2007. 09. 26. szerda — VI. Előadás (3. hét)

Frekvenciamoduláció (freq mod) + Fázismoduláció (phase mod) => szögmoduláció

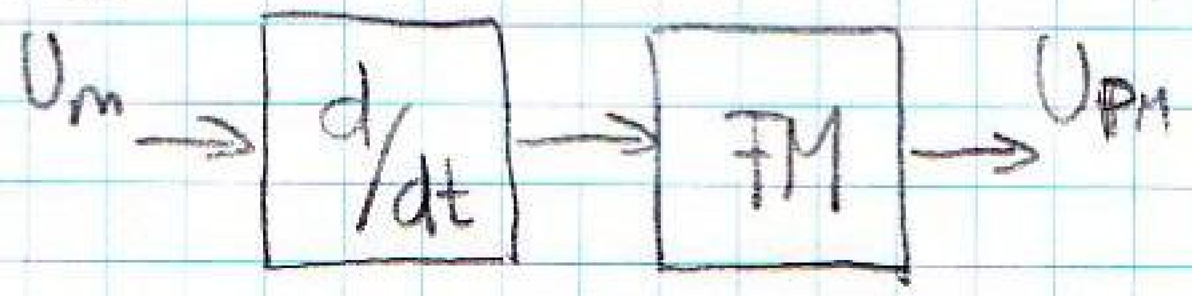
$$U_{PM} = U_v \cdot \cos\left[2\pi \cdot f_v \cdot t + k_{PM} \cdot U_m(t)\right] \qquad k_{PM} = \left[\frac{rad}{V}\right]$$

$$U_{FM} = U_v \cdot \cos\left(2\pi \cdot f_v \cdot t + \int_0^t 2\pi \cdot k_{FM} \cdot U_m(\tau)\, d\tau\right)$$

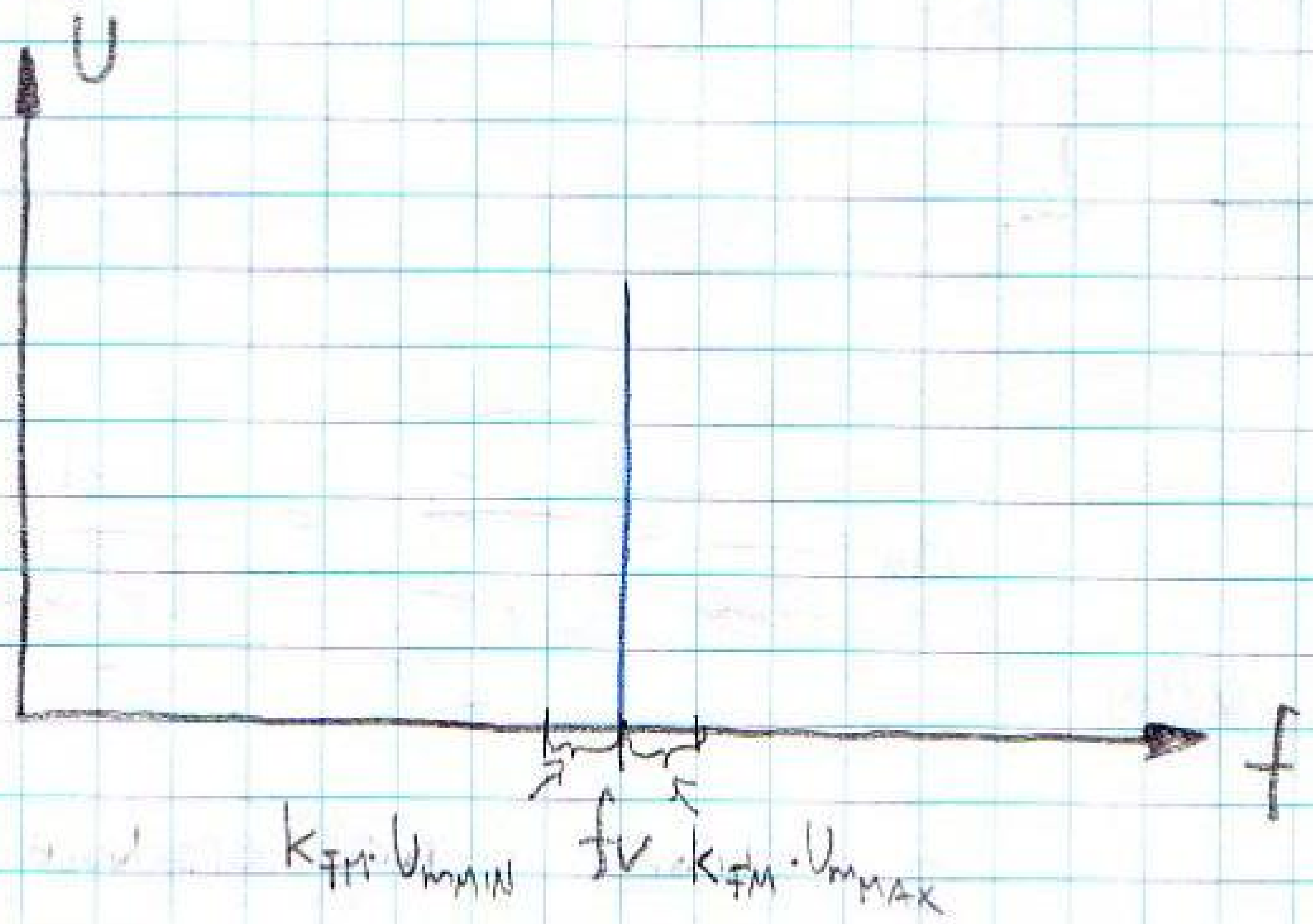
Modulátor:

VCO (Varicap, LC osc.)

P.M.:



FM-jel spektruma:



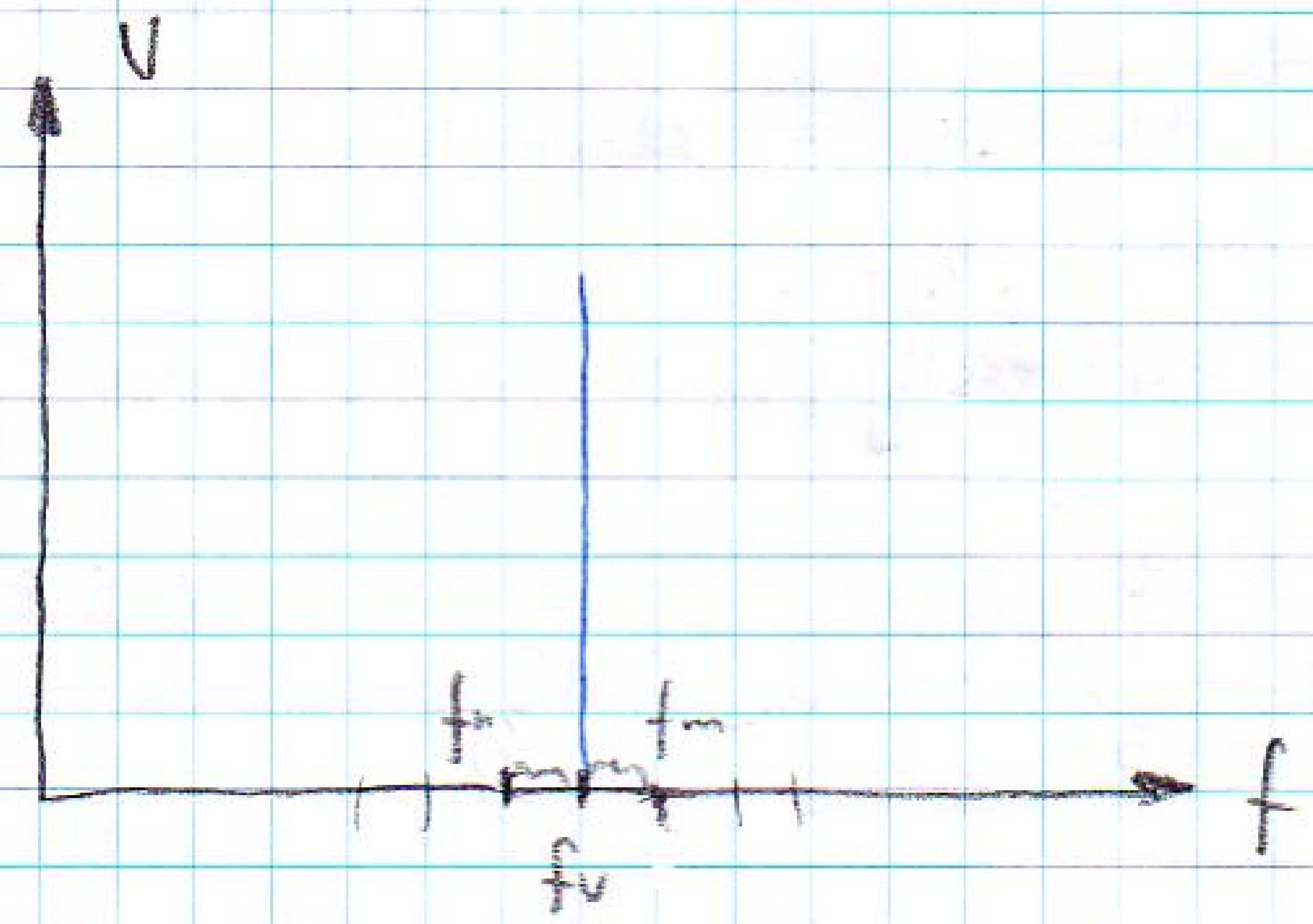
$$B_{FM} = k_{FM}(U_{mMAX} - U_{mMIN})$$

ha U_m szinuszos: $B_{FM} = 2\, k_{FM} \cdot U_m$

$k_{FM} \cdot U_m$: f_D – frekv. löket

$f_m \ll f_D$

f_m és f_D összemérhető:

