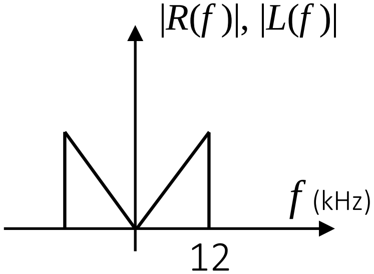
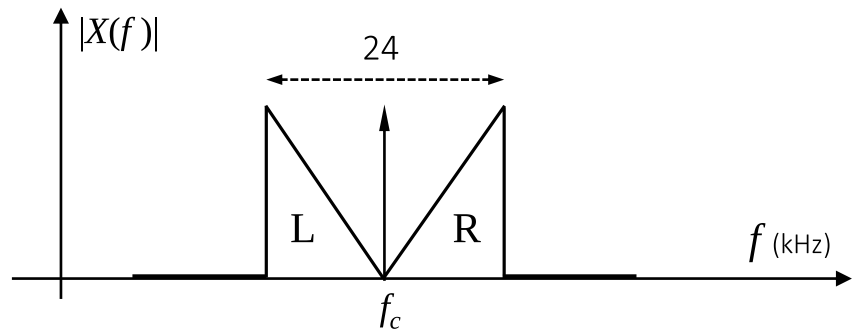
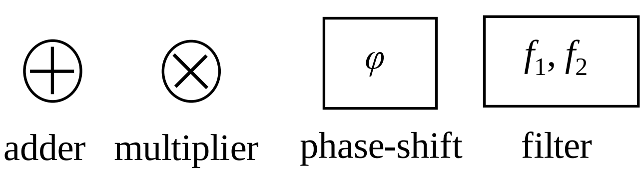
Ex-1

A stereo AM signal will be constructed from baseband signals $r(t)$ and $l(t)$, each with 12kHz bw. Desired spectrum of of $x(t)$ is shown with fc carrier frequency which is coherent with both usb and lsb parts. Design conceptual block diagram of the transmitter using adders, multipliers, phase shifters and cheap filters.





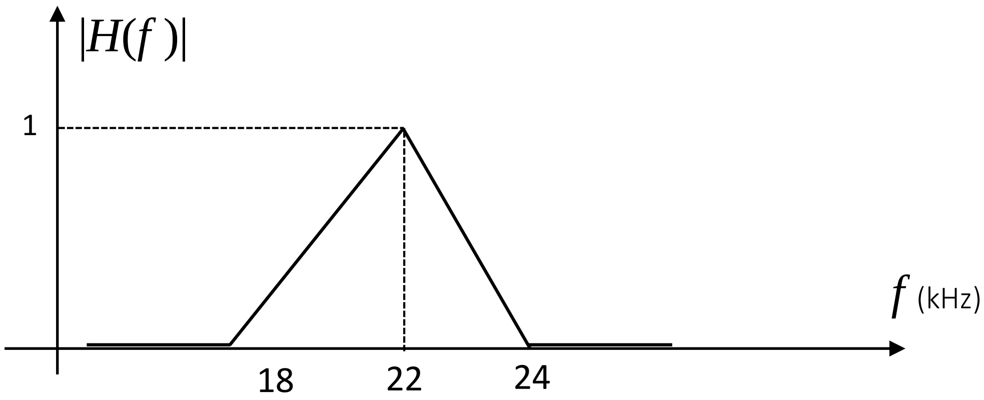
use these :



Ex-2

The sum of signal $x(t) = \sin(40 \times 10^3 \pi t)$ and AWG noise $\eta(t)$ is fed to a filter $H(f)$ whose spectral characteristic is shown in the figure.

Input noise power density is $N_0 = 10^{-6}$ [W/Hz]



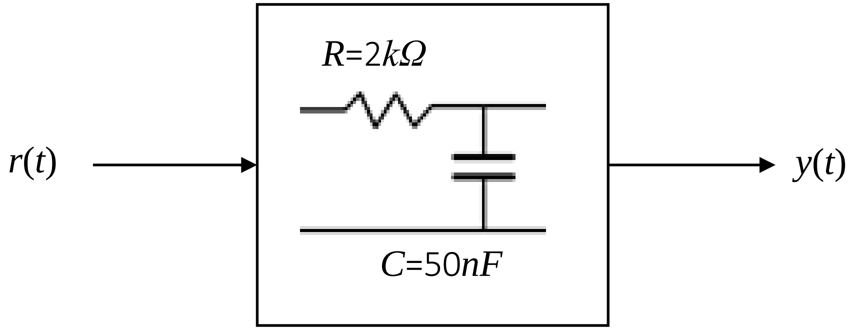
Calculate output SNR

Ex-3

A memoryless source generates the symbols $A=\{a, b, c\}$ with probabilities $z=\{0.6, 0.3, 0.1\}$. Determine the compression ratios for non-extended and 2nd extension sources when compressed using Huffman-tree generated codes.
(Note: let compression ratio be defined as output bits per input bit)

