Семинар 15.11

КО примери

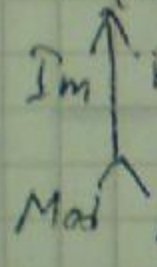
нехомогенна

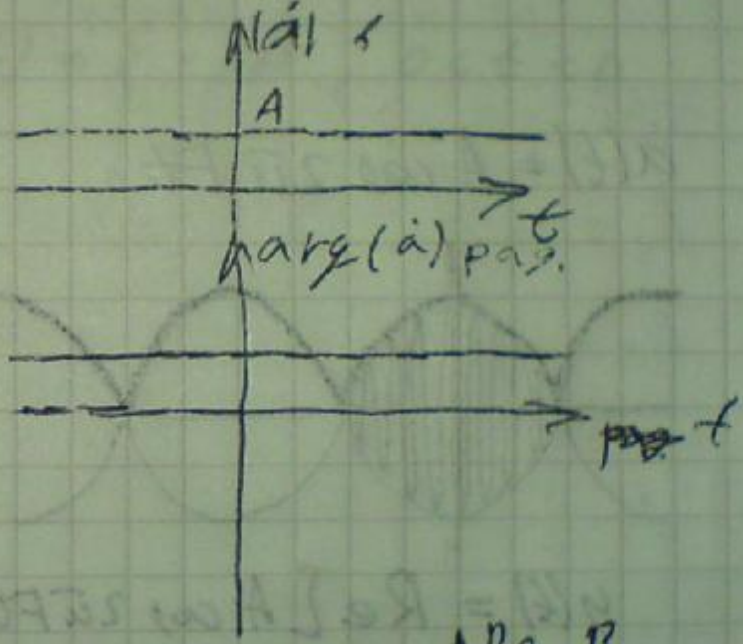
$$x(t) = A\cos(\omega t)$$

$$\dot{X}(t) = Ae^{j\varphi}$$

$$\dot{a}(t) = Ae^{j\varphi}$$

Mod, Arg

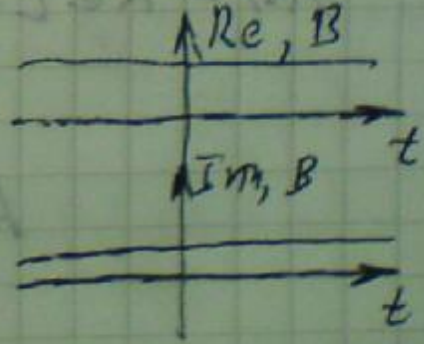




$$\Delta F = \frac{1}{2\pi}\frac{d[\arg(\dot{a}(t))]}{dt}$$

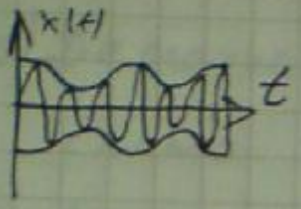
$$\Delta f(t) = 0$$

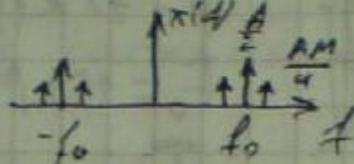
$$\dot{a}(t) = \underbrace{A\cos\varphi}_{Re} + j\underbrace{A\sin\varphi}_{Im}$$

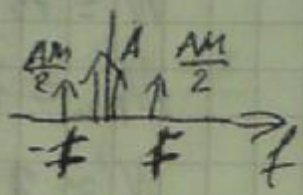


$x(t) = A\cos\varphi\cos(\omega_0 t) - A\sin\varphi\sin(\omega_0 t)$

2. $x(t) = A(1 + M\cos 2\pi Ft)\cos 2\pi f_0 t$ (AM)



