Lektion 4

7.3-6 **(a)**

$$x_a(t)=\Delta\left(\frac{t}{2\pi}\right)\cos(10t) \quad \Rightarrow$$

$$X_a(\omega)=\frac{\pi}{2}\left(\operatorname{sinc}^2\left(\frac{\pi(\omega-10)}{2}\right)+\operatorname{sinc}^2\left(\frac{\pi(\omega+10)}{2}\right)\right)$$

(b)

$$x_b(t)=x_a(t-2\pi)=\Delta\left(\frac{t-2\pi}{2\pi}\right)\cos\left(10(t-2\pi)\right) \quad \Rightarrow$$

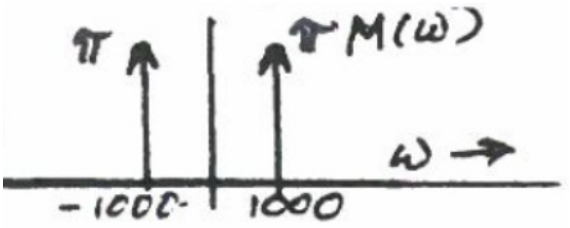
$$X_b(\omega)=X_a(\omega)e^{-j\omega 2\pi}=\frac{\pi}{2}\left(\operatorname{sinc}^2\left(\frac{\pi(\omega-10)}{2}\right)+\operatorname{sinc}^2\left(\frac{\pi(\omega+10)}{2}\right)\right)e^{-j2\pi\omega}$$

7.3-7 **(a)** $x(t)=\frac{2}{\pi}\operatorname{sinc}_N\left(\frac{t}{\pi}\right)\cos(4t)=\frac{2}{\pi}\operatorname{sinc}(t)\cos(4t)$

(b) $x(t)=\frac{2}{\pi}\operatorname{sinc}_N^2\left(\frac{t}{\pi}\right)\cos(4t)=\frac{2}{\pi}\operatorname{sinc}^2(t)\cos(4t)$

7.7-1 **(a)**

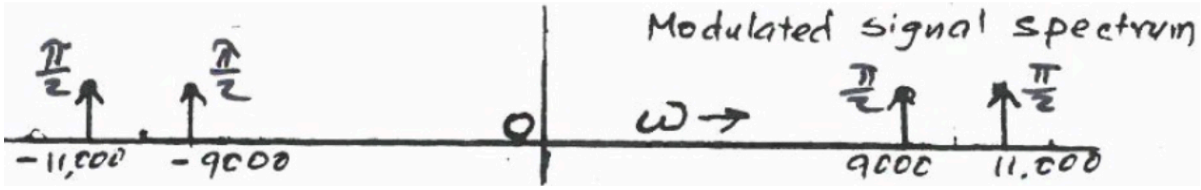
(i)



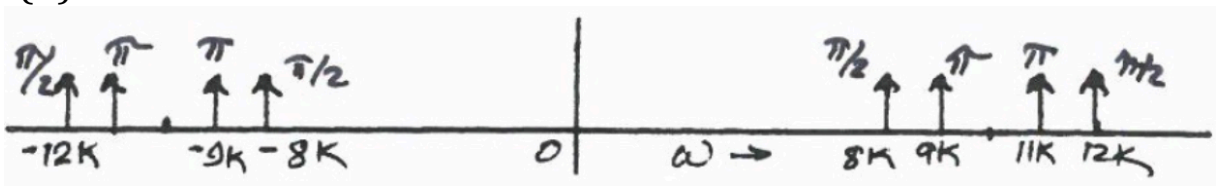
(ii)

(b)