Ex-4

$r(t) = 2\cos\left(8000\pi t + \frac{\pi}{4}\right) + \eta(t)$ is received from a communication channel. $\eta(t)$ is AWG noise with $N_0 = 10^{-6}$ W/Hz. The signal is then fed to a low-pass filter shown below.

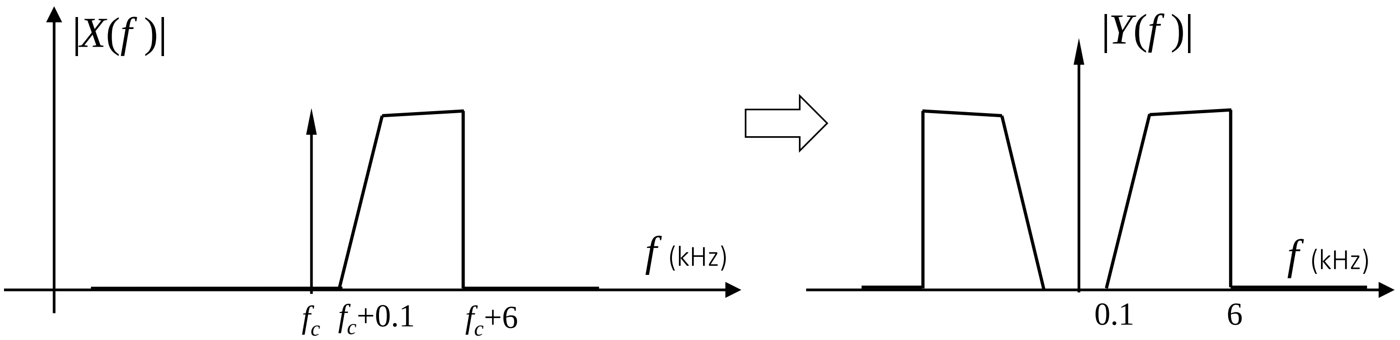


a) Determine the phase angle of the signal portion at the output.

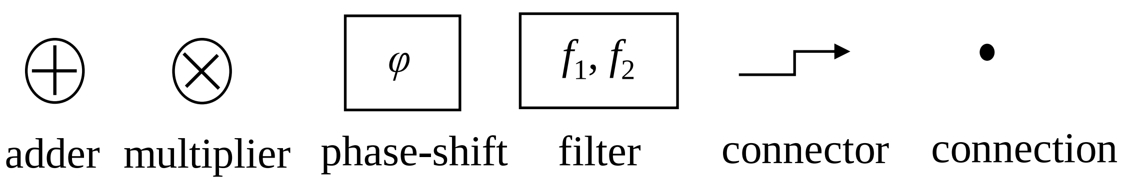
b) Calculate the SNR at the output.

Ex-5

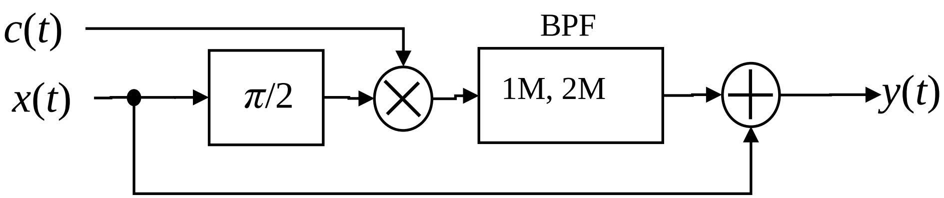
The following spectrum of a USB-AM modulated signal is given. Draw the block diagram of the receiver-demodulator (that gives out the baseband signal) using the basic components given.



use these :



