

$$f_{FM}(t) = A_c \cos[\omega_c t + K \int A_m \cos \omega_m t dt] \rightarrow \text{FM genel Formülü}$$

$$= A_c \cos \left[\omega_c t + \underbrace{\frac{K A_m}{\omega_m}}_{\beta} \sin \omega_m t \right]$$

$$= 50 \cos \left[2\pi \cdot 200 \times 10^3 t + \frac{2356 \cdot 20}{2\pi \cdot 15 \times 10^3} \sin 2\pi \cdot 15 \times 10^3 t \right]$$

$$= 50 \cos \left[2\pi \cdot 200 \times 10^3 t + \underbrace{0,5}_{\beta} \sin 2\pi \cdot 15 \times 10^3 t \right]$$

$\beta < 1 \text{ radian} \Rightarrow \text{Narrow band}$

$$BW = 2 f_m \Rightarrow 2 \cdot 15 \text{ kHz} = 30 \text{ kHz}$$

$$2) f_1(t) = 50 \cos [2\pi \cdot 200 \times 10^3 t + 0,5 \sin 2\pi \cdot 15 \times 10^3 t]$$

$$f_2(t) = 50 \cos 64 [2\pi \cdot 200 \times 10^3 t + 0,5 \sin 2\pi \cdot 15 \times 10^3 t]$$

\hookrightarrow sinyal garpici, oldurğundan

$$f_2(t) = 50 \cos [2\pi \cdot 12800 \cdot 10^3 t + 32 \sin 2\pi \cdot 15 \times 10^3 t]$$

$$f_3(t) = f_2(t) \cdot f_0(t) \Rightarrow 50 \cos [2\pi \cdot 12800 \cdot 10^3 t + 32 \sin 2\pi \cdot 15 \times 10^3 t] \cdot [20 \cos (2\pi \cdot 10900 \cdot 10^3 t)]$$

$$\frac{2 \cdot 20}{2} \left[\cos (2\pi \cdot 12800 \cdot 10^3 t + 32 \sin 2\pi \cdot 15 \cdot 10^3 t + 2\pi \cdot 10900 \cdot 10^3 t) + \cos (2\pi \cdot 12800 \cdot 10^3 t - 2\pi \cdot 10900 \cdot 10^3 t) \right]$$

$$f_4(t) = 500 \cos (2\pi \cdot 1900 \cdot 10^3 t + 32 \sin 2\pi \cdot 15 \cdot 10^3 t)$$

$$f_5(t) = 500 \cos 48 (2\pi \cdot 1900 \cdot 10^3 t + 32 \sin 2\pi \cdot 15 \cdot 10^3 t)$$

$$f_5(t) = 500 \cos (2\pi \cdot 91,200 \times 10^3 t + 1536 \sin 2\pi \cdot 15 \times 10^3 t) //$$