Analog Haberleşme

ELEC 361 Bonus Quiz çözümü (Fall 2023)

Orijinal not: ELM361-Quiz-Sol-Fall2023.pdf

UYARI Bu belge, el yazısı ders notlarından Claude (Anthropic) yardımıyla dijitale aktarılmıştır. Yardımcı kaynak olarak hazırlanmıştır; hata veya eksik içerebilir. Lütfen orijinal notları ve ders kaynaklarını esas alın.

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orj. s. 1

Şekil: Bu sayfa basılı materyal içeriyor (ör. ders slaytı); dijitalleştirilmedi. Basılı soru başlığındaki Q (25 p.) ifadesinin üstüne el yazısıyla kırmızı kalemle 30 p. yazılmış.
(orijinal notta, s. 1)

a)

$$z(t) = \underbrace{10.a.m(t)}_{\text{LP}} + \underbrace{10.a.\cos(2\pi f_c t)}_{\text{BP at } f_c} + \underbrace{b.m^2(t)}_{\text{LP}} + \underbrace{2b\,m(t)\cos(2\pi f_c t)}_{\text{BP at } f_c} + \underbrace{\frac{b}{2}}_{\text{LP}} + \underbrace{\frac{b}{2}\cos(2\pi\, 2f_c t)}_{\text{BP at } 2f_c}$$

$$Z(f) = 10a\,M(f) + 5a\left[\delta(f-f_c) + \delta(f+f_c)\right] + b\left[M(f) * M(f)\right] + b\left[M(f-f_c) + M(f+f_c)\right] + \frac{b}{2}\delta(f) + \frac{b}{4}\left[\delta(f-2f_c) + \delta(f+2f_c)\right]$$

i) DSB-SC-AM: $a = 0,\ b = 1$, BPF: Gain 1, C.F. $= f_c$, BW $= 2B$ Hz $\Rightarrow\ y(t) = 2\,m(t)\cos(2\pi f_c t)$

ii) DSB-LC-AM: $a = 1,\ b = 1$, Filter the same as i),

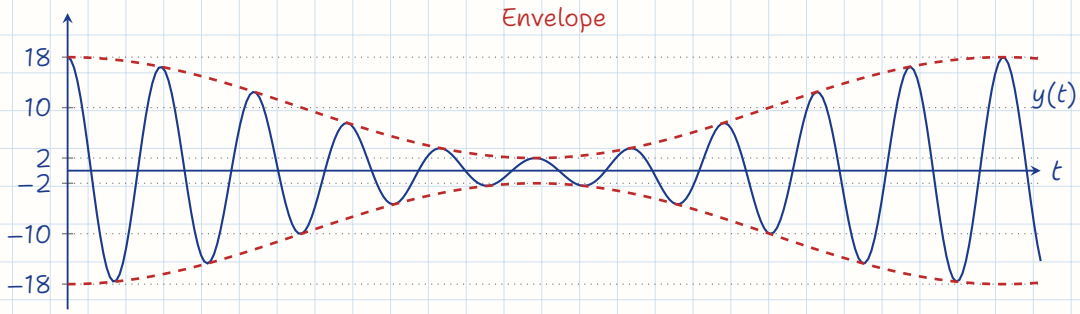
$$y(t) = 10\cos(2\pi f_c t) + 2\,m(t)\cos(2\pi f_c t) = 10\left[1 + \frac{2}{10}\,m(t)\right]\cos(2\pi f_c t)$$

iii) U-SSB: $a = 0,\ b = 1$, BPF: Gain 1, C.F. $= f_c + \frac{B}{2}$, BW $= B$ Hz, i.e.,
Gain 1 if $f_c \le |f| \le f_c + B \Rightarrow y(t) = 2\left[m(t)\cos(2\pi f_c t) - m_h(t)\sin(2\pi f_c t)\right]$

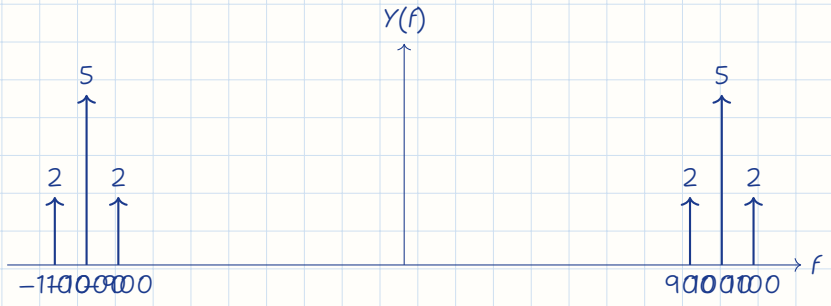
b)

$$y(t) = 10\left[1 + \underbrace{\frac{2}{10}\,4}_{\mu}\,\underbrace{\cos(200\pi t)}_{m_n(t)}\right]\cos(2000\pi t)$$

