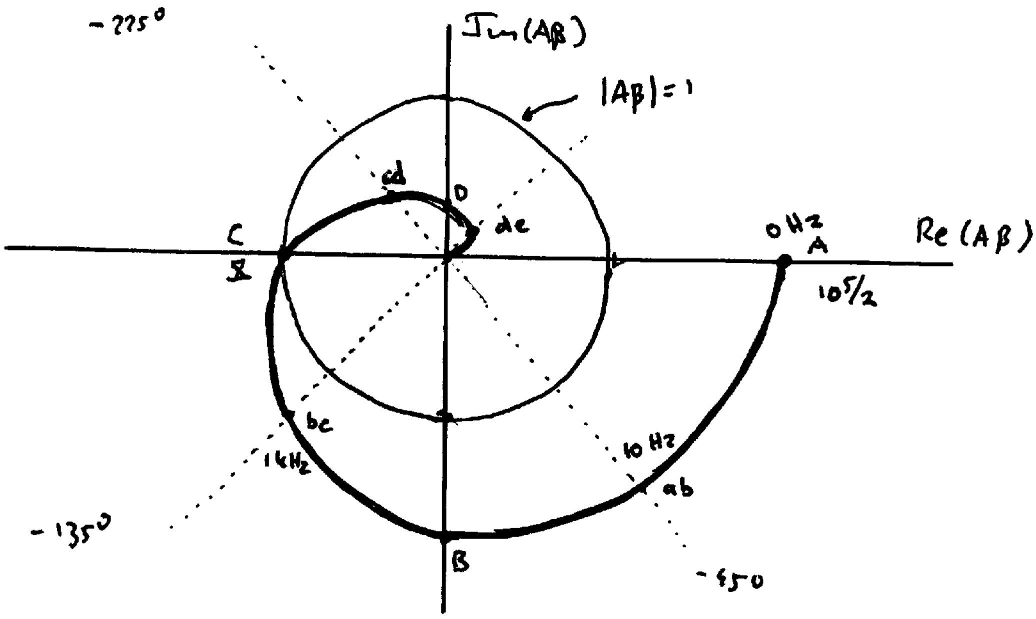
Summary:

A	0°	~ 1	$\Rightarrow$	10^5
ab	-45°	10 Hz	$\Rightarrow$	10^5
B	-90°	$\sim 1/f$	$\Rightarrow$	$10\ \text{Hz} \times 10^5 / f$
bc	-135°	1 kHz	$\Rightarrow$	10^3
C	-180°	$\sim 1/f^2$	$\Rightarrow$	$(1\ \text{kHz})^2 \times 10^3 / f^2$
cd	-225°	100 kHz	$\Rightarrow$	10^{-1}
D	-270°	$\sim 1/f^3$	$\Rightarrow$	$(100\ \text{kHz})^3 \times 10^{-1} / f^3$
de	-315°	1 MHz	$\Rightarrow$	10^{-6}
E	0°	$\sim 1/f^4$	$\Rightarrow$	$(1\ \text{MHz})^4 \times 10^{-6} / f^4$

It is immediatly clear that the crossing point of $|A|$ and $|1/\beta|$ occurs at a frequency between 1 kHz and 100 kHz, and the phase is $-180°$ at this point.



More or less at the Barkhausen point.



Analyzing the Nyquist plot above, it is clear that the circuit can (and will) oscillate in the frequency range bc - X

X can be found by the equation for line segment C

$$|A| = \frac{(1\ \text{kHz})^2 \times 10^3}{f^2} = |1/\beta| = 2$$

$$f = \sqrt{\frac{(1\ \text{kHz})^2 \times 10^3}{2}} = 22,4\ \text{kHz}$$

d) For this effect the $|1/\beta|$ line has to pass through the second pole (bc). For that we can use line segment B

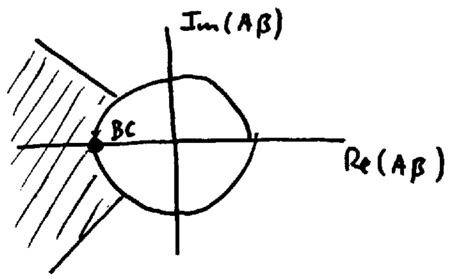
$$|A| = \frac{10\ \text{Hz} \times 10^5}{f}$$

In bc (1 kHz) this gives

$$|A| = \frac{10\ \text{Hz} \times 10^5}{1\ \text{kHz}} = 10^3 = |1/\beta| \Rightarrow$$

$$\beta = \frac{1}{1000}$$

e)

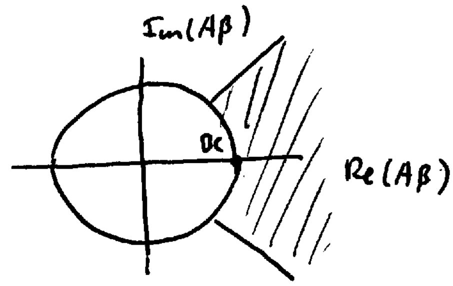


Negative feedback

$$A_f = \frac{A}{1 + A\beta}$$

Barkhausen:

$A\beta = -1$ → $|A\beta| = 1$, $\phi A\beta = -180°$

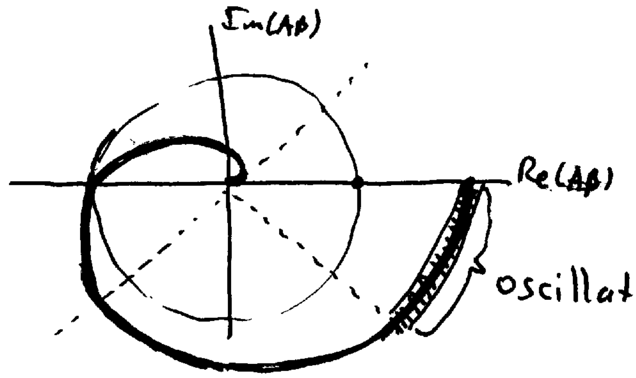


positive feedback

$$A_f = \frac{A}{1 - A\beta}$$

Barkhausen

$A\beta = +1$ → $|A\beta| = +1$, $\phi A\beta = 0°$



oscillations 0 – 10 Hz !