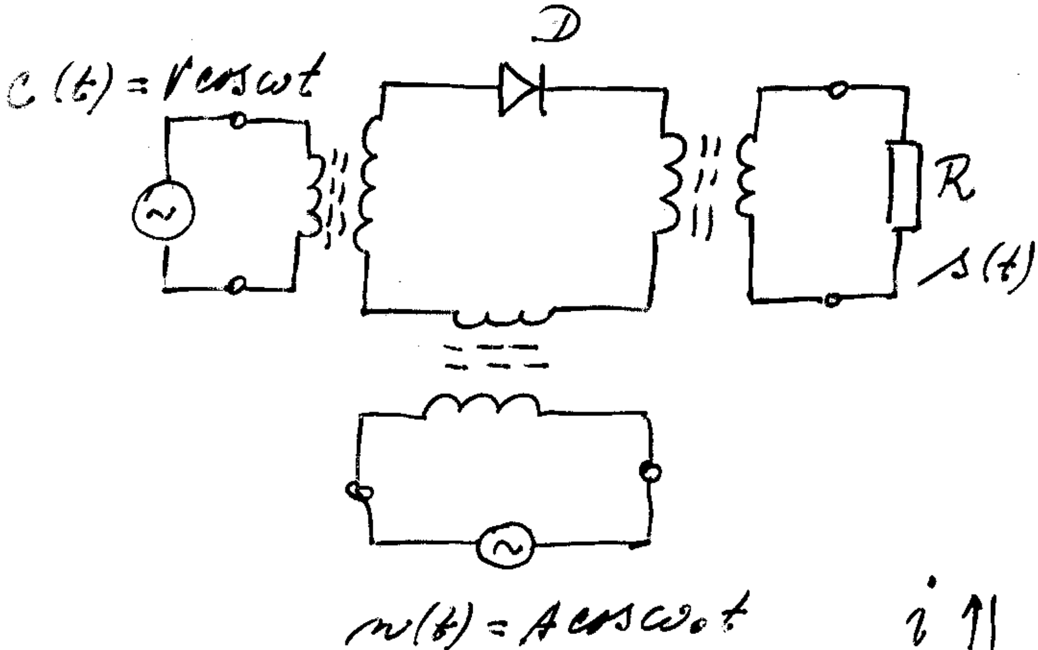
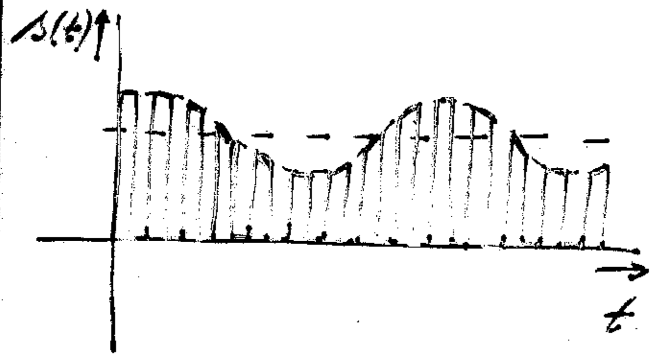
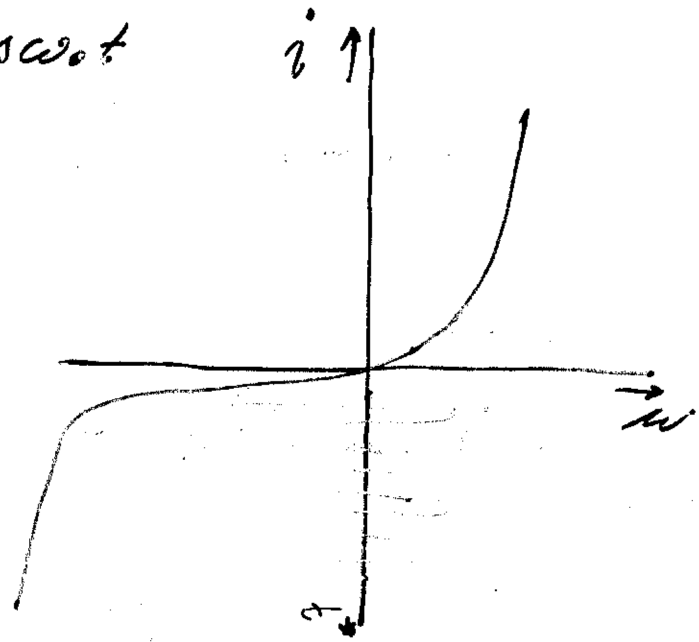
Modulátory

Amplitúdové modulátory

$$c(t) = V\cos\omega t$$
$$m(t) = A\cos\omega_0 t$$



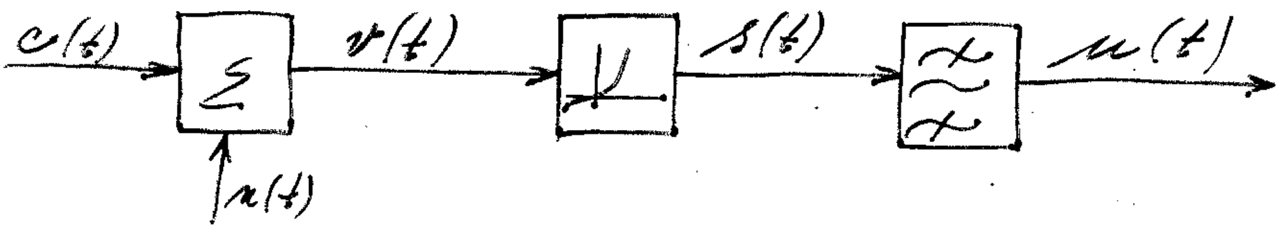


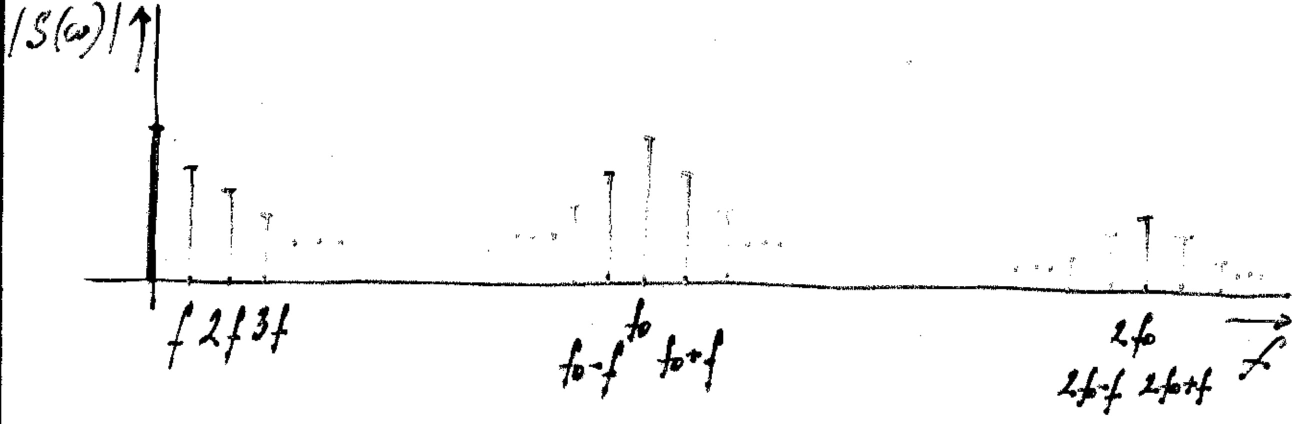


$$v(t) = V\cos\omega t + A\cos\omega_0 t$$

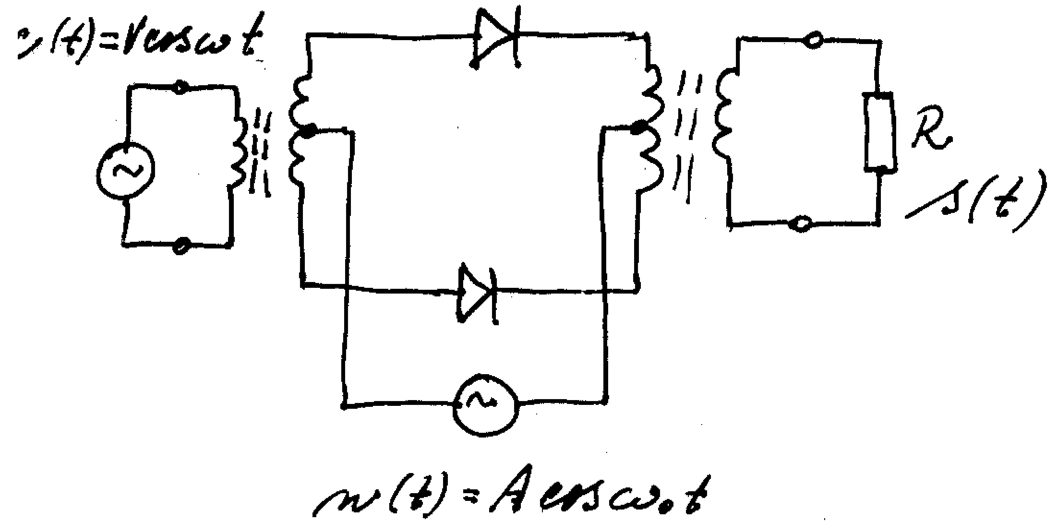
$$s(t) = a_1 v(t) + a_2 v^2(t) + a_3 v^3(t) + \dots$$

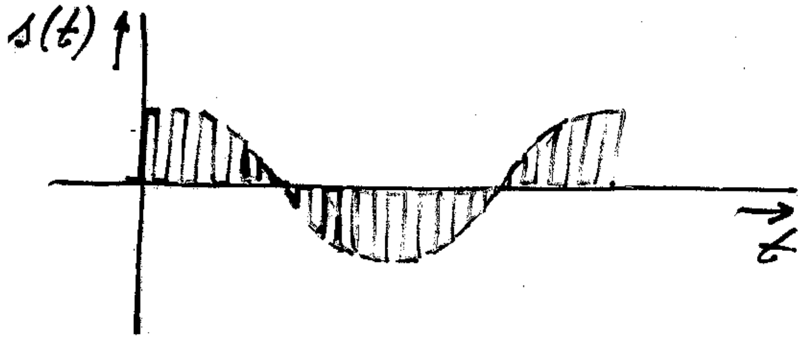
$$s(t) = a_1 v(t) + a_2 v^2(t) = a_1\{V\cos\omega t + A\cos\omega_0 t\} +$$
$$+ a_2\{V\cos\omega t + A\cos\omega_0 t\}^2 =$$
$$= a_1 V\cos\omega t + a_1 A\cos\omega_0 t + a_2 V^2\cos^2\omega t + 2a_2 VA\cos\omega t\cos\omega_0 t +$$
$$+ a_2 A^2\cos^2\omega_0 t = \underline{a_1 V\cos\omega t} + \underline{a_1 A\cos\omega_0 t} + \tfrac{1}{2}a_2 V^2 +$$
$$+ \tfrac{1}{2}a_2 V^2\cos 2\omega t + \underline{a_2 VA\cos(\omega_0-\omega)t} + \underline{a_2 VA\cos(\omega_0+\omega)t} +$$
$$+ \tfrac{1}{2}a_2 A^2 + \tfrac{1}{2}a_2 A^2\cos 2\omega_0 t$$