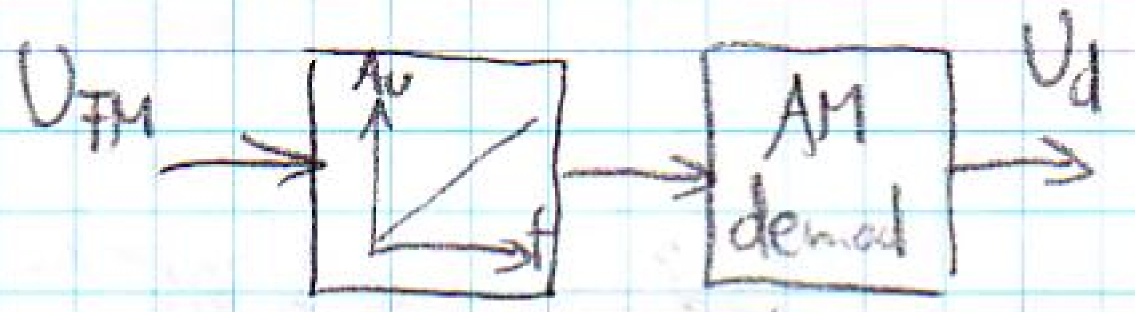


Carson-szabály:

ha $P_{98\%}$ $\Rightarrow B_{FM} = 2(f_D + f_m)$

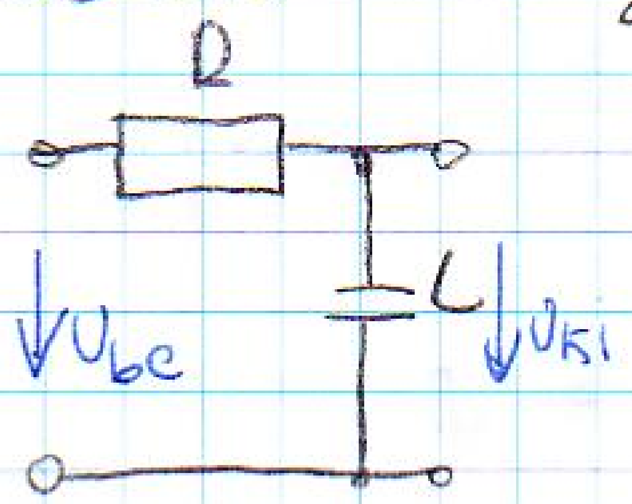
FM-jel demodulálása:

Közvetett FM demodulátor:



csúcsegyen-/ absz. érték

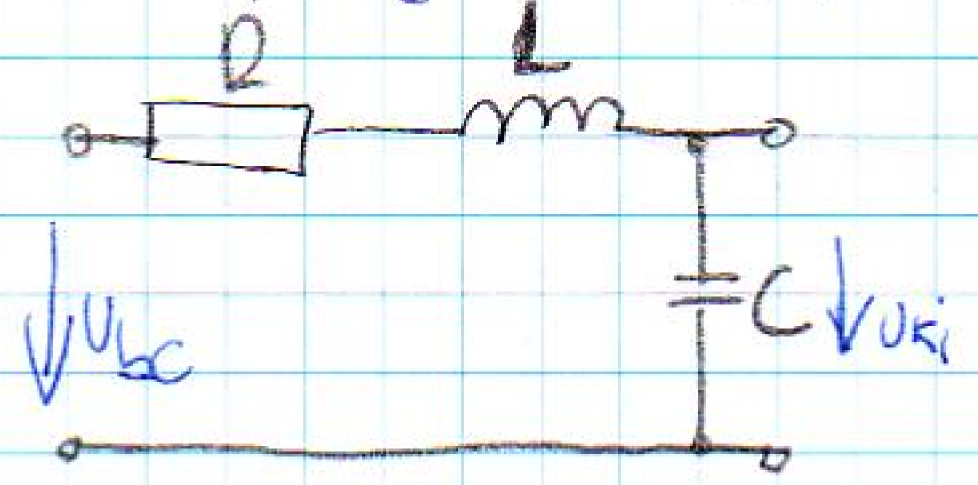
① Hándós szűrő



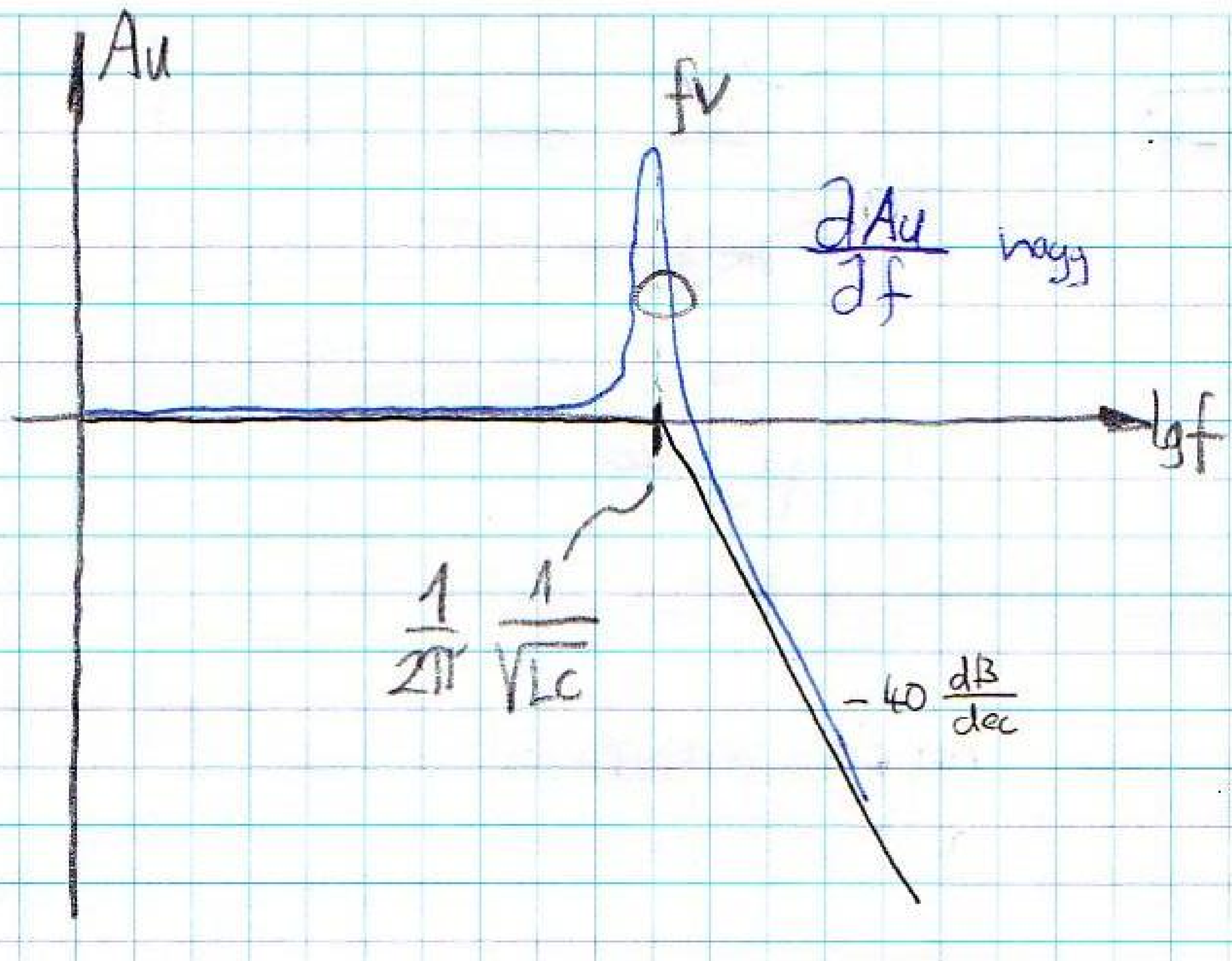
$$A_u = \frac{U_{ki}}{U_{be}} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{1}{1 + j\omega RC}$$