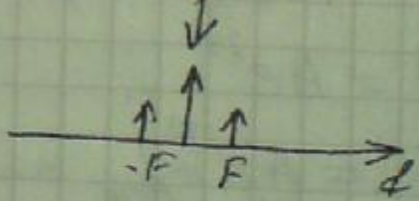


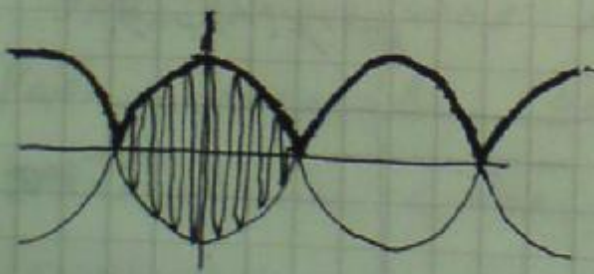


$\dot{a}(t) = A(1 + M\cos 2\pi Ft)$

3. $y(t) = A\cos 2\pi Ft\cos 2\pi f_0 t$ (Бап AM)

$\dot{a}(t) = A\cos 2\pi Ft$





$y(t) = \mathrm{Re}[A\cos 2\pi Ft \cdot e^{j2\pi f_0 t}]$

$\dot{z}(t) \times e^{-j2\pi f_0 t}$

$A\cos 2\pi Ft = \dot{a}_y(t)$

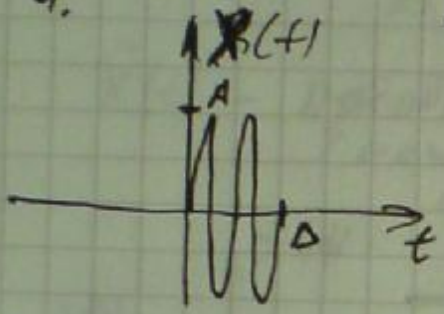
$$s(t) = A \sin 2\pi F t \sin 2\pi f_0 t$$

$$s(t) = A \sin 2\pi F t \cdot \cos\left(2\pi f_0 t - \frac{\pi}{2}\right) =$$

$$= Re\left[A \sin 2\pi F t \cdot e^{j\left(2\pi f_0 t - \frac{\pi}{2}\right)}\right]$$

$$a_s(t) = -jA \sin 2\pi F t$$

4.

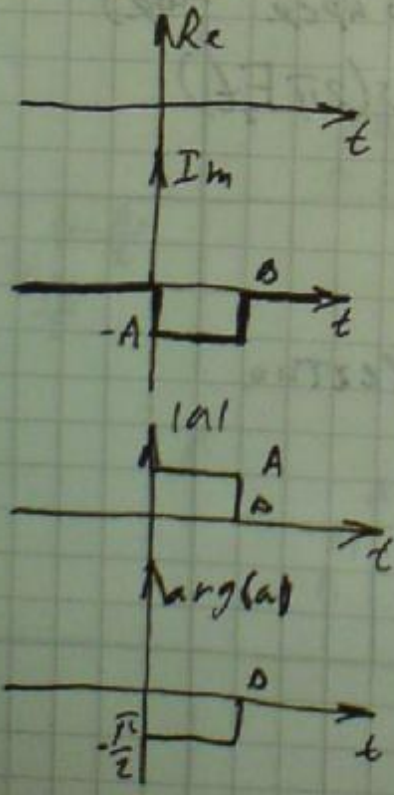


$$x(t) = \begin{cases} A \sin 2\pi \frac{3}{\Delta} t, & 0 < t < \Delta \\ 0, & \text{ост. } t \end{cases}$$

$$F_0 = \frac{3}{\Delta}$$

$$0 < t < \Delta \quad x(t) = Re\left[A e^{j\left(2\pi \frac{3}{\Delta} t - \frac{\pi}{2}\right)}\right]$$