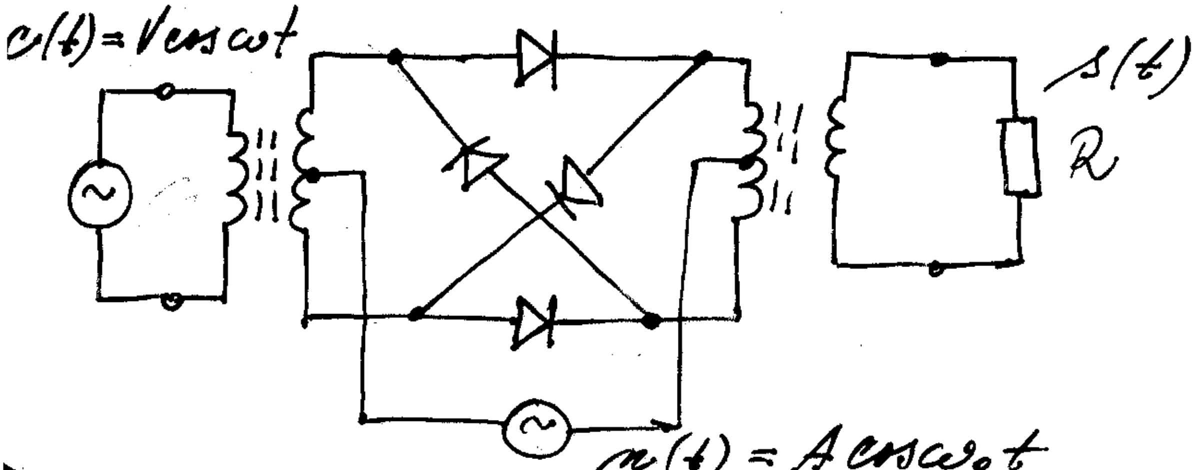


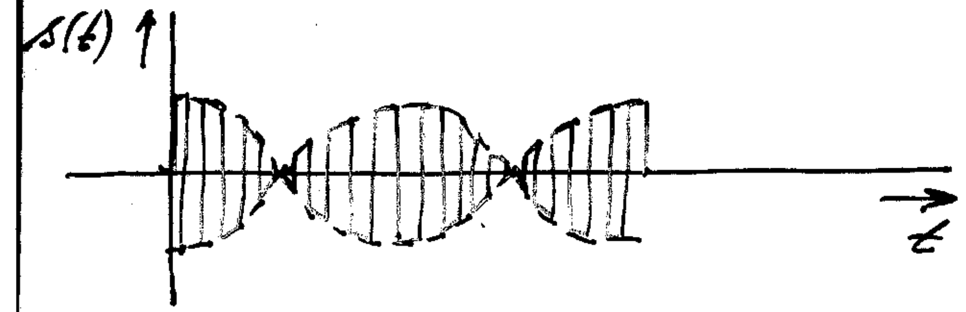
Vyvážený modulátor



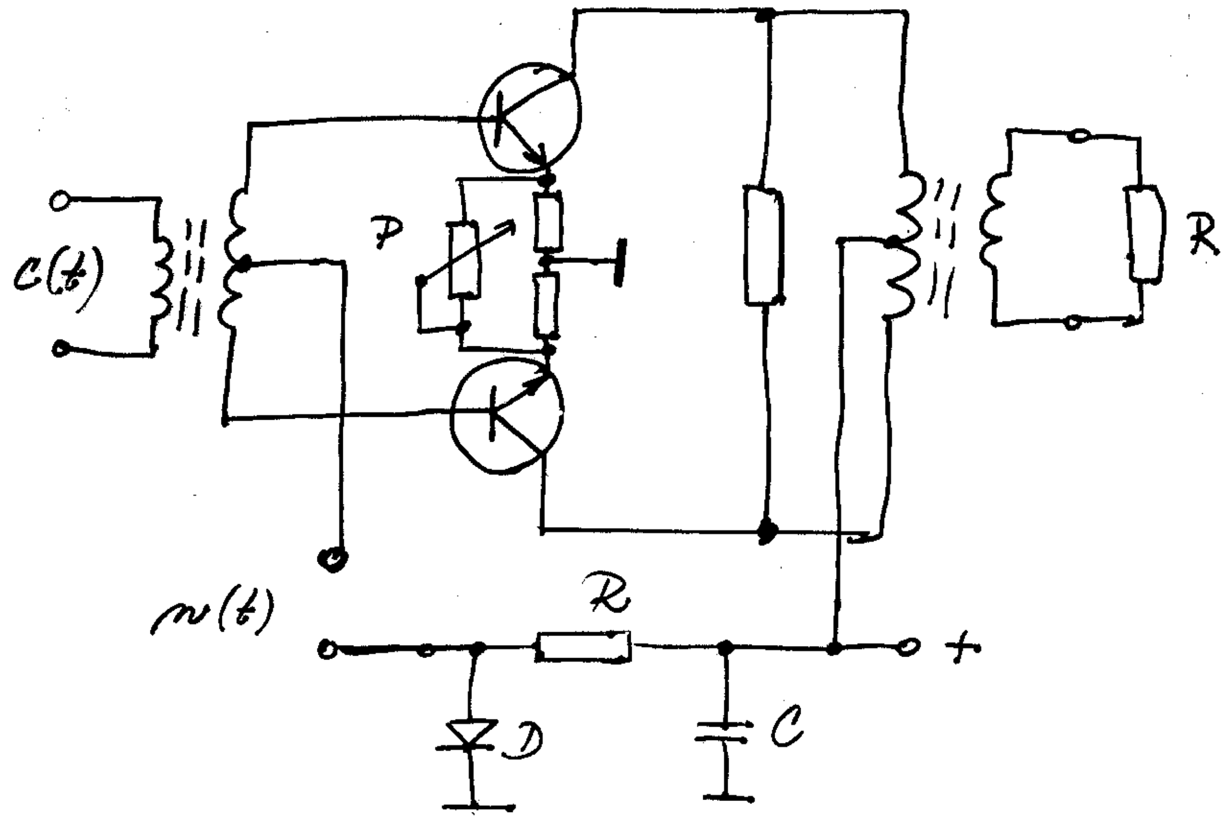


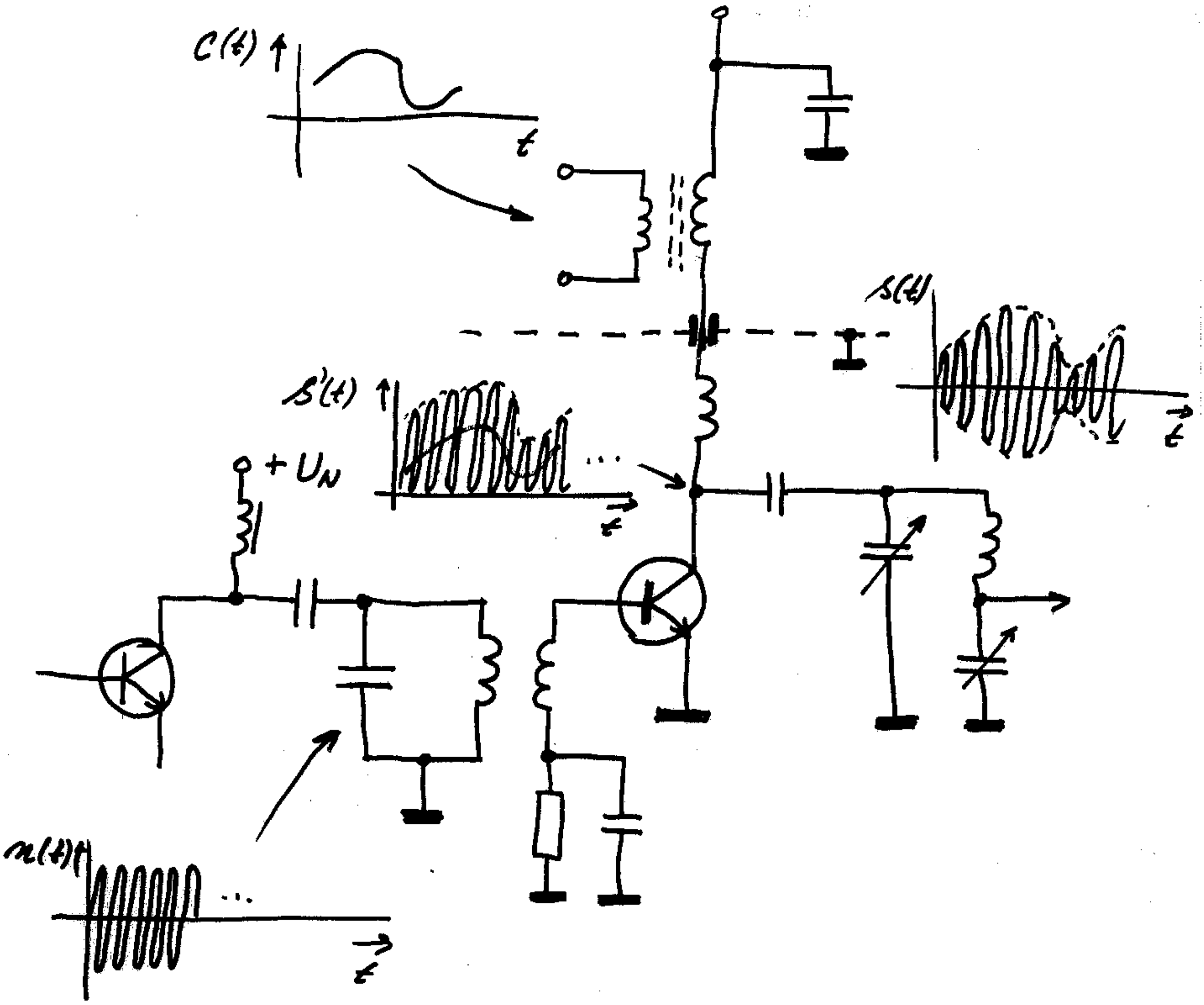
Dvojitý vyvážený modulátor



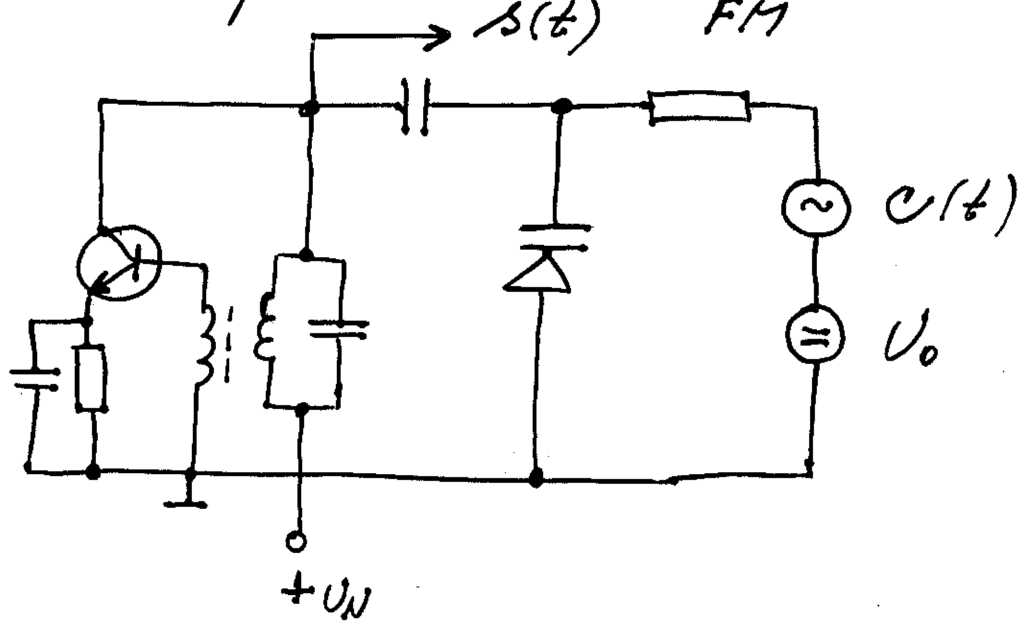


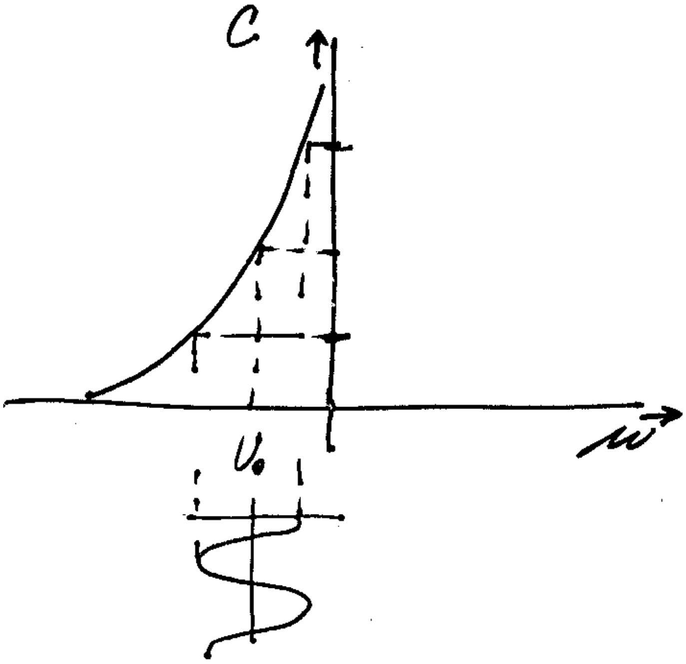
Jednoduchý vyvážený AM aktívny modulátor




C(t)
t
s(t)
s'(t)
+U_N
n(t)

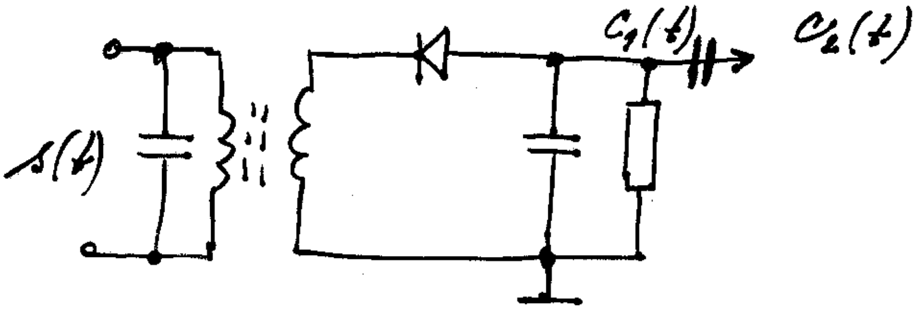
Kmitočtový modulátor

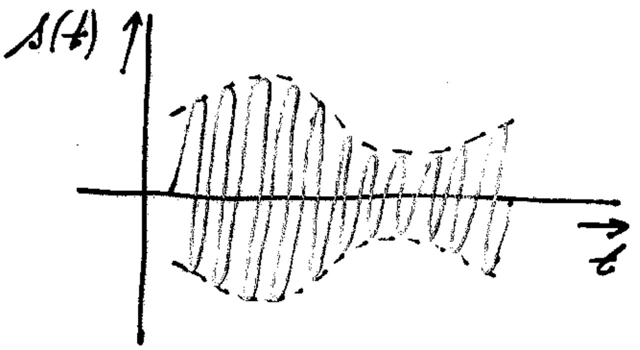


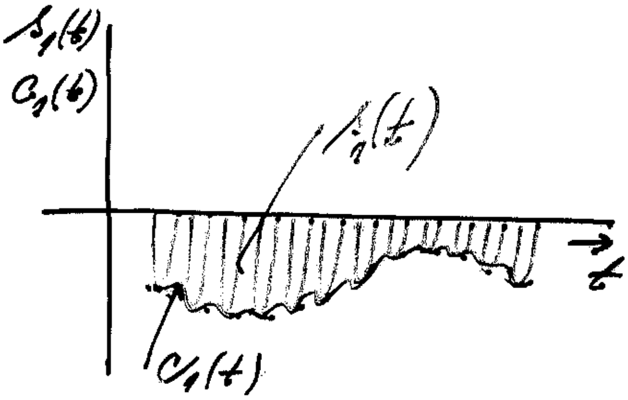


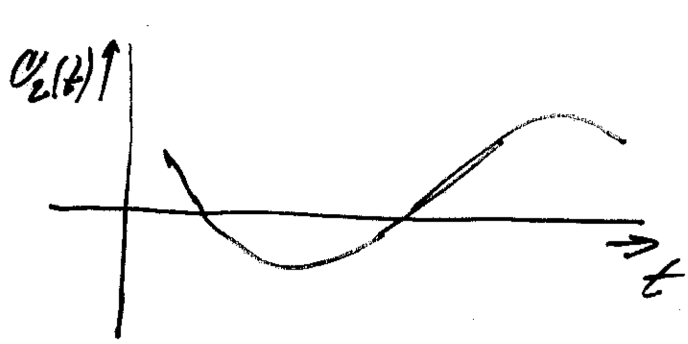
Demodulátory