↯ túl kicsi a frekv.-érzékenység ⇒ nem jó FM-DEMOD-nak

② Hándós / Rezgőköros FM/AM-átalakító



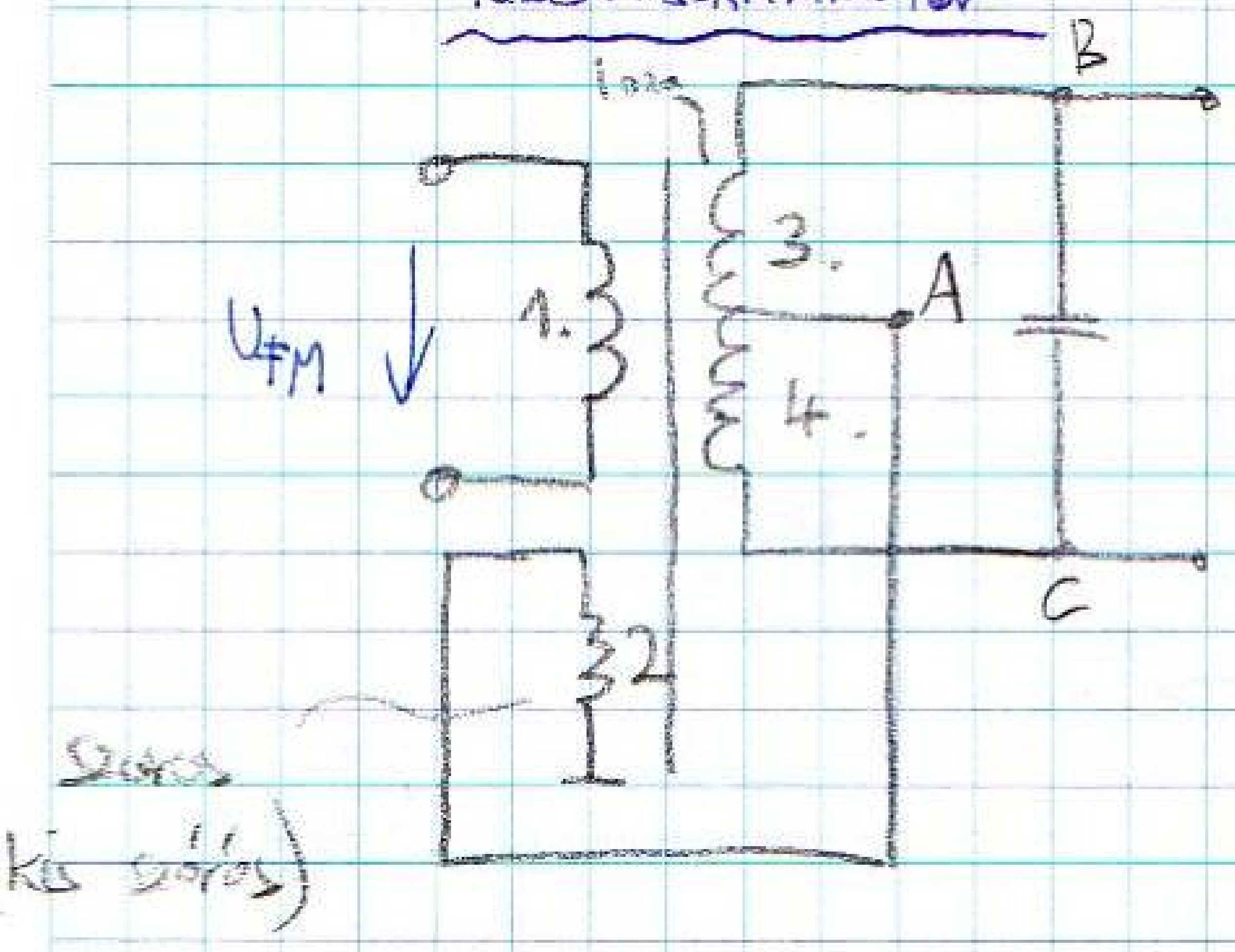
$$A_u(j\omega) = \frac{\frac{1}{j\omega C}}{R + j\omega L + \frac{1}{j\omega C}} = \frac{1}{j\omega RC + 1 - \omega^2 LC}$$