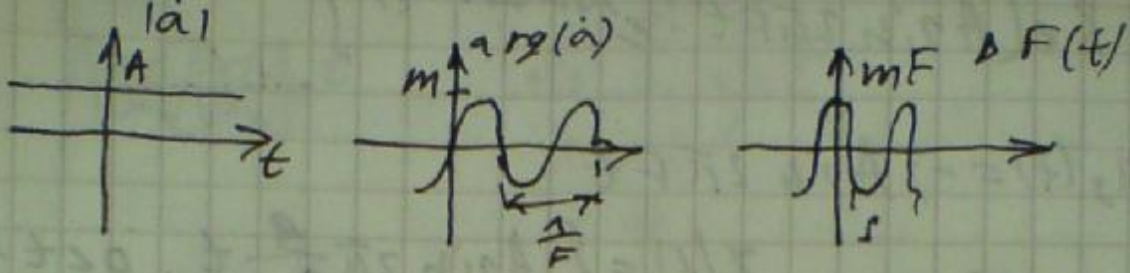
$$\dot{a}(t) = -jA$$

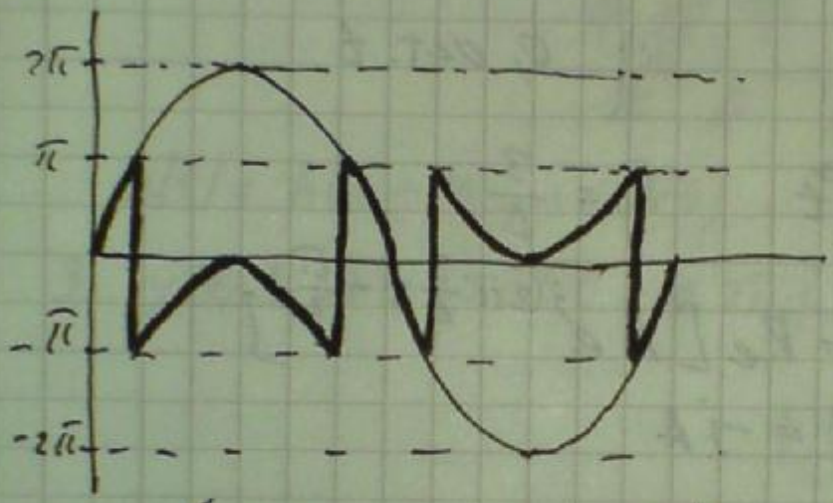


$$\dot{a}(t) = \begin{cases} -jA, & 0 < t < \Delta \\ 0, & \text{ост. } t \end{cases}$$

5. $y(t) = A\cos(\omega_0 t + M\sin 2\pi F t)$ $\dot{a}(t)$

$\dot{a}(t) = Ae^{im\sin\Omega t}$ $\Delta F = \frac{\Omega m}{2\pi}\cos\Omega t = m_F \cos\Omega t$



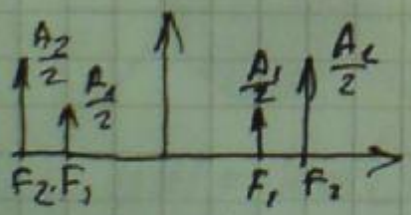


Сигнал со сложн. (не о прер. мод.)

$x(t) = A_1\cos(2\pi F_1 t) + A_2\cos(2\pi F_2 t)$

$A_1 = 2\,В$ $F_1 = 2.2\,МГц$

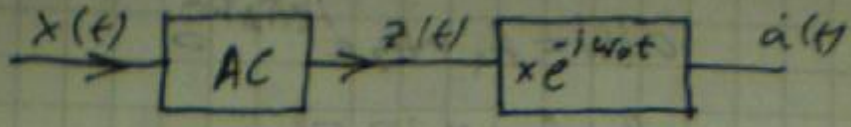
$A_2 = 3\,В$ $F_2 = 2.5\,МГц$

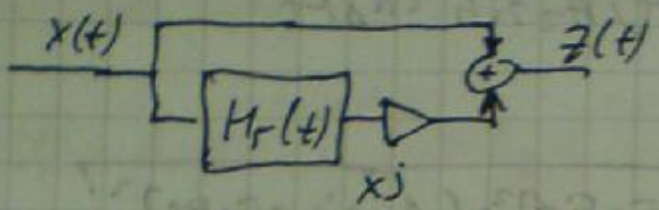


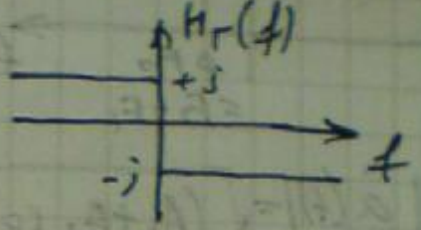
f_0 - неизвестно.