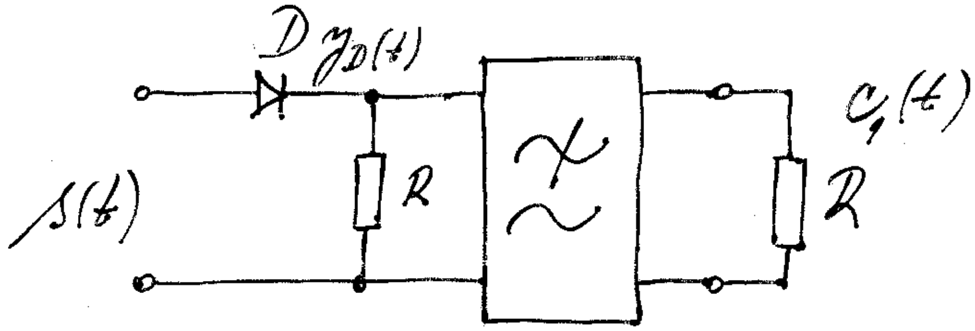
Demodulátor AM signálu







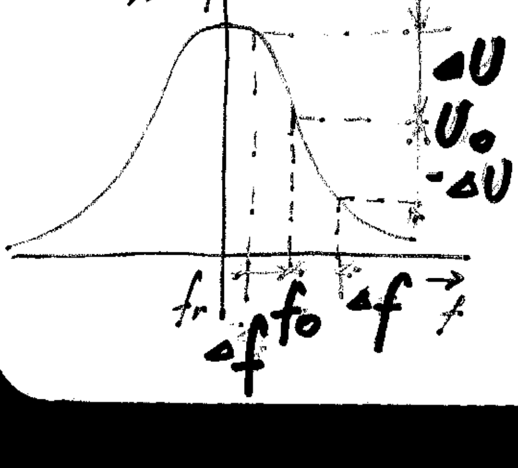


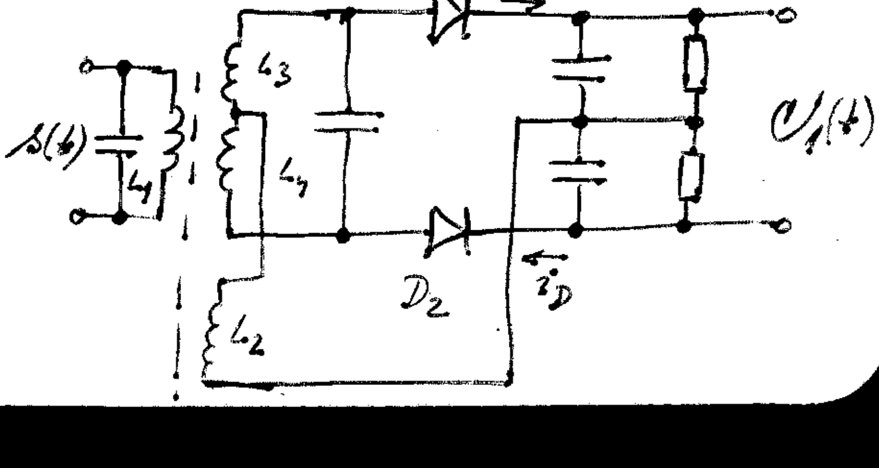


$$y_D(t) = a_1 s(t) + a_2 s^2(t) = a_1\{A + c(t)\}\cos\omega_0 t +$$
$$+ a_2\{[A + c(t)]\cos\omega_0 t\}^2 =$$
$$= a_1 A\cos\omega_0 t + a_1 c(t)\cos\omega_0 t + a_2 A^2\cos^2\omega_0 t +$$
$$+ \underbrace{2a_2 A c(t)\cos^2\omega_0 t} + a_2 c^2(t)\cos^2\omega_0 t =$$
$$= 2a_2 A c(t)\cdot\frac{1}{2}\{1 + \cos 2\omega_0 t\} + \cdots =$$
$$= \underline{\underline{a_2 A c(t)}} + a_2 A c(t)\cos 2\omega_0 t + \cdots$$