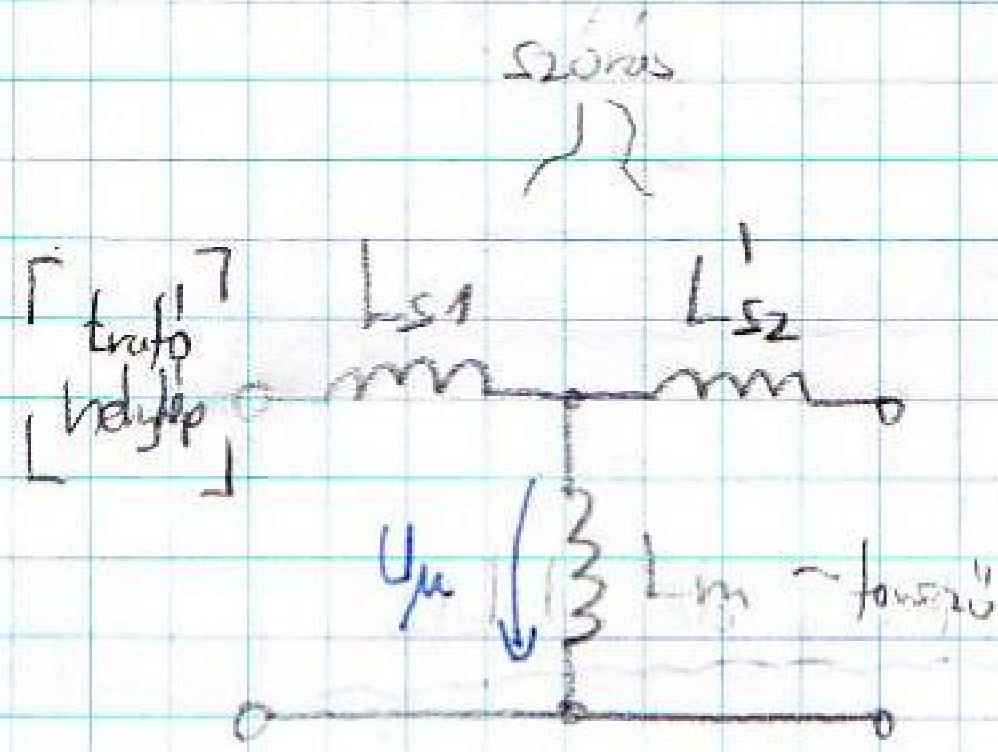


Hátrány: erős nemlinearitás

FM-modulátor

Fázisdiszkriminátor



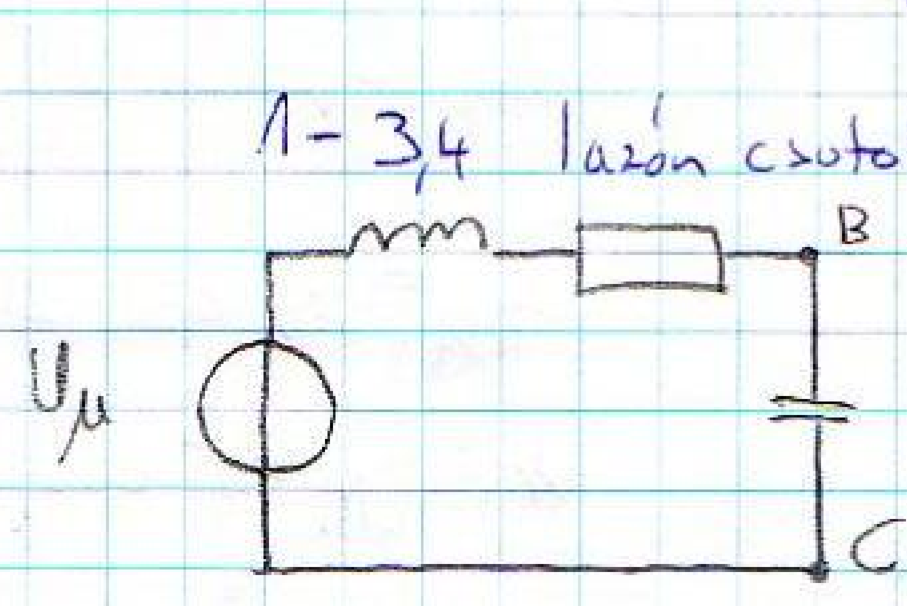


1 − 2 szorosan csatolt (szórás kicsi)

$L_s \approx \phi$

$U_A = U_{FM} \cdot \frac{N_s}{N_p}$

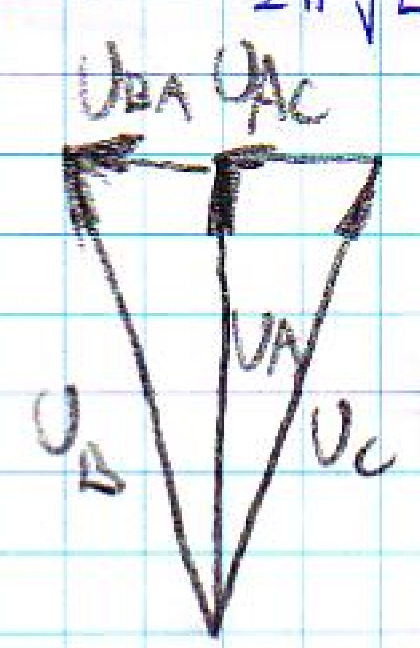
1 − 3,4 lazán csatolt (szórás nagy)



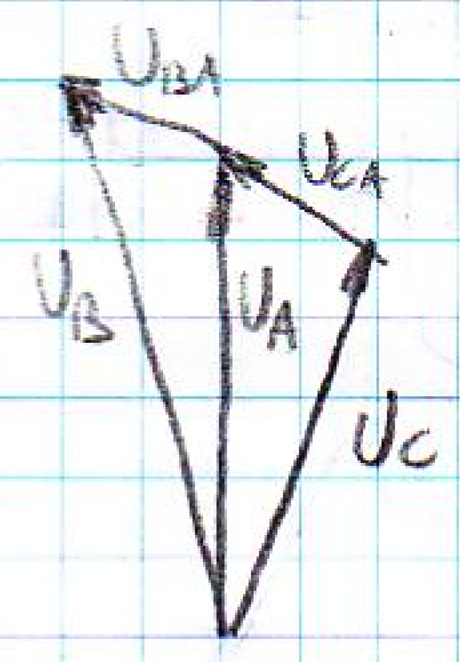
$$U_{BC} = U_\mu \cdot \frac{\frac{1}{j\omega C}}{j\omega L + R + \frac{1}{j\omega C}} =$$