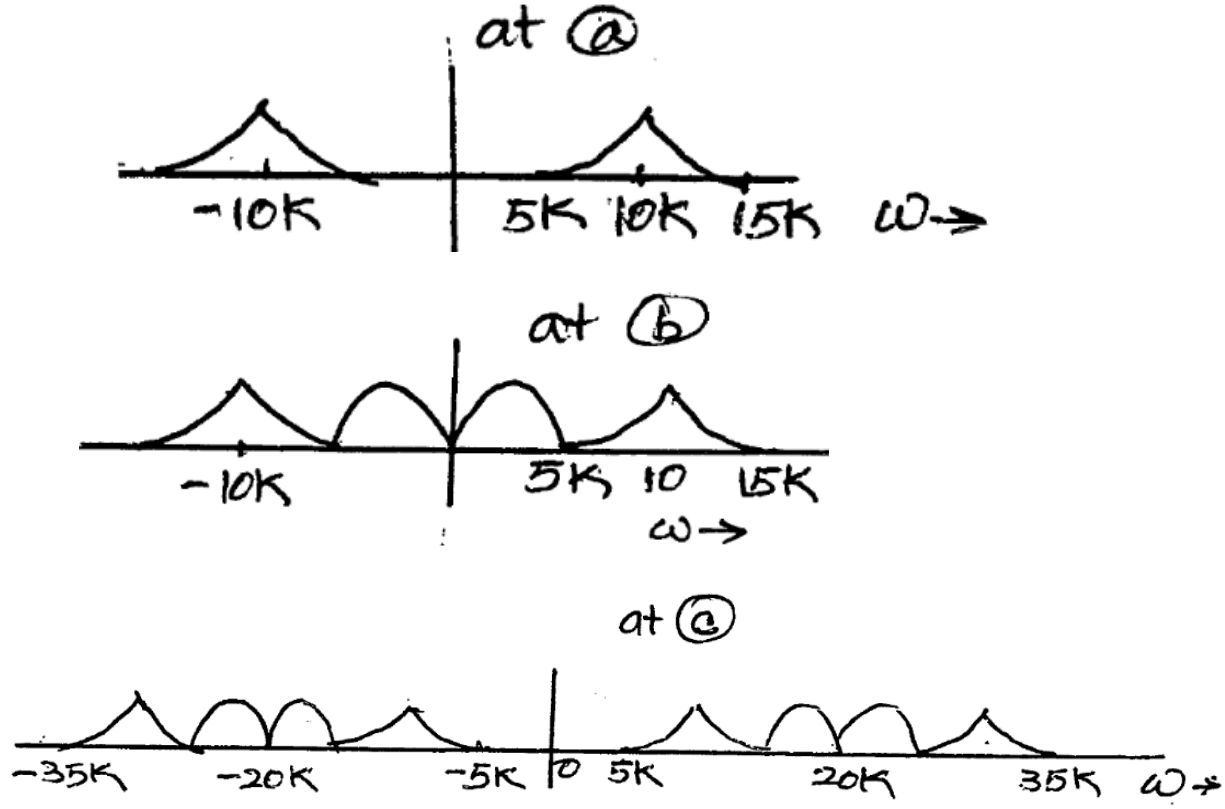
(i)



(ii)



7.7-4 **(a)**



(b) Kanalen måste ha en bandbredd på minst 30.000 rad/s: från 5000 till 35000 rad/s

(c)

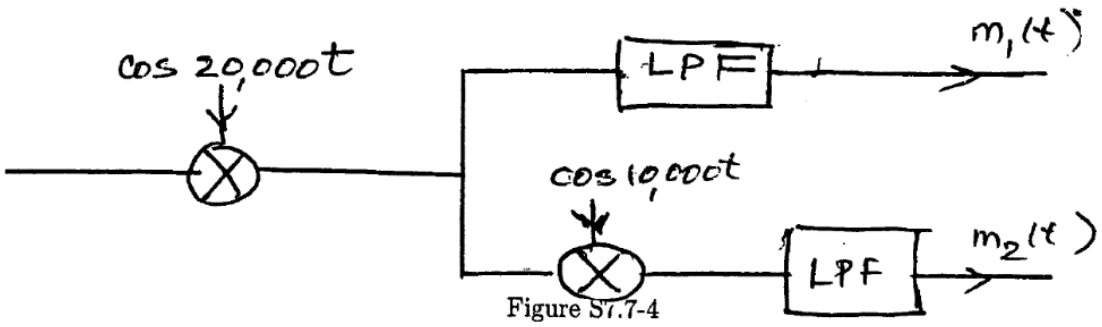


Figure S7.7-4

8.1-1 ”Nyquist sampling rate” $f_{s,\min}$ = den minsta sampelfrekvens (antal sampel/sek) som medför att samplingsteoremet uppfylls, dvs. dubbla signalens bandbredd: $f_{s,\min} = 2B$.