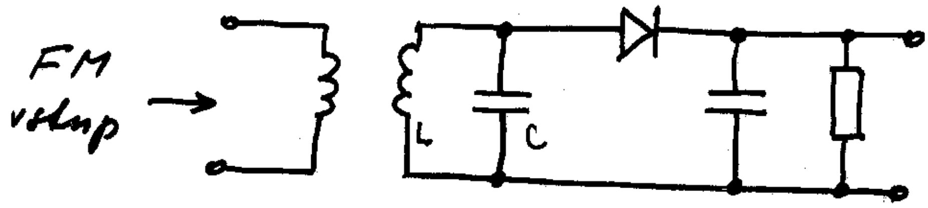
Detektory FM signálu

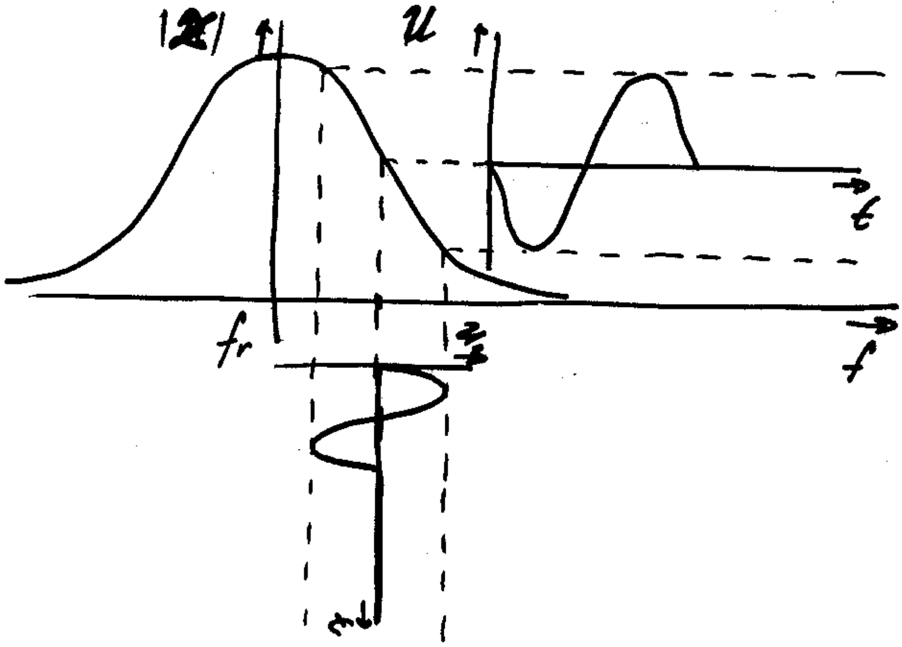
Kmitočtový diskriminátor

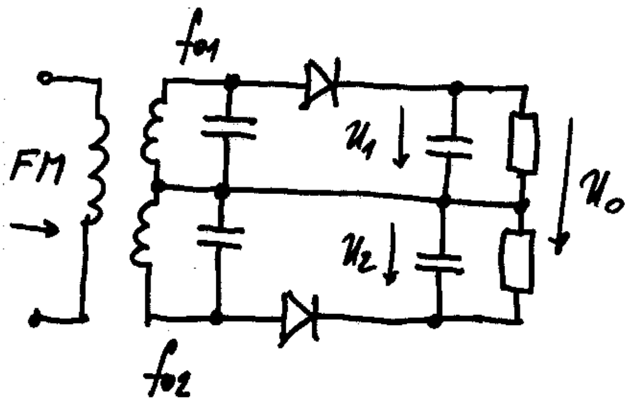


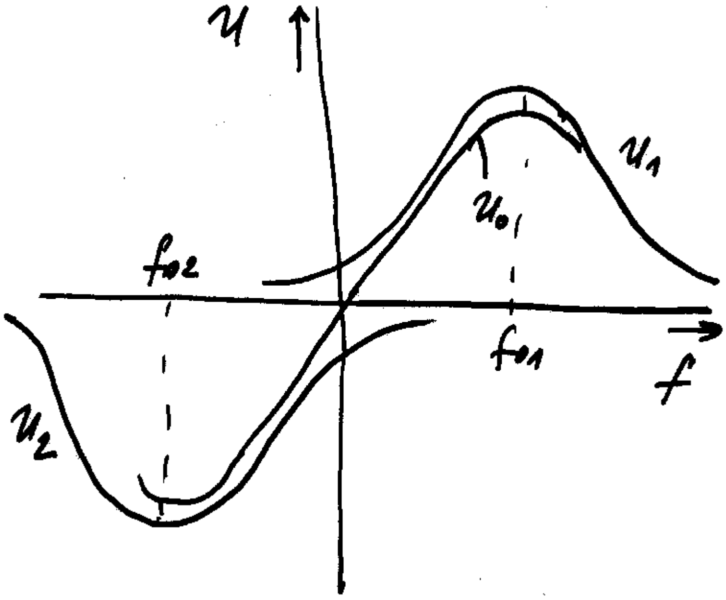


FM demodulátor (zákl. zapojenie)



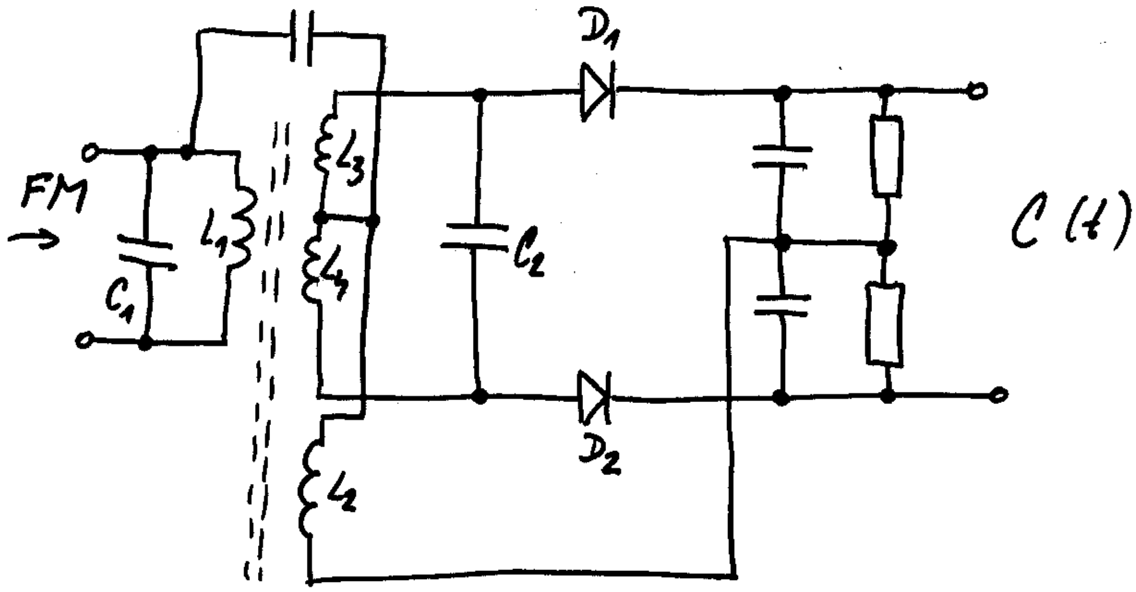


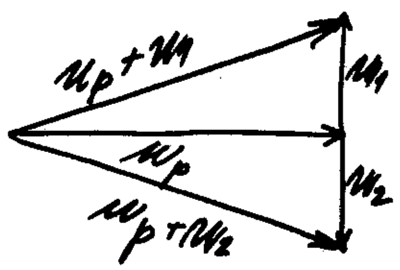


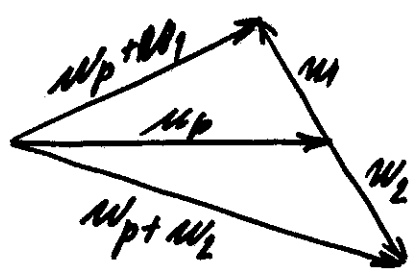


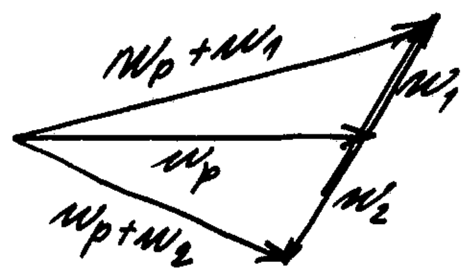
(fázový)