$f_0 = F_1$

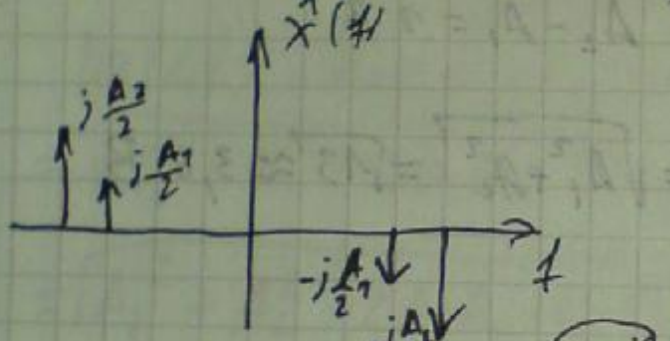
$f_0 = 2{,}4\,МГц$ $F_1 < f_0 < F_2$



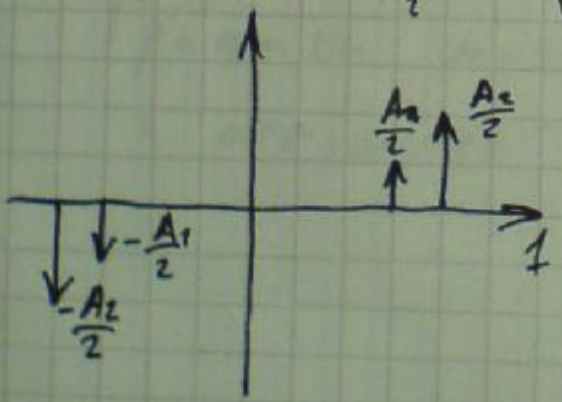


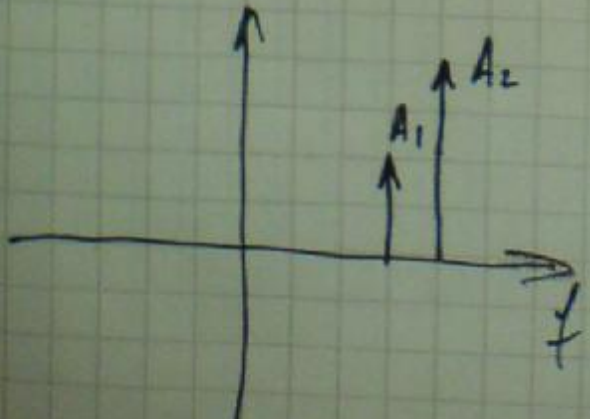


$\hat{x}(t)$ - преобр Гильберта (сопряженный сигнал)