$$= U_\mu \frac{1}{1 + j\omega RC - \omega^2 LC}$$

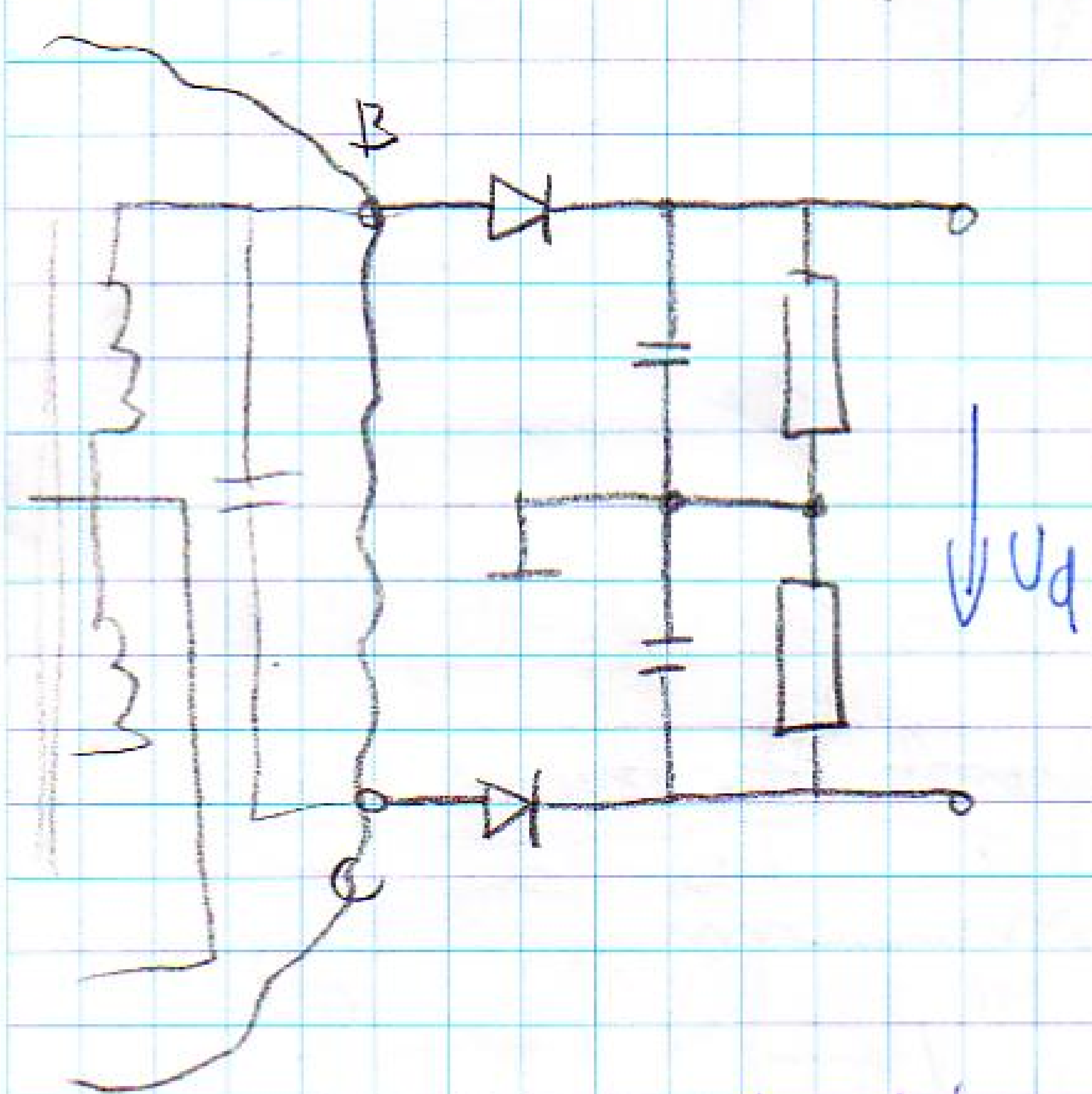
$$f = f_v = \frac{1}{2\pi\sqrt{LC}}$$



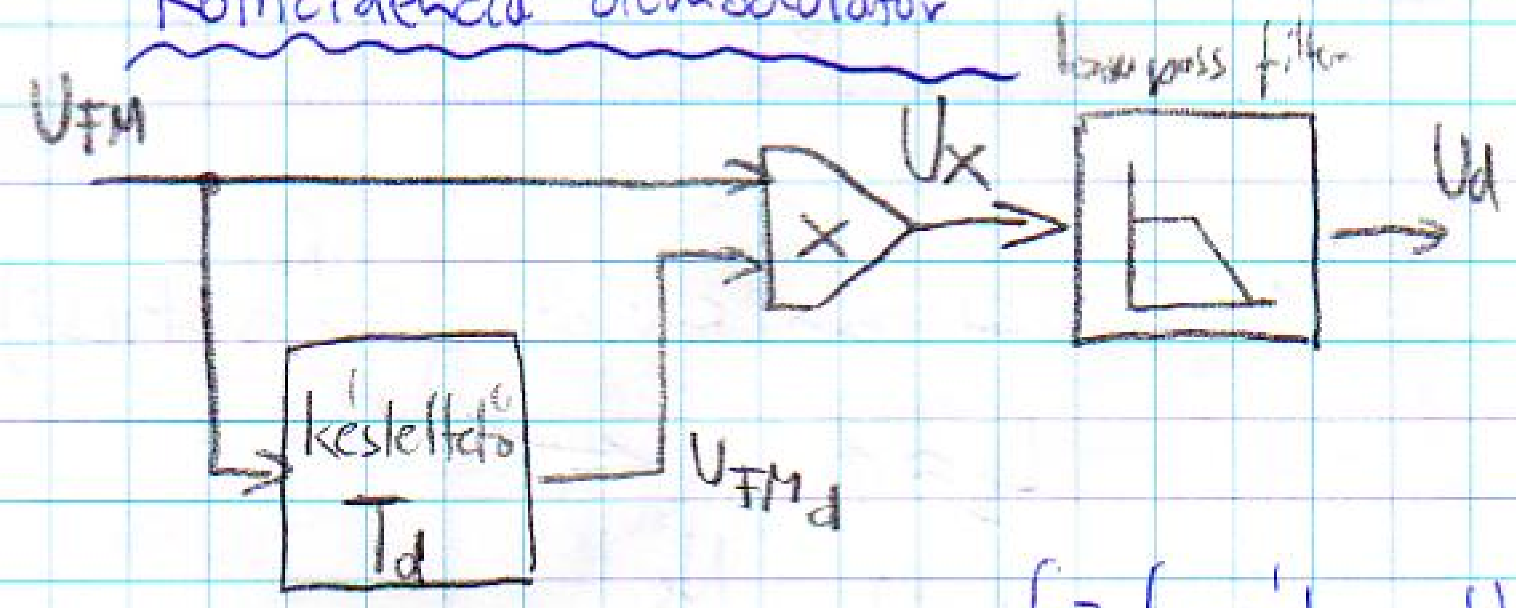
$f > f_v$



⇒ ezután már csak AM-dem szükséges :

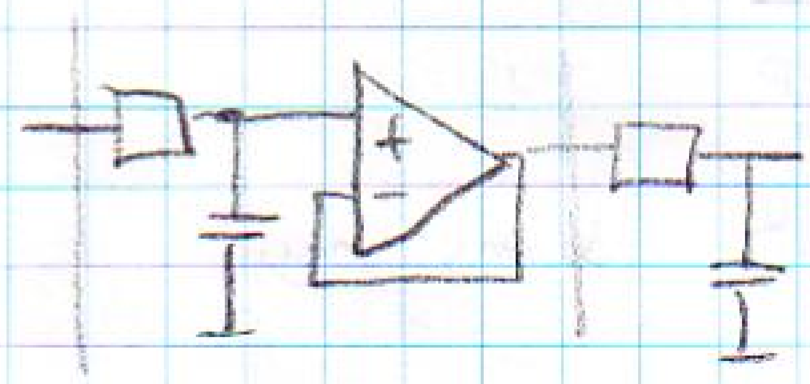


Koincidencia demodulátor



$f = f_v$ -nél $U_d = 0$

$U_{FM} = U_v \cdot \cos 2\pi \cdot f \cdot t$



$U_{FMd} = U_v \cdot \cos(2\pi f t - 2\pi f T_d)$

$U_x = K_M \, U_v^2 \cos(2\pi f t) \cdot \cos(2\pi f t - 2\pi f T_d) =$

$= K_{FM} \cdot U_f^2 \cdot \cos(2\pi f t) \cos(2\pi f t - \underbrace{2\pi (f_v + K_{FM} \cdot U_m) \cdot T_d}_{\frac{\pi}{2} + 2\pi \cdot K_{FM} \cdot U_m \cdot T_d}) =$

$f = f_v + K_{FM} \cdot U_m(t)$

$2\pi \cdot f \cdot t = 2\pi(f_v + K_{FM} \cdot U_m)t$

$= K_{FM} \cdot U_f^2 \cdot \cos(2\pi \cdot f t) \sin(2\pi f t - \underbrace{2\pi \, K_{FM} \, U_m \, T_d}_{\frac{\pi}{2 f_v} \cdot K_{FM} \cdot U_m}) =$

$\frac{\pi}{2} = 2\pi f_v \cdot T_d$

$2\pi T_d = \frac{\pi}{2 f_v}$

$$= \overset{K_M}{\sqrt{}}\frac{1}{2} U_v^2 \left(\underbrace{\sin\left(4\pi f t - \frac{\pi}{2 f_v} \cdot k_{FM} \cdot U_m\right)}_{\text{LPF miatt } \emptyset} + \sin\left(-\frac{\pi}{2 f_v} k_{FM} U_m\right)\right)$$

$$U_d \approx K_M \cdot \frac{1}{2} U_v^2 \sin\left(-\frac{\pi}{2 f_v} k_{FM} \cdot U_m\right)$$