Kmitočtový diskriminátor

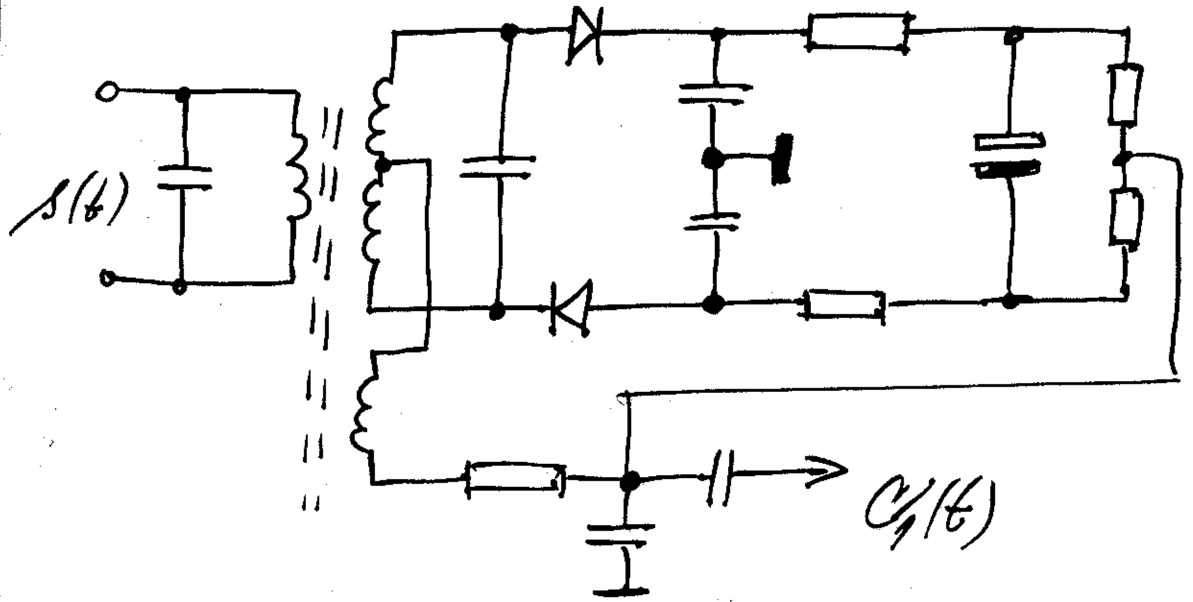




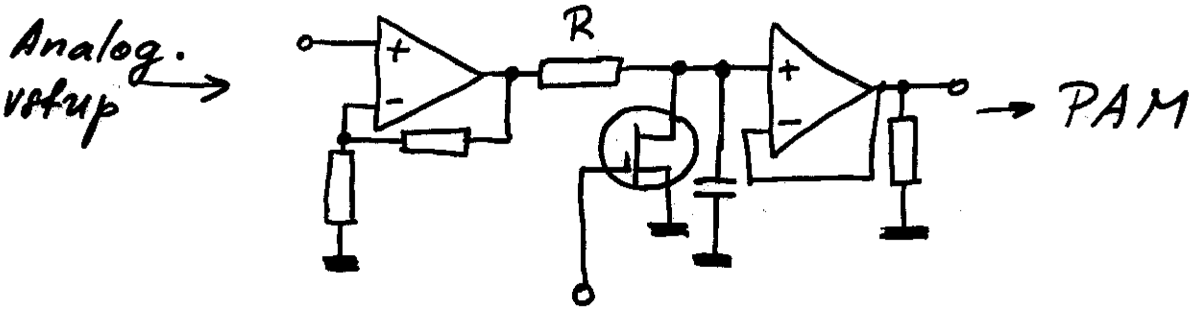


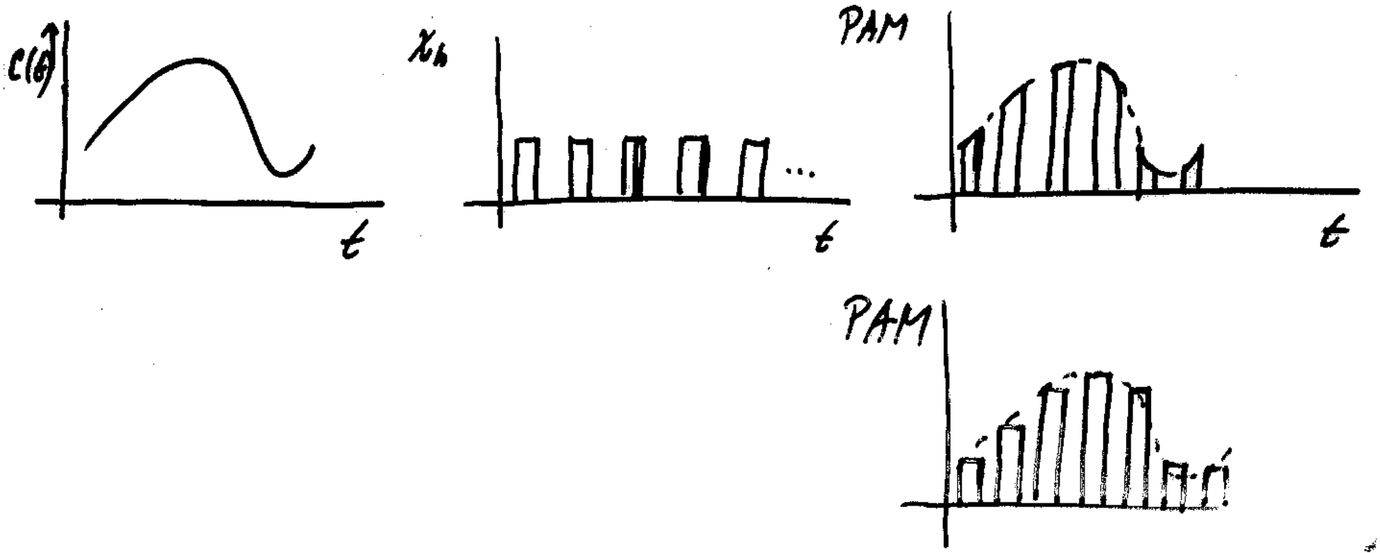


Pomerový detektor

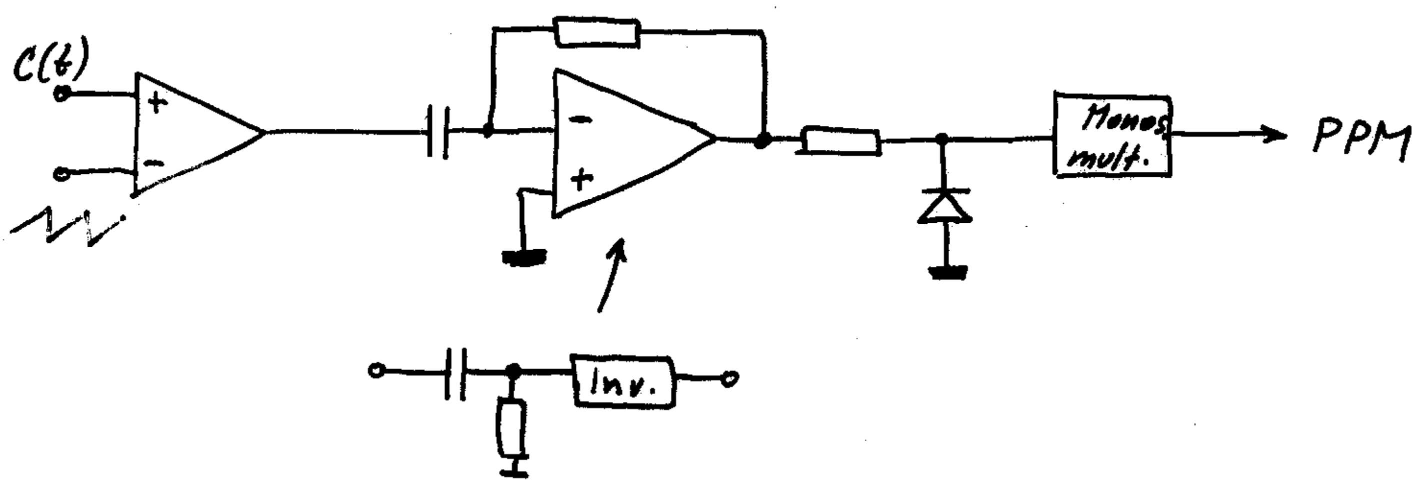


Impulzne amplitúdový modulátor

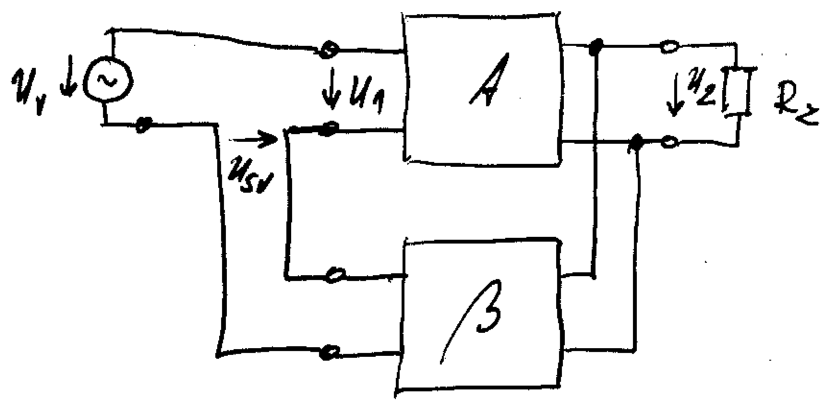




Impulzne šírkový a impulzne polohový modulátor



OSCILÁTORY



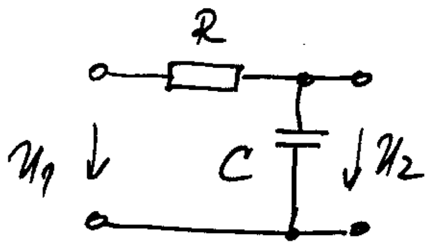
$$A_\beta = \frac{A}{1+A\beta}$$

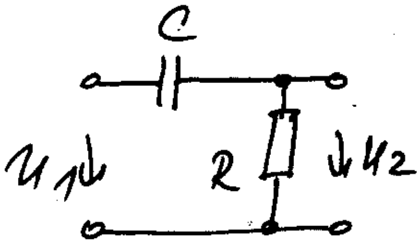
$$-A\beta = \frac{u_{sv}}{u_1}$$

$$-A\beta = 1 \Rightarrow \left.\begin{array}{l} |A\beta| = 1 \\ \angle -A\beta = 0 \end{array}\right\} -A\beta = 1\angle 0$$

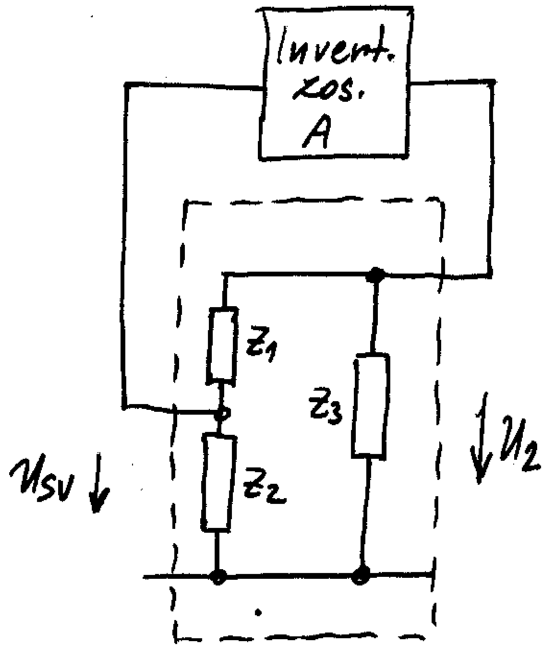
Ak $\angle A = -180° \Rightarrow \angle -\beta = -180°$

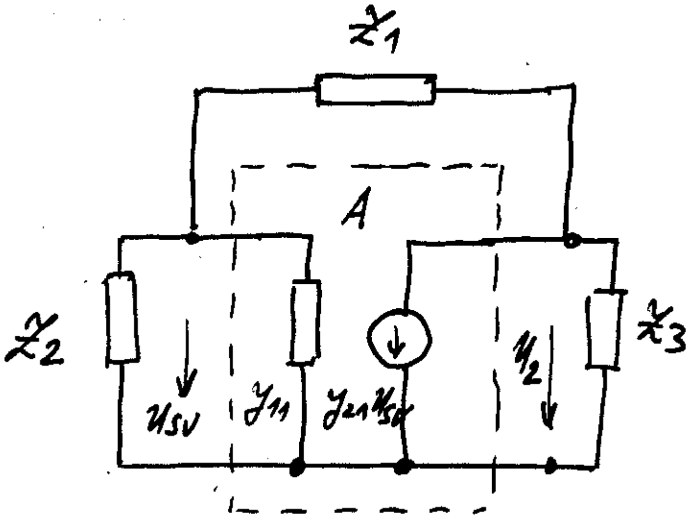
RC oscilátory





$$K_u(\omega) = \frac{u_2}{u_1} = \left|\frac{u_2}{u_1}\right| e^{j\varphi} \quad ; \quad \varphi \in (0°; 90°)$$





zaťažovacia imped. zosil. $Z_3 \,\|\, (Z_1 + Z_2 \,\|\, y_{11})$

$$Y_3 + \left[\frac{Y_1(Y_2+y_{11})}{Y_1+Y_2+y_{11}}\right]$$

$$U_2 = \frac{-y_{21}U_{sv}}{Y_3+\left[\frac{Y_1(Y_2+y_{11})}{Y_1+Y_2+y_{11}}\right]} \Rightarrow A = \frac{U_2}{U_{sv}} = \frac{-y_{21}}{Y_3+\left[\frac{Y_1(Y_2+y_{11})}{Y_1+Y_2+y_{11}}\right]}$$

$$U_{sv} = U_2\,\frac{Z_2 \,\|\, y_{11}}{Z_2 \,\|\, y_{11} + Z_1} = U_2\,\frac{\frac{1}{y_{11}+Y_2}}{\frac{1}{y_{11}+Y_2}+\frac{1}{Y_1}} = U_2\,\frac{Y_1}{Y_1+Y_2+y_{11}}$$

$$\beta = \frac{U_{sv}}{U_2} = \frac{Y_1}{Y_1+Y_2+y_{11}}$$

$$A\beta = \frac{-y_{21}Y_1}{\left\{Y_3+\frac{Y_1(Y_2+y_{11})}{\cdots}\right\}(Y_1+Y_2+y_{11})} = \frac{-y_{21}Y_1}{Y_3(Y_1+Y_2+y_{11})+Y_1(Y_2+y_{11})}$$

