Prof. Dr. İbrahim Altunbaş

6.1.2022

EHB 351

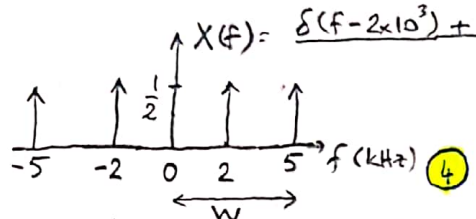
Analog Haberleşme

(Ara Sınav 2 Çözümleri)

CRN: 10813

① $x(t) = \cos 2\pi 2\times10^3 t + \cos 2\pi 5\times10^3 t$

a) $X(f) = \dfrac{\delta(f-2\times10^3)+\delta(f+2\times10^3)+\delta(f-5\times10^3)+\delta(f+5\times10^3)}{2}$



$W = 5$ kHz (2)

(4)

b) $x_c(t) = \dfrac{A_c}{2}x(t)\cos\omega_c t - \dfrac{A_c}{2}\hat{x}(t)\sin\omega_c t$ (TYB (Ü.t))

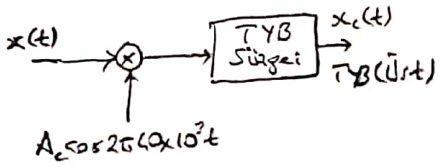
$x(t) = \cos 2\pi 2\times10^3 t + \cos 2\pi 5\times10^3 t \Rightarrow \hat{x}(t) = \sin 2\pi 2\times10^3 t + \sin 2\pi 5\times10^3 t$

$A_c = 2$ V, $f_c = 40$ kHz $\Rightarrow$

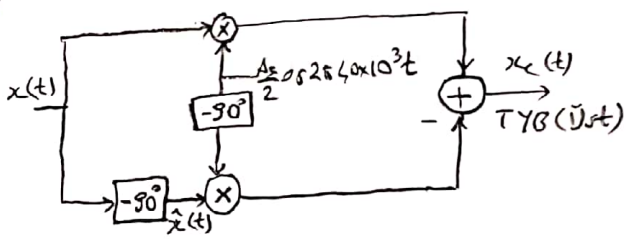
$x_c(t) = (\cos 2\pi 2\times10^3 t + \cos 2\pi 5\times10^3 t)\cos 2\pi 40\times10^3 t - (\sin 2\pi 2\times10^3 t + \sin 2\pi 5\times10^3 t)\sin 2\pi 40\times10^3 t$

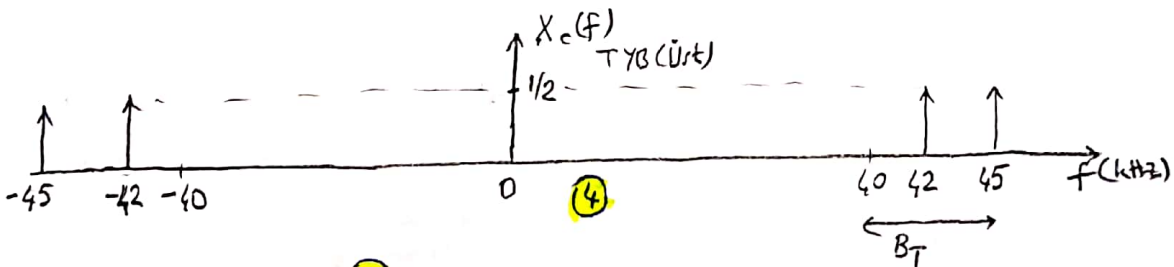
$= \frac{1}{2}[\cos 2\pi 42\times10^3 t + \cos 2\pi 38\times10^3 t + \cos 2\pi 45\times10^3 t + \cos 2\pi 35\times10^3 t - \cos 2\pi 38\times10^3 t + \cos 2\pi 42\times10^3 t$
$- \cos 2\pi 35\times10^3 t + \cos 2\pi 45\times10^3 t]$

$= \cos 2\pi 42\times10^3 t + \cos 2\pi 45\times10^3 t$ (6)



veya (4)