$\Rightarrow \mu = 0{,}8$ Sinusoidal message signal (tone mod.) $\Rightarrow \eta = \dfrac{\mu^2}{2+\mu^2} = 0{,}242 \cong 24\%$.



$$y(t) = 10\cos(2\pi 1000t) + 4\left[\cos(2\pi 900t) + \cos(2\pi 1100t)\right]$$
$$Y(f) = 5\left[\delta(f-1000) + \delta(f+1000)\right] + 2\left[\delta(f-900) + \delta(f+900)\right] + 2\left[\delta(f-1100) + \delta(f+1100)\right]$$



orj. s. 2

> *Şekil:* Bu sayfa basılı materyal içeriyor (ör. ders slaytı); dijitalleştirilmedi. Basılı soru metni ve blok diyagram sayfa 1'dekiyle aynı; Q (25 p.) ifadesinin üstüne el yazısıyla 30 p. yazılmış.
> *(orijinal notta, s. 2)*

$x(t) = m(t) + \cos(2\pi f_c t)$ $\quad \cos^2(2\pi f_c t) = \frac{1}{2} + \frac{1}{2}\cos(2\pi\, 2f_c t)$ $\quad$? . . . $m(t)\cos(2\pi f_c t) + b$

a)

$$z(t) = 10a\,x(t) + b\,x^2(t)$$
$$= 10a\,m(t) + 10a\cos(2\pi f_c t) + b\,m^2(t) + 2b\,m(t)\cos(2\pi f_c t) + \frac{b}{2} + \frac{b}{2}\cos(2\pi\, 2f_c t)$$

i) $a = 0 \quad b = 1 \Rightarrow z(t) = m^2(t) + 2\,m(t)\cos(2\pi f_c t) + \frac{1}{2} + \frac{1}{2}\cos(2\pi\, 2f_c t)$
BPF at f_c $\quad$ BW= $2B$ $\quad$ $y(t) = 2\,m(t)\cos(2\pi f_c t)$

ii) $a = 1 \quad b = 1$

$$z(t) = 10\,m(t) + \underline{10\cos(2\pi f_c t)} + m^2(t) + \underline{2\,m(t)\cos(2\pi f_c t)} + \frac{1}{2} + \frac{1}{2}\cos(2\pi\, 2f_c t)$$

BPF at f_c $\quad$ BW= $2B$ $\quad$ $y(t) = 10\cos(2\pi f_c t) + 2\,m(t)\cos(2\pi f_c t)$

$$y(t) = 10\left[1 + \frac{2\,m(t)}{10}\right]\cos(2\pi f_c t)$$

iii) $a = 0 \quad b = 1 \Rightarrow$

$$z(t) = m^2(t) + 2\,m(t)\cos(2\pi f_c t) + \tfrac{1}{2} + \tfrac{1}{2}\cos(2\pi\, 2f_c t)$$

BPF at $f_c + \frac{B}{2}$ BW= B

$$y(t) = 2\left[m(t)\cos(2\pi f_c t) - m_h(t)\sin(2\pi f_c t)\right]$$

b) $f_c = 1k \quad m(t) = 4\cos(2\pi 100t) \quad m_p = 4 \quad m_n(t) = \cos(2\pi 100t)$

$$y(t) = 10\left[1 + \frac{8}{10}\underbrace{m_n(t)}_{\cos(2\pi 100t)}\right]\cos(2\pi 1k\, t) \qquad \mu = 0{,}8$$

$$= 10\cos(2\pi 1k\, t) + 8\left[\cos(2\pi 100t)\cdot\cos(2\pi 1k\, t)\right]$$

$$= 10\cos(2\pi 1k\, t) + 4\cos(2\pi 1{,}1k\, t) + 4\cos(2\pi 0{,}9k\, t)$$

$$Y(f) = 5\left[\delta(f + 1k) + \delta(f - 1k)\right]$$
$$+ 2\left[\delta(f + 1{,}1k) + \delta(f - 1{,}1k) + \delta(f + 0{,}9k) + \delta(f - 0{,}9k)\right]$$

$$\eta = \frac{\mu^2 P_{m_n}}{1 + \mu^2 P_{m_n}} \qquad P_{m_n} = \tfrac{1}{2} \quad \text{Ton modülasyonu}$$

$$= \frac{\mu^2}{2 + \mu^2}$$

$$\cong \%24$$