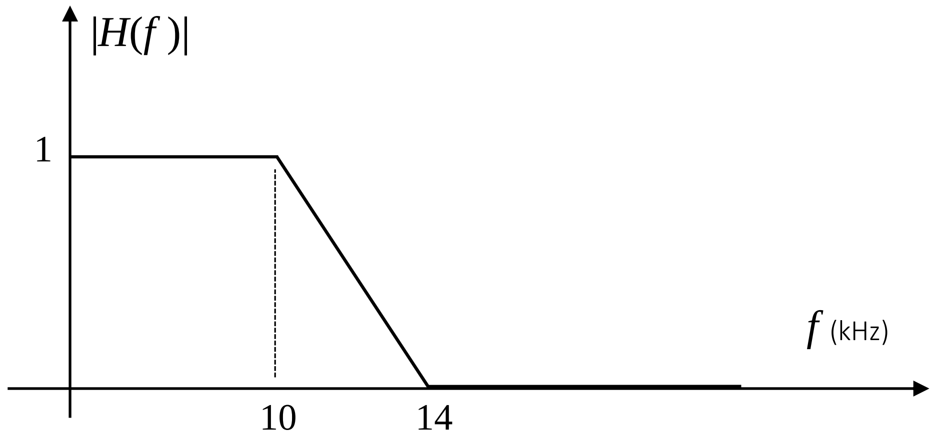
example :



example is not related to the question

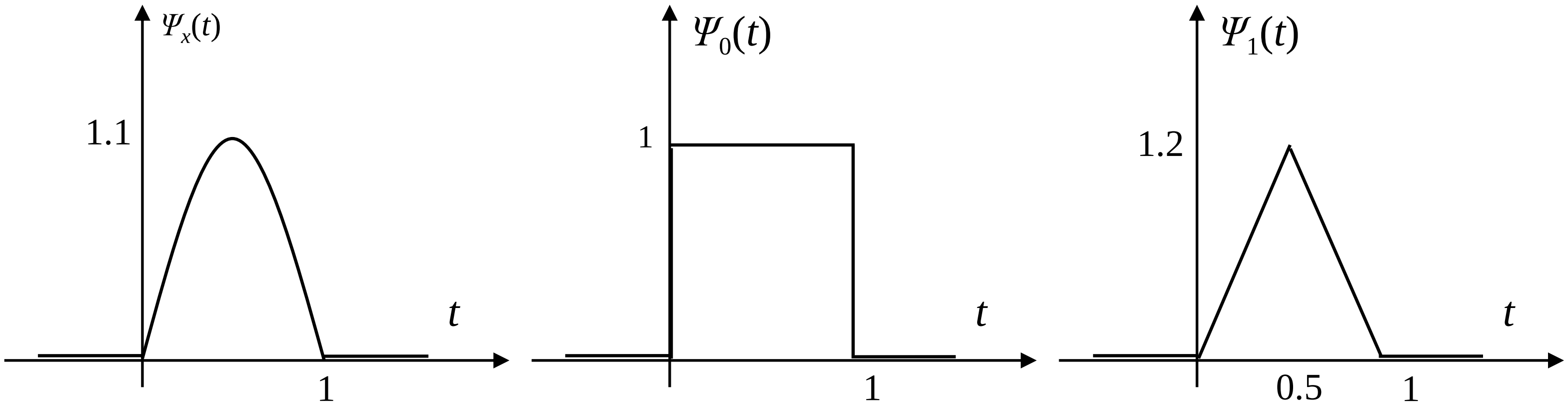
Ex-6

Determine the noise-equivalent-bandwidth of the low-pass filter whose characteristics is given in the figure.



Ex-7

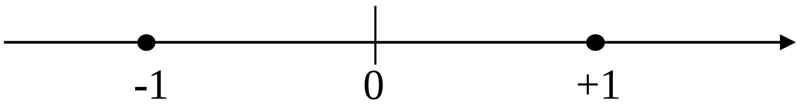
Three pulses, $\psi_x(t)$, $\psi_0(t)$ and $\psi_1(t)$, are given. By performing/showing the necessary calculations, determine which one of $\psi_0(t)$ and $\psi_1(t)$ is more similar to $\psi_x(t)$.



$$\psi_x(t) = \begin{cases} 1.1\sin(\pi t), & 0 < t < 1 \\ 0 & otherwise \end{cases}$$

Ex-8

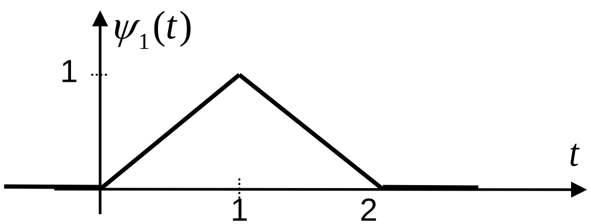
A communication system with the following constellation diagram has BER=10^{-3} under AWGN. We wish to use an output amplifier at the transmitter in order to improve performance to BER=10^{-5}. What should be the amplifier power gain?