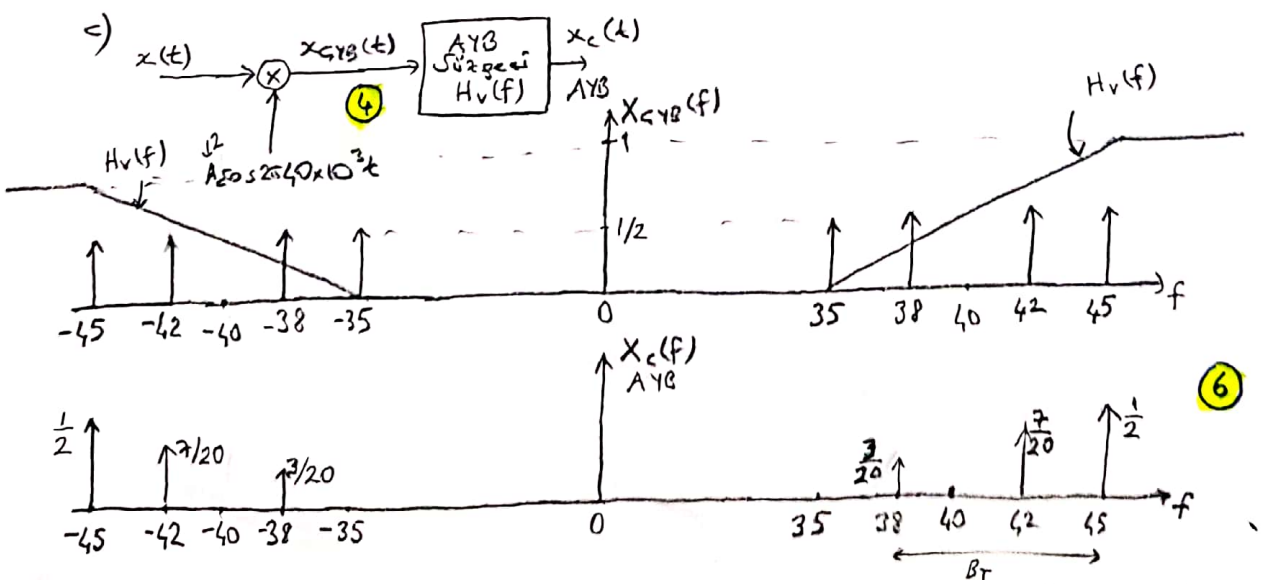


(4)

$P_T = \frac{1^2}{2} + \frac{1^2}{2} = 1$ W (2)

$B_T = 5$ kHz $(= W)$ (2)

c)



(4)

(6)

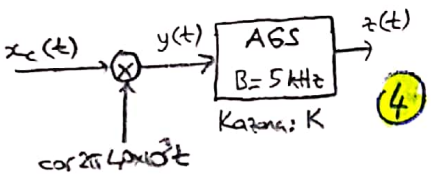
c) (Devam)

$\Rightarrow x_c(t) = \frac{3}{10}\cos 2\pi 38\times10^3 t + \frac{7}{10}\cos 2\pi 42\times10^3 t + \cos 2\pi 45\times10^3 t$ (6)

$P_T = \left(\frac{3}{10}\right)^2\cdot\frac{1}{2} + \left(\frac{7}{10}\right)^2\cdot\frac{1}{2} + \frac{1^2}{2} = 0.79\,W$ (2)

$B_T = 7\,kHz$ (2)

d)



(4)

✓ TYB (Üst) için zaman bölgesinde demodülasyonun gösterilmesi:

$y(t) = (\cos 2\pi 42\times10^3 t + \cos 2\pi 45\times10^3 t)\cos 2\pi 40\times10^3 t$

$= \frac{1}{2}\left[\cos 2\pi 2\times10^3 t + \cos 2\pi 82\times10^3 t + \cos 2\pi 5\times10^3 t + \cos 2\pi 85\times10^3 t\right]$

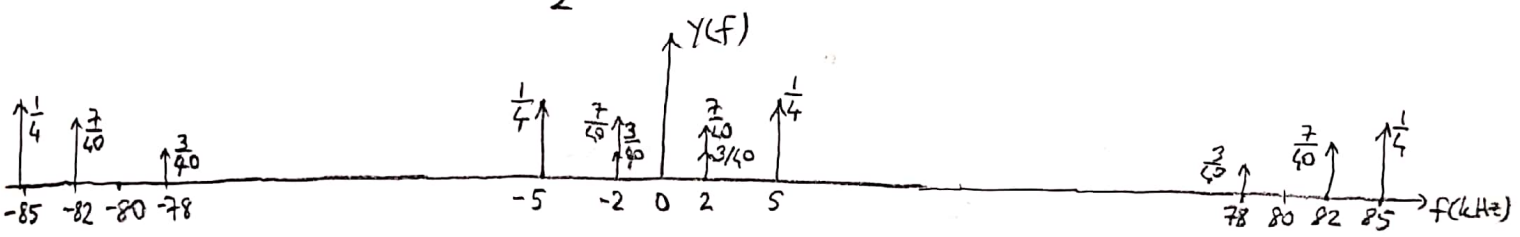
K = 2 kazançlı AGS'ten sonra,

$z(t) = \cos 2\pi 2\times10^3 t + \cos 2\pi 5\times10^3 t = x(t)$ (6)

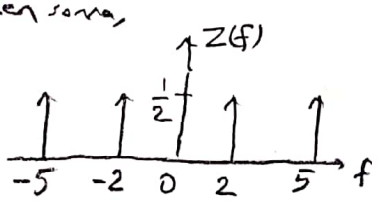
✓ AYB için frekans bölgesinde demodülasyonun gösterilmesi:

$y(t) = x_c(t)\cos 2\pi 40\times10^3 t \Rightarrow$

$Y(f) = \frac{X_c(f-40\times10^3) + X_c(f+40\times10^3)}{2}$



K = 2 kazançlı AGS'ten sonra,



$\Rightarrow z(t) = \cos 2\pi 2\times10^3 t + \cos 2\pi 5\times10^3 t$

$= x(t)$

(6)

② $x_c(t) = \cos(10^6\pi t + 3\sin 2\pi 10^3 t)$ ($A_c = 1$ V, β, f_m)

a) $f_c = \frac{10^6}{2} = 500$ kHz (2)

$x(t) = a\cos\omega_m t \Rightarrow x_c(t) = A_c\cos(\omega_c t + \beta\sin\omega_m t) \Rightarrow \beta = 3$ ($f_m = 1$ kHz) (2)

$\beta = \frac{\Delta f}{f_m} \Rightarrow \Delta f = \beta f_m = 3\times10^3 = 3$ kHz (2)

b) $\Delta f = \frac{k_f a}{2\pi} = \frac{6000\pi a}{2\pi} = 3\times10^3 \Rightarrow a = 10$ V $\Rightarrow x(t) = 10\cos 2\pi 10^3 t$ (2)

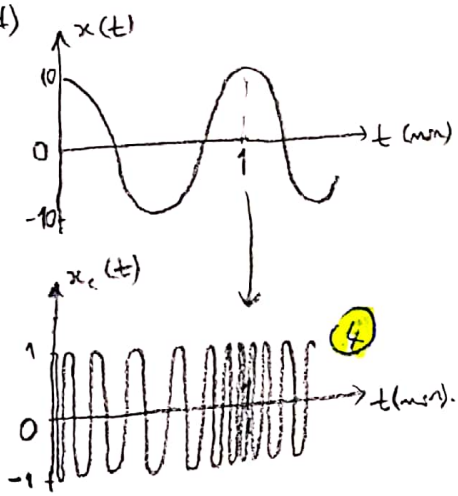
$\omega = f_m = 1$ kHz (2)

$\beta << \frac{\pi}{2}$ olmadığı için geniş bant FM (2)

c) $\omega_a(t) = \omega_c + k_f x(t)$

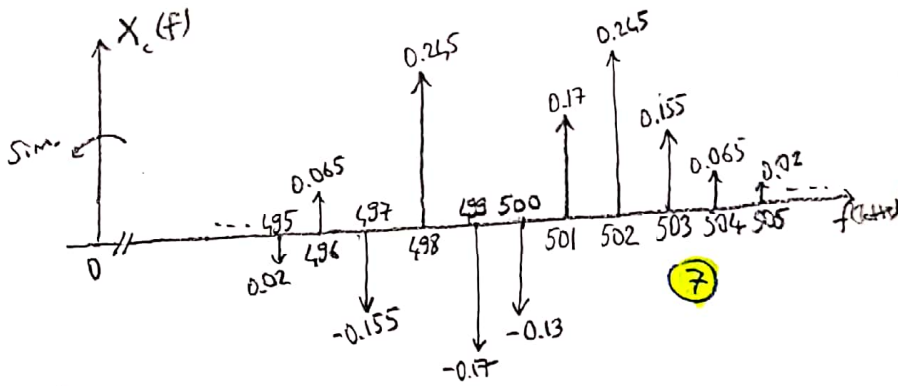
$f_a(t) = f_c + \frac{k_f}{2\pi}x(t) = 500\times10^3 + 3000\cos 2\pi 10^3 t$ (5)

d)



(4)

$x_c(t) = \cos(10^6\pi t + 3\sin 2\pi 10^3 t) = \sum_n J_n(3)\cos 2\pi(500\times10^3 + 10^3 n)t$ (β, f_c, f_m)

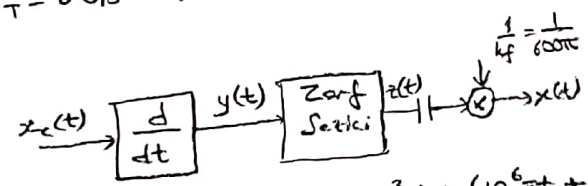


(7)

e) $P_T = \frac{1^2}{2} = \frac{1}{2}$ W (2)

$B_T = BG_{10} = 2(\beta+1)f_m = 2(3+1)10^3 = 8$ kHz (2)

f)



(4)

$y(t) = -(10^6\pi + 6\pi 10^3\cos 2\pi 10^3 t)\sin(10^6\pi t + 3\sin 2\pi 10^3 t)$

y(t)'nin zarfı $|10^6\pi + 6\pi 10^3\cos 2\pi 10^3 t| = 10^6\pi + 6\pi 10^3\cos 2\pi 10^3 t$

($f_c >> f_m$ olduğu için)

$\Rightarrow$

$z(t) = 10^6\pi + 6\pi 10^3\cos 2\pi 10^3 t$

Kondansatör ve zayıflatma işleminden sonra $x(t) = 10\cos 2\pi 10^3 t$ olarak bulunur.

(4)