14.09.18 - PS IX

1) $m(t) = e^{-t^2}$

$f_c = 10^4\ kHz$

$k_f = 6000\pi$

$k_p = 8000\pi$

a) Table 3.1. $\rightarrow e^{-t^2/2\sigma^2} \longleftrightarrow \sigma\sqrt{2\pi}\, e^{-\frac{\sigma^2 w^2}{2}}$

$e^{-t^2} \longleftrightarrow \sqrt{\frac{1}{2} 2\pi} \cdot e^{-\frac{w^2}{2} \cdot \frac{1}{2}} = \underbrace{\sqrt{\pi} \cdot e^{-w^2/4}}_{= M(w)}$

$\sigma = \sqrt{1/2}$

$M(w) = \sqrt{\pi} \cdot e^{-w^2/4}$

$m_p = [m(t)]_{max} = (e^{-t^2})_{t=0} = 1$

$\dot{m}(t) \Leftrightarrow jw M(w)$

$= j\sqrt{\pi}\, w e^{-w^2/4}$

FM $\rightarrow \Delta f = \frac{k_f . m_p}{2\pi} = \frac{6000\pi \times 1}{2\pi} = 3000 = 3kHz$

$B_{FM} = 2(B + \Delta f) \cong 2\Delta f = 6kHz \quad (\Delta f \gg B)$

PM $\rightarrow \Delta f = \frac{k_p . \dot{m}_p}{2\pi} \rightarrow \dot{m}(t) = -2t . e^{-t^2}$

To find $\dot{m}_p \rightarrow \ddot{m}(t) = 0$

$\ddot{m}(t) = -2 . e^{-t^2} + 2t . 2t . e^{-t^2}$

$= -2e^{-t^2/2} + 4t^2 . e^{-t^2} = 0$

$t = 1/\sqrt{2}$

$$m\left(\frac{1}{\sqrt{2}}\right) = m_p = 0.858$$

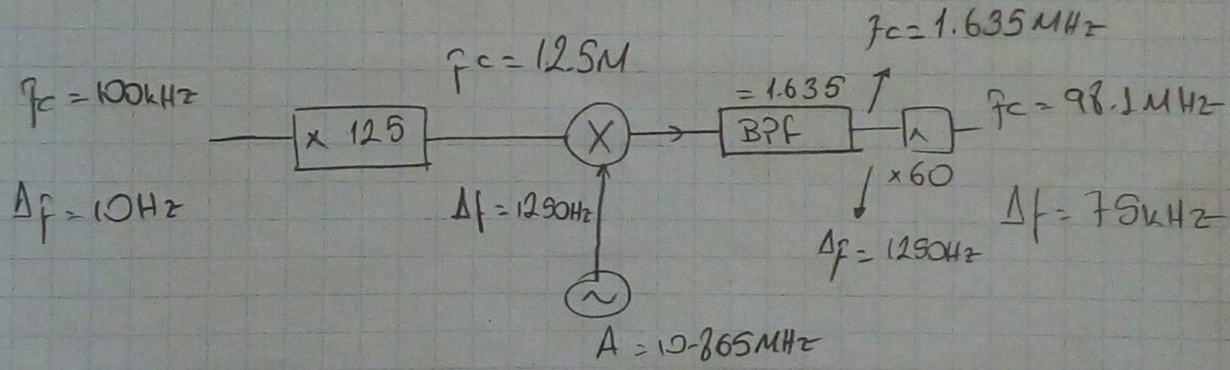
$$\Delta f = \frac{k_p \cdot m_p}{2\pi} = \frac{8000\pi \times 0.858}{2\pi} = 3.432\ \text{kHz}$$

$$B_{PM} = 2(B + \Delta f) \cong 2\Delta f = 6.864\ \text{kHz}$$

Q2) → Carr. freq = 98.1 MHz] 2
Δf = 75 kHz

1 [FM gen. = 100 kHz
Δf = 10 Hz.

Osc. = 10-11 MHz



$$\frac{\Delta f_{last}}{\Delta f_{1st}} = \frac{75 \times 10^3\ \text{Hz}}{10\ \text{Hz}} = 7500$$

125 × 60

f_c = 12.5 MHz

→ 12.5 - A = 1.635

→ A = 10.865 MHz

3) $f_c = 200kHz$ $\qquad f_{c1} = 12.8MHz \qquad f_{c2} = 3MHz$

$$\longrightarrow \underset{64}{\boxed{A}} \longrightarrow \otimes \longrightarrow \boxed{BPF} \longrightarrow \underset{32}{\boxed{B}} \longrightarrow \quad f_c = 96MHz$$

$\Delta f = 9 \sim 10Hz$ $\qquad \Delta f_2 = 625\ Hz \qquad \Delta f = 20kHz$

$\cong 9.7656$

$X\ (9-10MHz)$

$= 9.8MHz$

$\sim$ 9-10MHz

$$\frac{\Delta f}{\Delta f} = \frac{20000}{9} \cong 2222$$

$2000 < A.B < 2222$

$$\text{or} \quad \frac{2000}{10} \cong 2000$$

Only frequency doublers are available:

$A = 2^{n_1} > 45 \rightarrow n_1 = 6 = 64$ $\quad \rightarrow A \times B = 2048$

$B = 2^{n_2} \qquad n_2 = 5 = 32$

$$\left[\begin{array}{c} f_c \times A > X_{min}\ (=9MHz) \\ 2\times10^5 \times A > 9.10^6 \\ A > 45 \end{array}\right]$$

$f_{c1} = 200kHz \times 64 = 12.8MHz$

$$f_{c2} = \frac{96MHz}{32} = 3MHz$$

$f_{c1} - X = 3MHz$

$12.8 - X = 3$

$X = 9.8\ MHz$