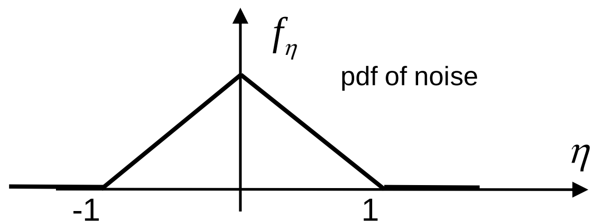


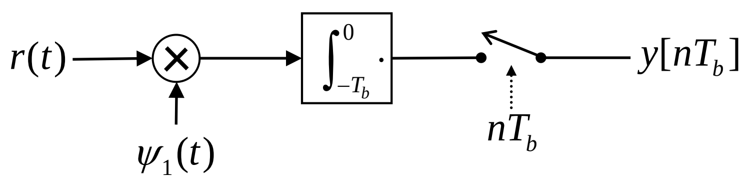
Ex-9

A binary transmission system uses the following waveform and its antipodal counterpart to represent binary 1 and 0 symbols respectively. On the receiver, a correlator receiver is used as shown. The correlator output signal at the fully synchronous measurement times is $y[nT_b] = R[nT_b] + \eta$

η is the noise component whose pdf is also given below.



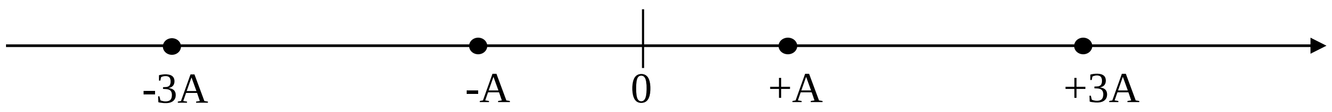




Calculate the probability of decision error p_e. , assuming that the system is in full synchronization, symbol transmission probabilities are equal and the channel has no ISI (intersymbol interference)

Ex-10

A 4-ary ASK transmission system uses a rectangular pulse set with amplitudes $\{3A, A, -A, -3A\}$.
Determine optimum *probability of symbol error* under AWGN with power spectral density of $N_0/2$.



Assume that transmission probabilities of all symbols are equal and neighboring symbols have only one differing bit (Gray Coded).

Ex-11

An OFDM signal is created at baseband with 64 complex carriers and upconverted to 100 MHz center frequency.

DC is not used and set to zero,

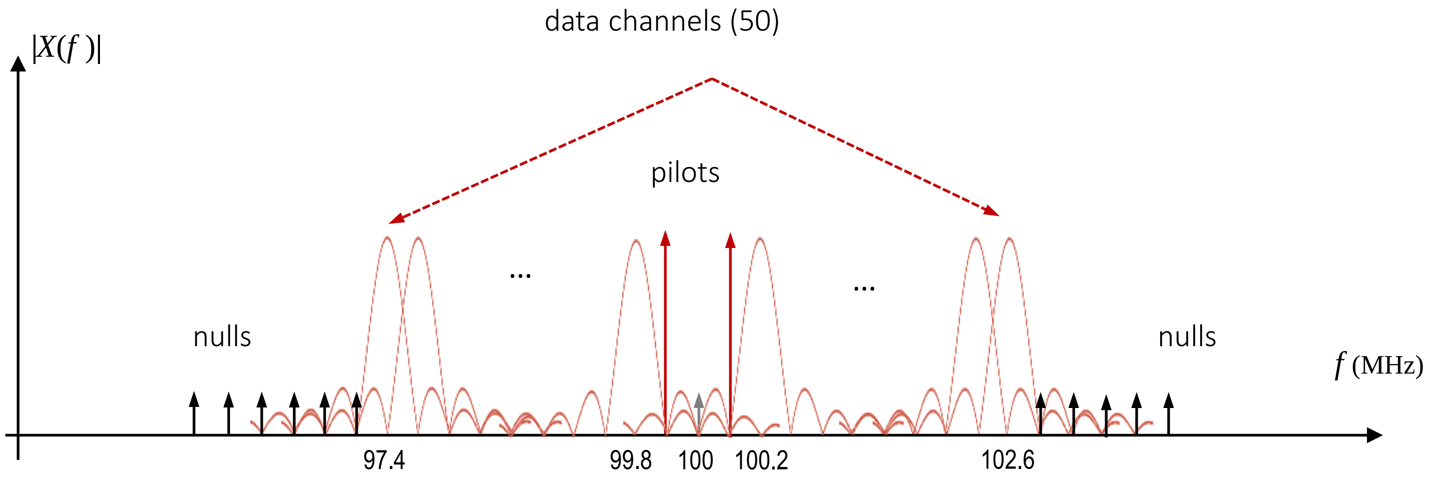
2 pilot carriers are used next to DC,

highest 5 and lowest 6 (at the band edges) carrier frequencies are used as null carriers (set to zero),