$x_1(t)$: $f_{s,\min} = 200$ kHz, $x_2(t)$: $f_{s,\min} = 300$ kHz, $x_1^2(t)$: $f_{s,\min} = 400$ kHz,

$x_2^3(t)$: $f_{s,\min} = 900$ kHz, $x_1(t)x_2(t)$: $f_{s,\min} = 500$ kHz

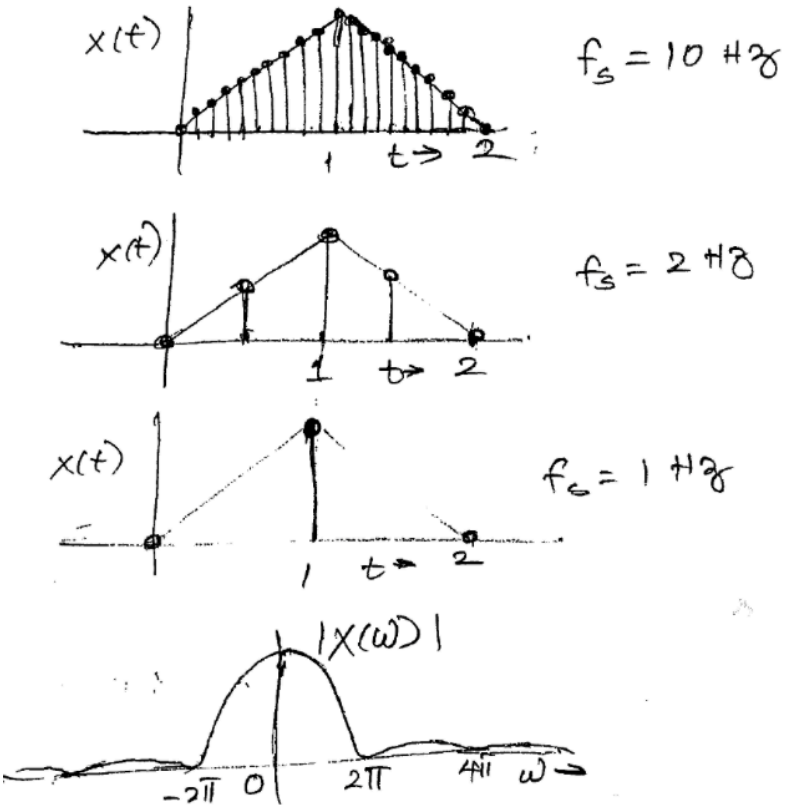
8.1-2 **(a)** $f_{s,\min} = 200$ Hz $\Rightarrow$ $T = \dfrac{1}{f_{s,\min}} = \dfrac{1}{200}$ sek

(b) $f_{s,\min} = 200$ Hz $\Rightarrow$ $T = \dfrac{1}{f_{s,\min}} = \dfrac{1}{200}$ sek

(c) $f_{s,\min} = 120$ Hz $\Rightarrow$ $T = \dfrac{1}{f_{s,\min}} = \dfrac{1}{120}$ sek