Barkhausenova podmienka

$$|A\beta| = 1 \; ; \; \varphi_{A\beta} = 0 ; \; 360°$$

$$Z_i = j\omega L_i \; , \text{ resp. } \; Z_i = -j\frac{1}{\omega C_i}$$

$$Y_i = 1/Z_i = 1/jX_i$$

$$A\beta = \frac{-y_{21} X_2 X_3}{y_{11}(X_1 X_2 + X_2 X_3) - j(X_1 + X_2 + X_3)}$$

$$\varphi_{A\beta}(\omega) = -180° - \operatorname{arctg}\{-(X_1 + X_2 + X_3)/[y_{11}(X_1X_2 + X_2X_3)]\}$$

$$\varphi_{A\beta}(\omega_0) \stackrel{!}{=} 0 \; , \text{ resp. } 360° \Rightarrow X_1 + X_2 + X_3 = 0$$

$$[A\beta]_{\omega_0} = \frac{-y_{21} X_3}{y_{11}(X_1 + X_3)}$$

$$X_1 + X_3 = -X_2$$

$$[A\beta]_{\omega_0} = \frac{-y_{21} X_3}{y_{11}(X_1 + X_3)} = \frac{y_{21} X_3}{y_{11} X_2}$$

$A\beta > 0$ (opačná orientácia u_{sv})

$\Downarrow$

$\boxed{X_3 , X_2 \text{ rovnaký charakter } \Rightarrow X_1 \text{ opačný}}$

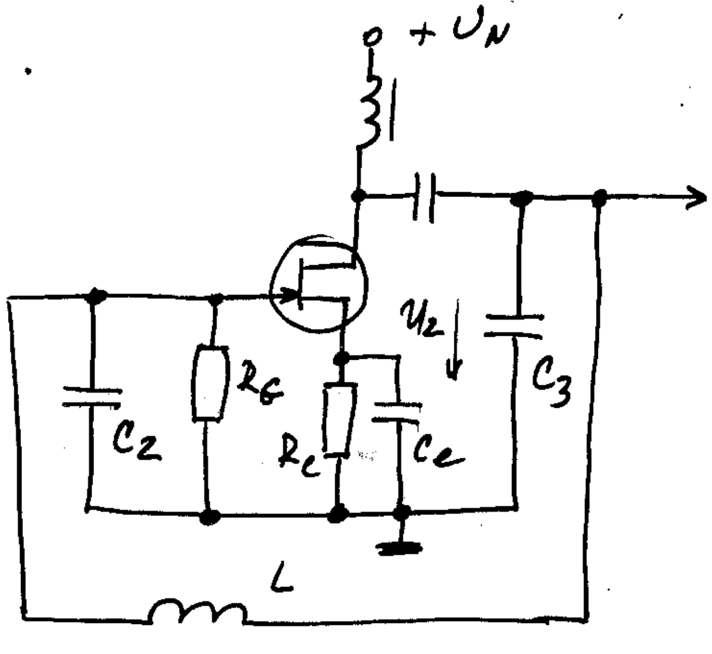
$$A\beta = 1 = \frac{y_{21} X_3}{y_{11} X_2} \Rightarrow \boxed{X_2 = X_3 \frac{y_{21}}{y_{11}}}$$

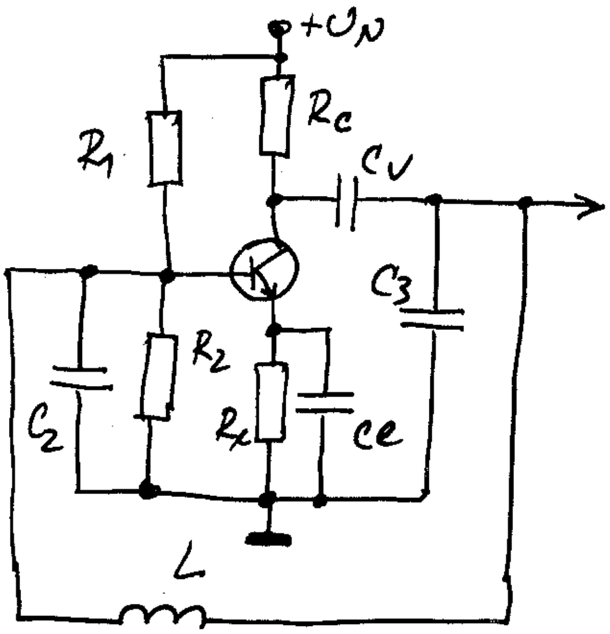
COLPITTS-ov oscilátor

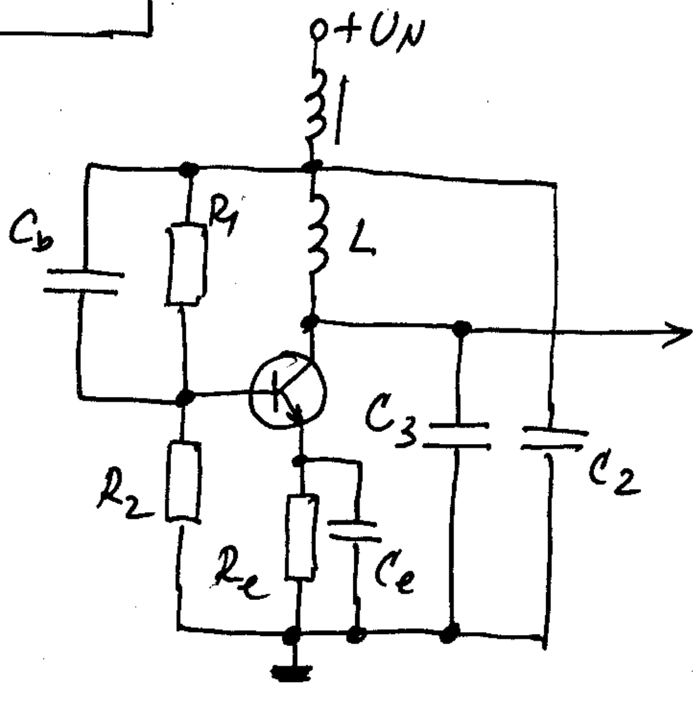
Z_1 – indukčnosť → Z_2, Z_3 kapacity

$C_3 = C_2 \dfrac{y_{21}}{y_{11}}$; $\omega_0 L - \dfrac{1}{\omega_0 C_2} - \dfrac{1}{\omega_0 C_3} = 0$

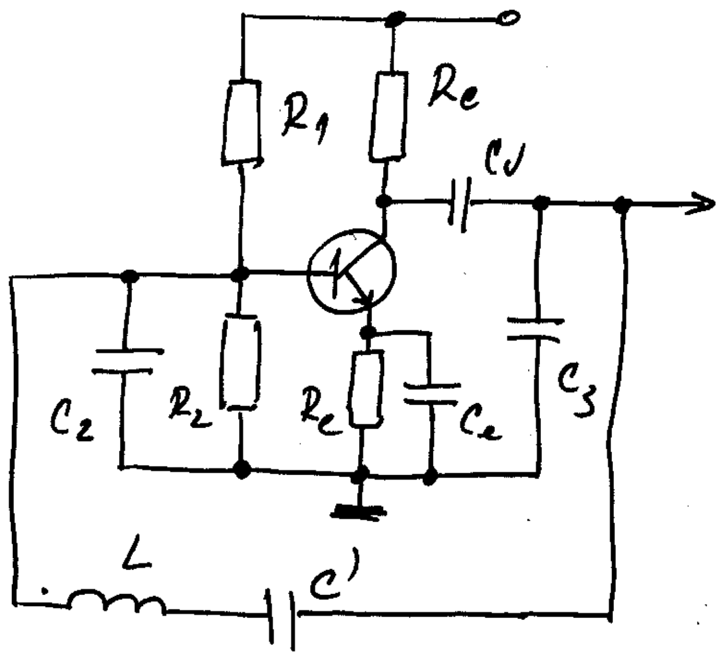
$$f_0 = \frac{1}{2\pi \sqrt{L \dfrac{C_2 C_3}{C_2 + C_3}}}$$







CLAPP-ov oscilátor



ak $C' \ll C_2$ a C_3 $\Rightarrow$ $f_0 \doteq \dfrac{1}{2\pi\sqrt{L.C'}}$

HARTLEY oscilátor

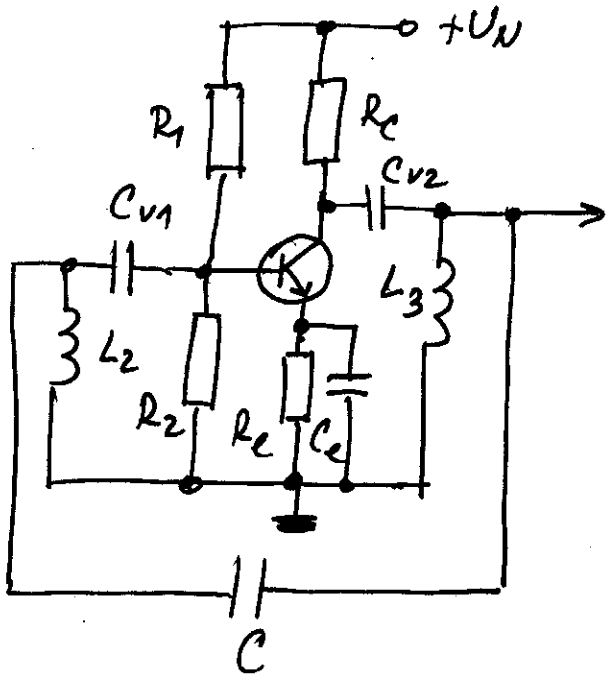
Z_1 — kapacita

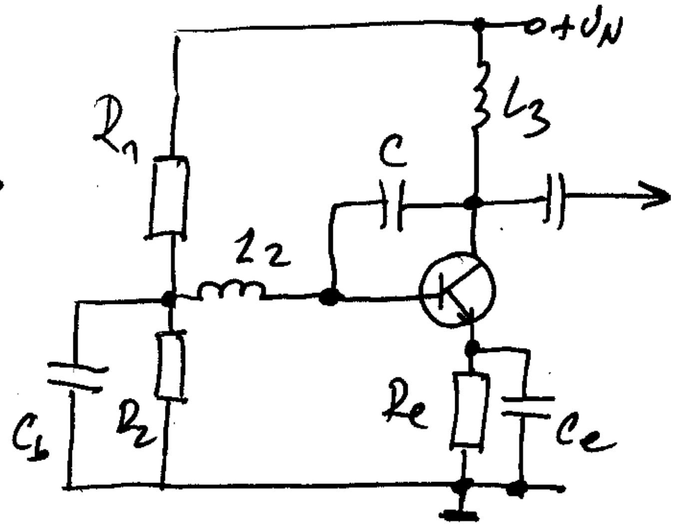
Z_2, Z_3 — indukčnosti

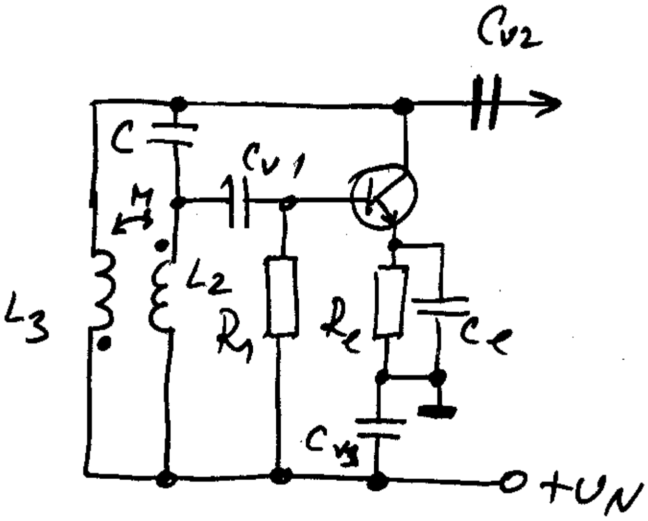
$$X_2 = X_3 \frac{y_{21}}{y_{11}} \Rightarrow L_2 = L_3 \frac{y_{21}}{y_{11}}$$