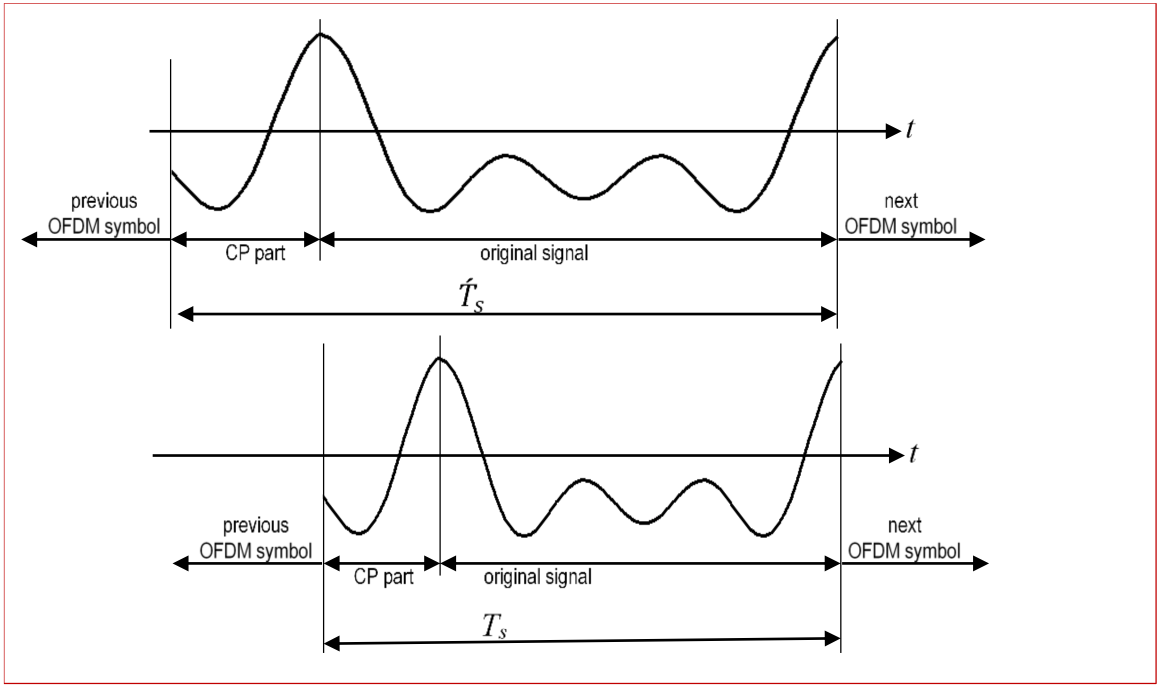
The remaining are data channels.

OFDM symbol rate is 100 ksym/s. 25% of total OFDM symbol duration is used for CP.

a. Draw the spectrum with all critical frequencies given.
b. Determine the maximum bit rate if data channels can employ BPSK, QPSK or 16-QAM.