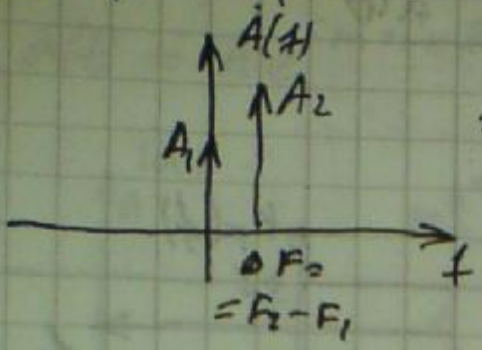
xj





$$\dot{z}(t) = A_1 e^{j2\pi F_1 t} + A_2 e^{j2\pi F_2 t}$$

① $f_0 = F_1$



$$\dot{a}(t) = A_1 + A_2 e^{i 2\pi F_0 t} =$$

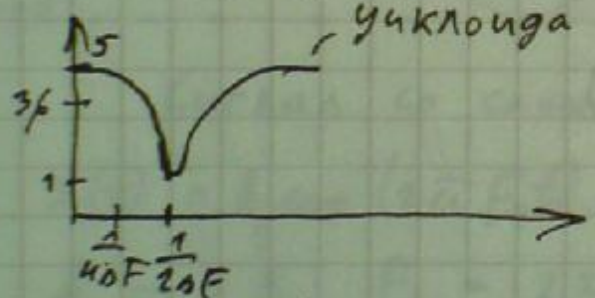
$$= A_1 + A_2 \cos 2\pi F_0 t + j A_2 \sin 2\pi F_0 t$$

$$|\dot{a}(t)| = \sqrt{(A_1 + A_2 \cos 2\pi F_0 t)^2 + (A_2 \sin 2\pi F_0 t)^2}$$

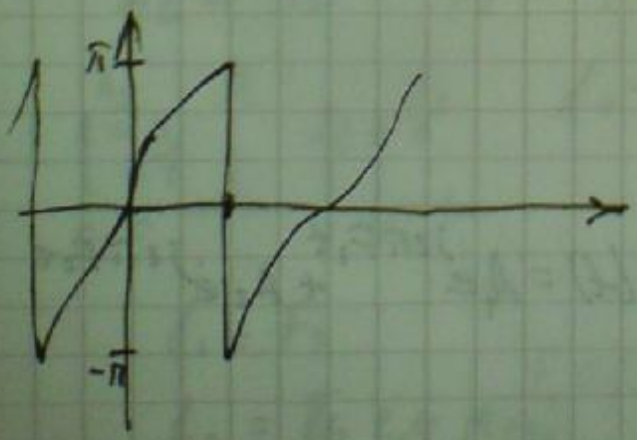
$t = 0$ $\quad |\dot{a}(0)| = A_1 + A_2 = 5$ В

$t = \frac{1}{2F_0}$ — пол периода $\quad |\dot{a}(\frac{1}{2F_0})| = A_2 - A_1 = 1$ В

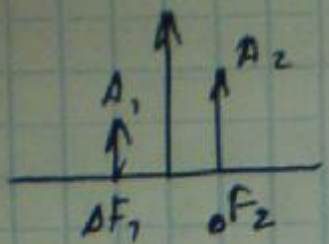
$t = \frac{1}{4F_0}$ — четверть п. $\quad |\dot{a}(\frac{1}{4F_0})| = \sqrt{A_1^2 + A_2^2} = \sqrt{13} \approx 3{,}6$ В



$\text{Arg}(a(0)) = 0$



② $f_0 = 2{,}4$ МГц



$\Delta F_1 = F_1 - \Delta F = -0{,}2$ МГц

$\Delta F_2 = F_2 - \Delta F = 0{,}2$ МГц

$$\dot{a}(t) = A_1 e^{j 2\pi \Delta F_1 t} + A_2 e^{j 2\pi \Delta F_2 t} =$$

$$= A_1 \cos(2\pi \Delta F_1 t) + A_2 \cos(2\pi \Delta F_2 t) +$$

$$+ j\left(A_1 \sin(2\pi \Delta F_1 t) + A_2 \sin(2\pi \Delta F_2 t)\right)$$

$$|a(t)| = \sqrt{(A_1\cos\alpha_1 + A_2\cos\alpha_2)^2 + (A_1\sin\alpha_1 + A_2\sin\alpha_2)^2}$$

$$= \sqrt{A_1^2 + A_2^2 + 2A_1A_2(\cos\alpha_1\cos\alpha_2 + \sin\alpha_1\sin\alpha_2)} =$$

$$\cos(\alpha_1 - \alpha_2)$$

$$= \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos(2\pi \Delta F t)}$$

Графики модулей совпадут, а аргументы будут разные.