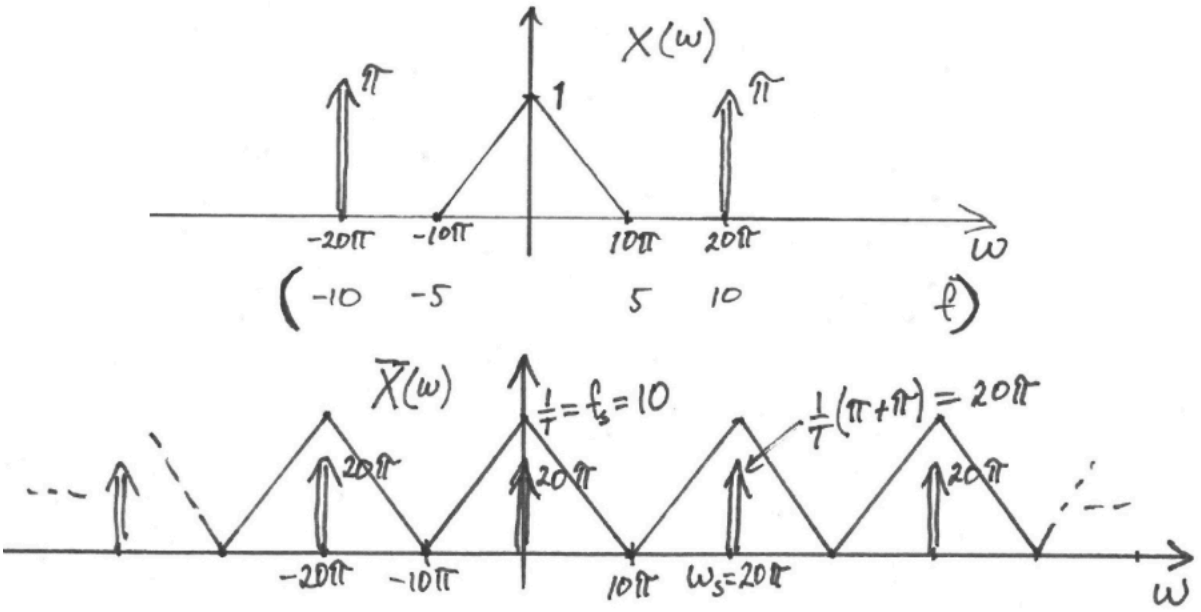
(d) $f_{s,\min} = 150$ Hz $\Rightarrow$ $T = \dfrac{1}{f_{s,\min}} = \dfrac{1}{150}$ sek

8.1-6

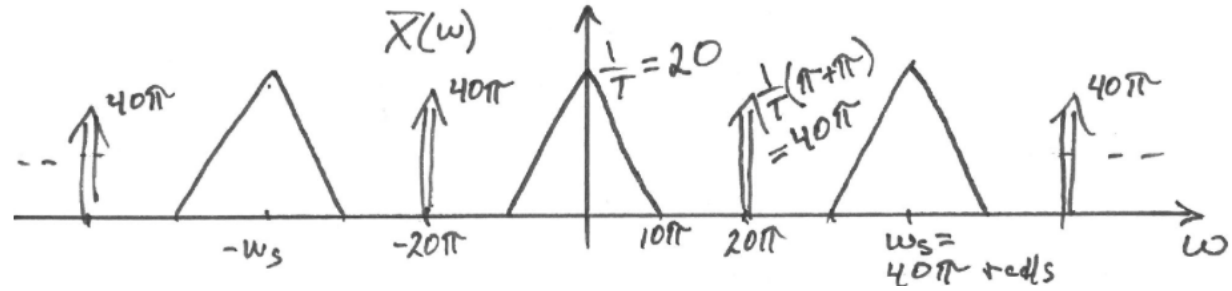


Från signalens amplitudspektrum ser man att det mesta (möjligen tillräckligt) av signalens energi finns inom huvudloben, dvs. upp till vinkelfrekvensen 2π rad/s (upp till frekvensen 1 Hz). I så fall kan det vara tillräckligt att välja sampelfrekvensen $f_s = 2 \cdot 1 = 2$ Hz. (Läs mer i lösningsförslaget.)