$$-\frac{1}{\omega_0 C} + \omega_0 L_1 + \omega_0 L_2 = 0 \Rightarrow$$

$$f_0 = \frac{1}{2\pi\sqrt{C(L_2+L_3)}}$$







$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$L = L_2 + L_3 + 2M$$

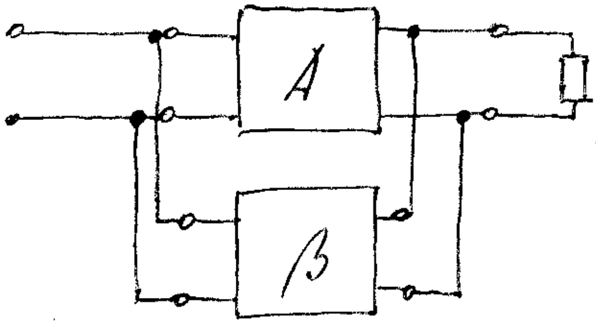
NÁZOV:

PREDMET:

ROČNÍK:

ČÍSLO:

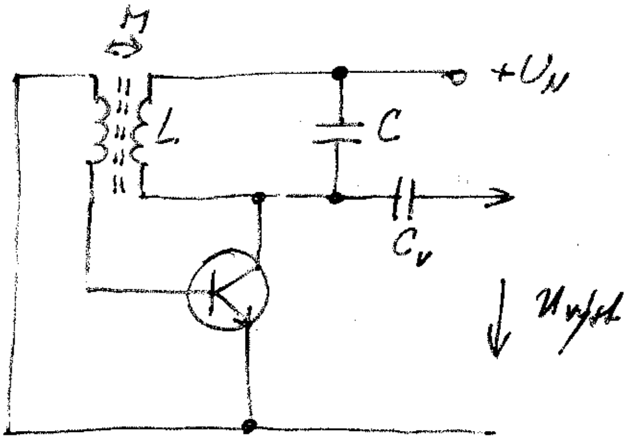
ČÍSLO ZLOŽKY | | 4 | 3 | a |



$\beta A = 1$

LC – oscilátory

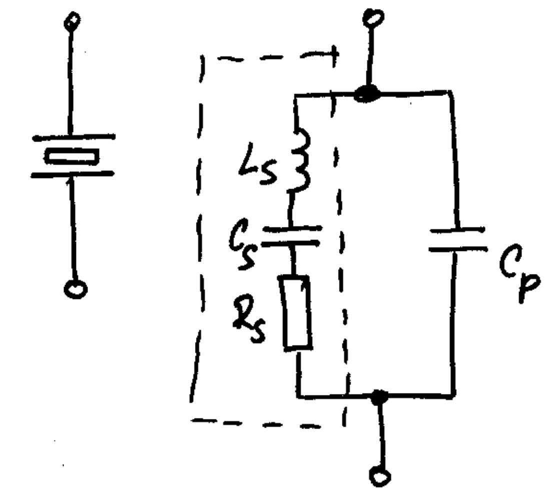
Transformátorový oscilátor

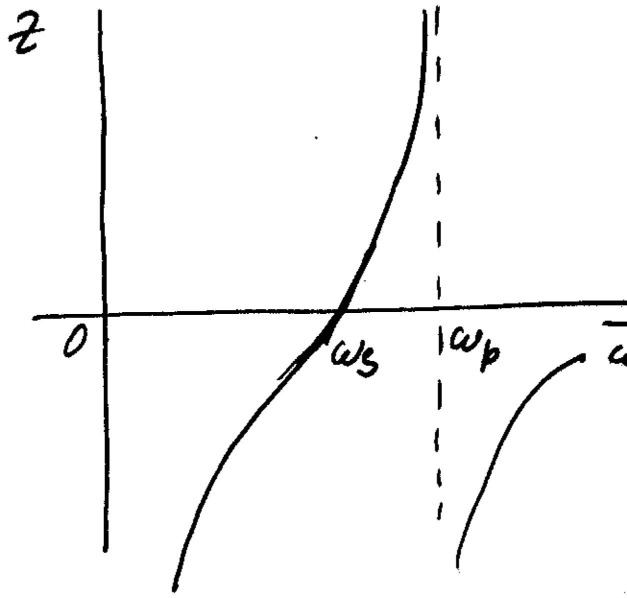


$$u_{výst} = U_{výst} \cos \omega_0 t$$

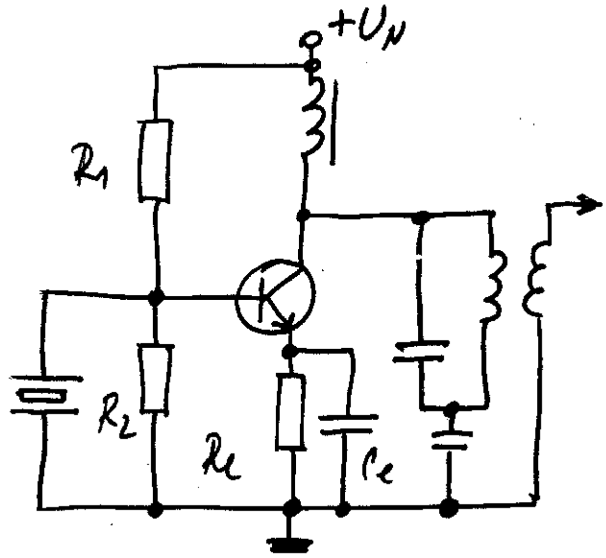
$$\omega_0 = \frac{1}{\sqrt{L(C+C_{ce})}}$$

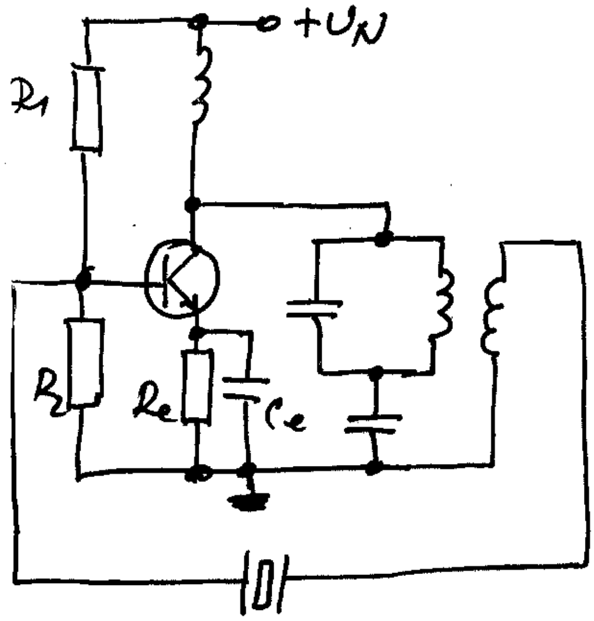
Krystálové oscilátory

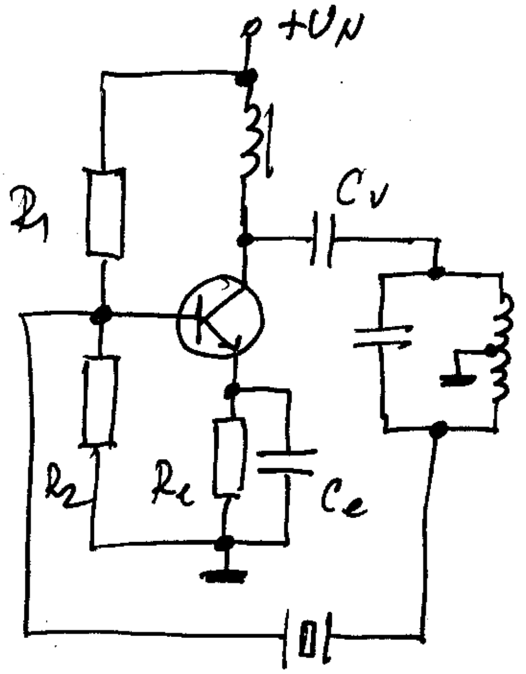


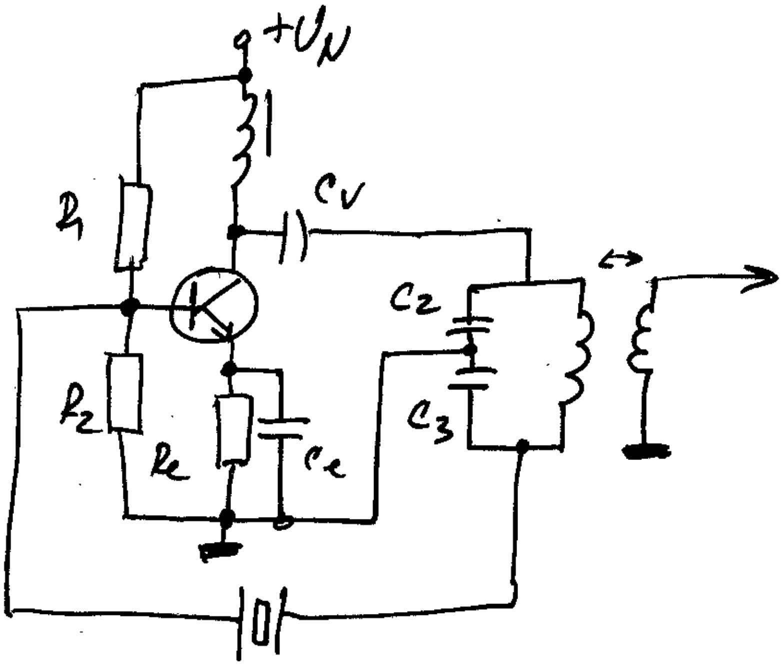


$$\omega_s = \frac{1}{\sqrt{L_s C_s}} \qquad \omega_p = \frac{1}{\sqrt{L_s \frac{C_s C_p}{C_s + C_p}}}$$






+U_N
R1
Cv
R2
Re
Ce


+U_N
Cv
R1
C2
C3
R2
Re
Ce

NÁZOV:

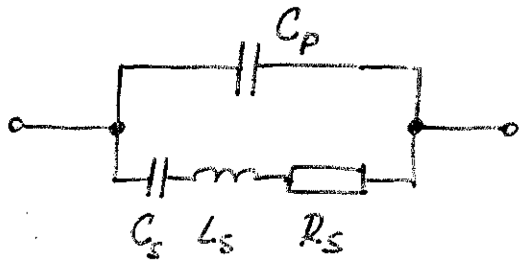
PREDMET:

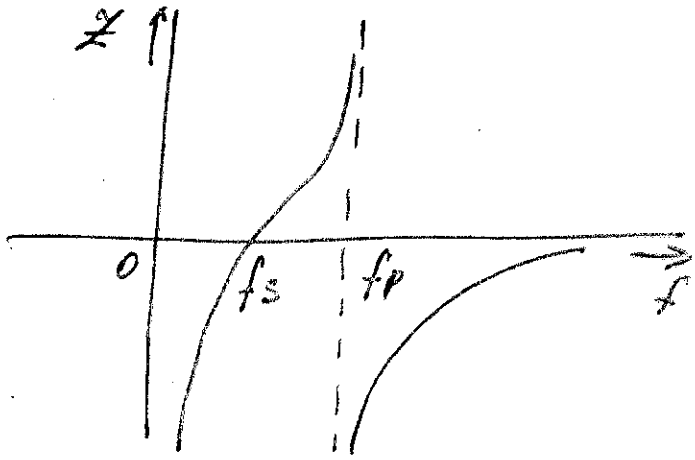
ROČNÍK:

ČÍSLO:

ČÍSLO ZLOŽKY

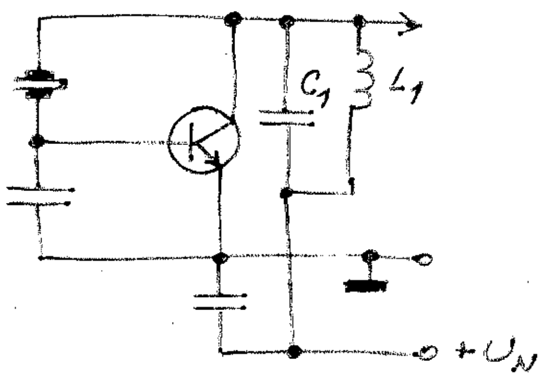
| | 4 | 3 | c |





$$\omega_s = \frac{1}{\sqrt{C_s L_s}} \qquad \omega_p = \frac{1}{\sqrt{L_s \frac{C_s C_p}{C_s + C_p}}}$$

Pierceov oscilátor



NÁZOV:

PREDMET:

ROČNÍK:

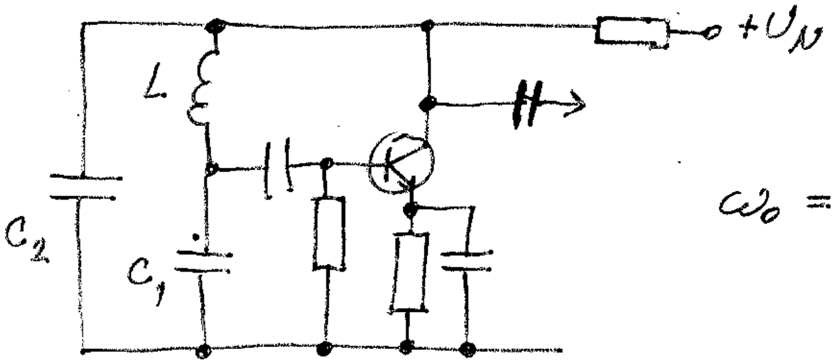
ČÍSLO:

ČÍSLO ZLOŽKY

| | 4 | 3 | b |

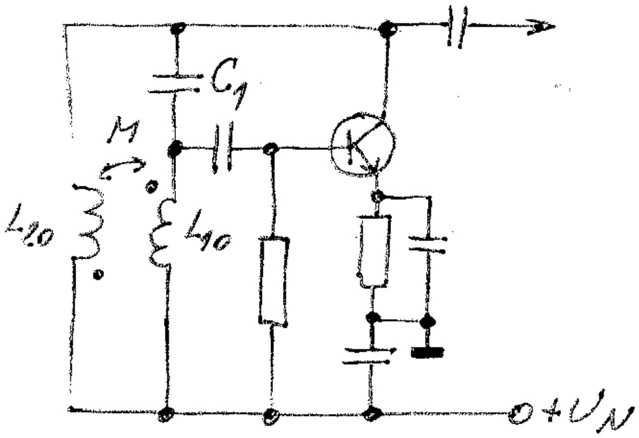
Trojbodové LC oscilátory

Colpittsov oscilátor



$$\omega_0 = \frac{1}{\sqrt{L\frac{C_1 C_2}{C_1 + C_2}}}$$

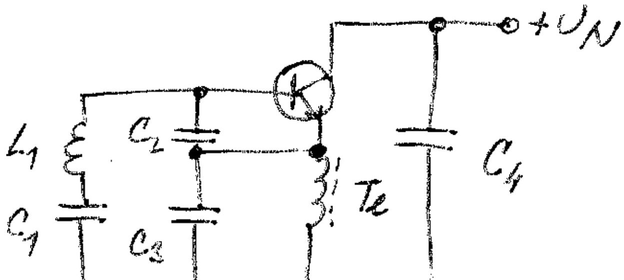
Hartleyov oscilátor



$$L_1 = L_{10} + L_{20} + 2M$$

$$\omega_0 = \frac{1}{L_1 C_1}$$

Clappov oscilátor



$$\omega_0 = \frac{1}{\sqrt{L_1 C_c}}$$

$$C_c = \frac{C_1 C_2 C_3}{C_1 C_2 + C_1 C_3 + C_2 C_3}$$

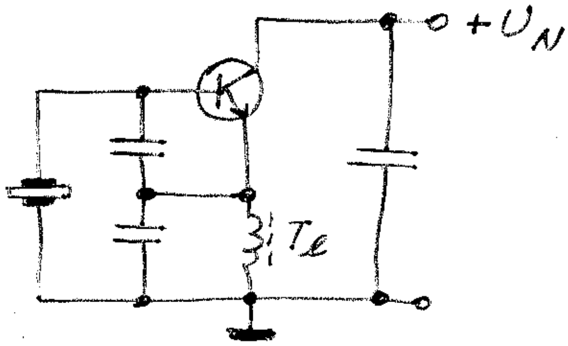
NÁZOV: PREDMET:

ROČNÍK:

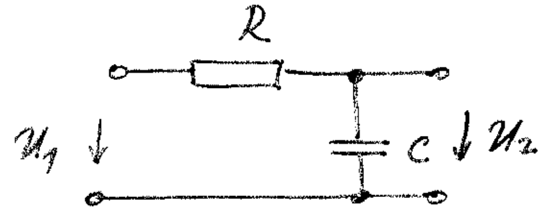
ČÍSLO: ČÍSLO ZLOŽKY

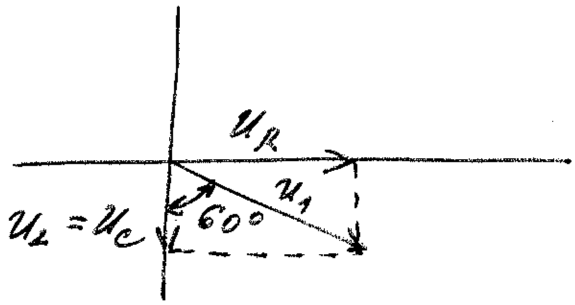
| | 4 | 3 | d |

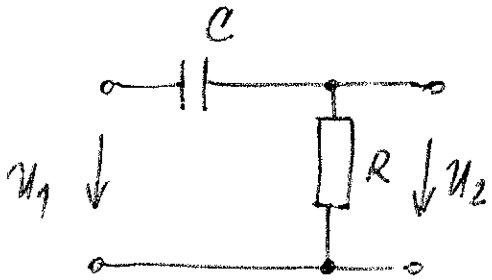
Clappov oscilátor

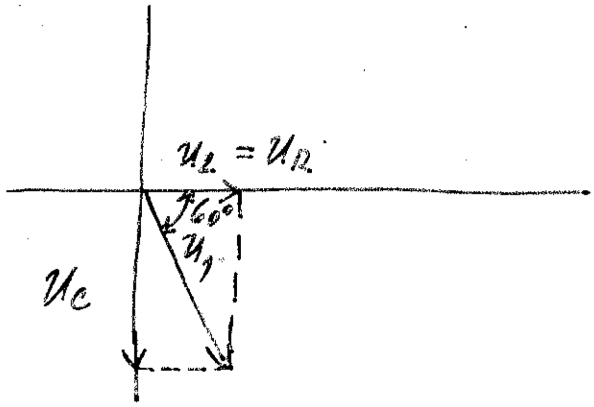


RC oscilátory









NÁZOV:

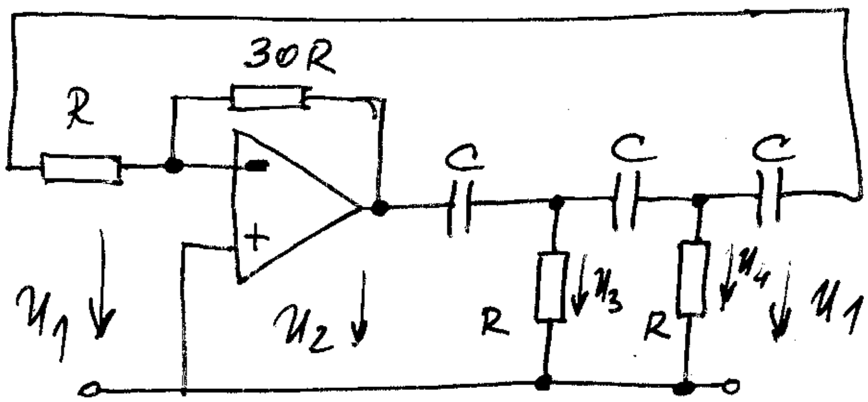
PREDMET:

ROČNÍK:

ČÍSLO:

ČÍSLO ZLOŽKY

	4	3	e



$$\beta = \frac{u_1}{u_2} = \frac{u_1}{u_4} \cdot \frac{u_4}{u_3} \cdot \frac{u_3}{u_2} =$$

$$= \frac{\omega^3 C^3 R^3}{(\omega^3 C^3 R^3 - 5\omega RC) - j(6\omega^2 C^2 R^2 - 1)}$$

$$\varphi_\beta(\omega) = \operatorname{arctg} \frac{6\omega^2 C^2 R^2 - 1}{\omega^3 C^3 R^3 - 5\omega CR}$$

$$6\omega_0^2 C^2 R^2 - 1 = 0$$

$$\varphi_\beta(\omega_0) = 0 \Rightarrow f_0 = \omega_0 / 2\pi = \frac{1}{2\pi\sqrt{6}\,CR}$$

potom

$$|\beta(\omega_0)| = \frac{1}{29}$$