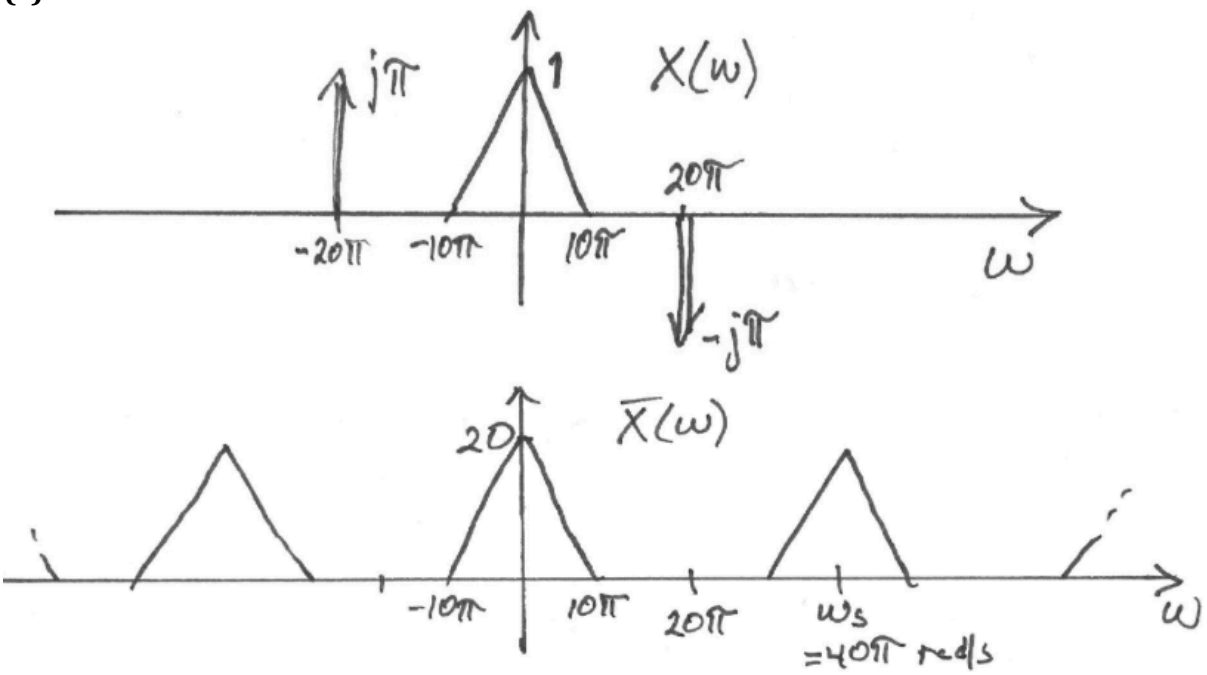
8.1-7 **(a)**


X(ω)
π
1
π
-20π
-10π
10π
20π
ω
(-10 -5 5 10 f)
X̄(ω)
1/T = f_s = 10
1/T(π+π) = 20π
20π
-20π
-10π
10π
ω_s=20π
ω

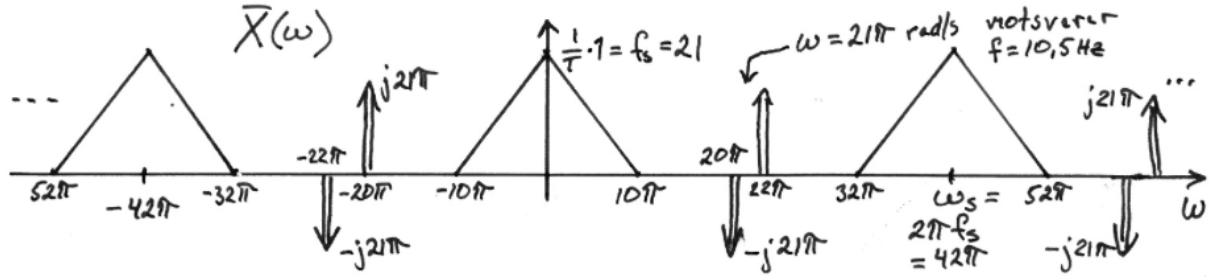
(b)


X̄(ω)
1/T = 20
40π
-ω_s
-20π
10π
20π
ω_s =
40π rad/s
ω

(c)


jπ
1
X(ω)
20π
-20π
-10π
10π
ω
-jπ
20
X̄(ω)
-10π
10π
20π
ω_s
=40π rad/s
ω

(d)


X̄(ω)
1/T·1 = f_s = 21
ω = 21π rad/s
motsvarar
f = 10,5 Hz
j21π
-22π
-20π
-j21π
-10π
10π
20π
22π
-j21π
32π
ω_s =
2π f_s
= 42π
52π
-42π
-32π
j21π
-j21π
ω