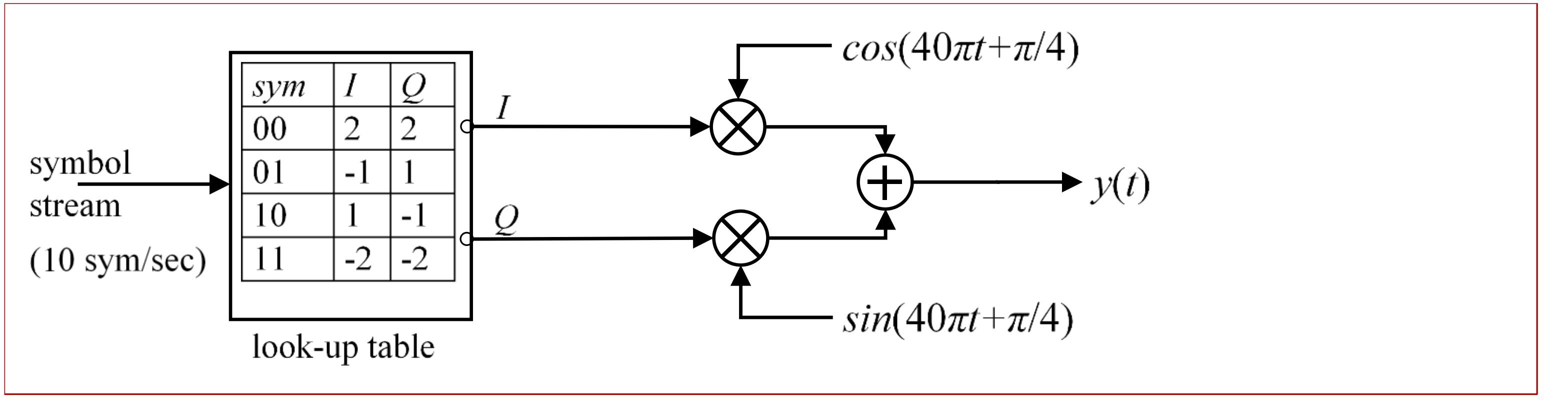


data channels (50)
|X(f)|
pilots
...
...
nulls
nulls
f (MHz)
97.4
99.8
100
100.2
102.6

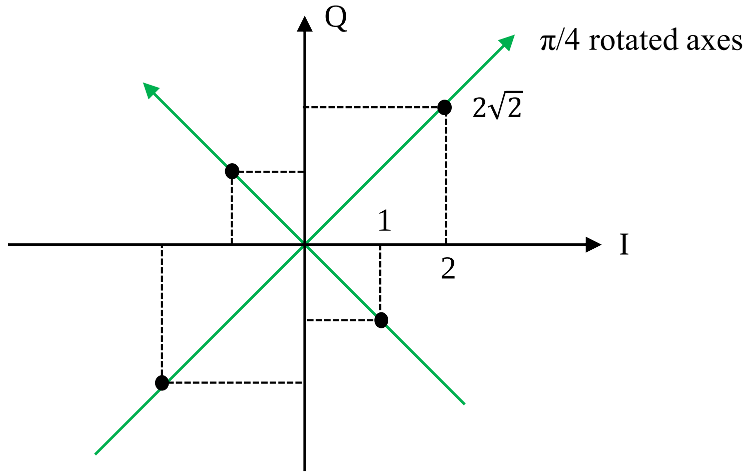


t
previous
OFDM symbol
CP part
original signal
next
OFDM symbol
Ť_s
t
previous
OFDM symbol
CP part
original signal
next
OFDM symbol
T_s

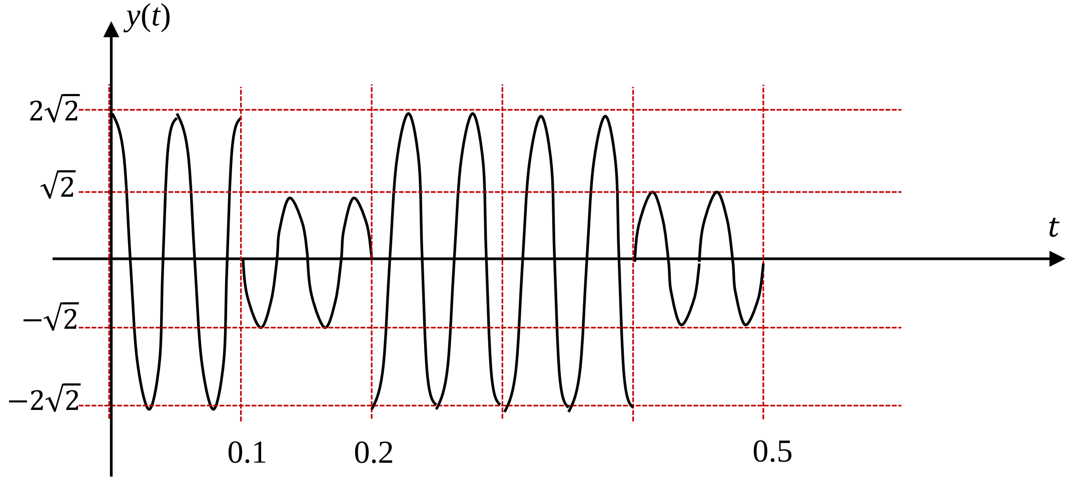
The following quadrature modulator is given.



Draw $y(t)$ when the symbol stream is {00,10,11,11,01}. Do not forget the axis names and scale info (tick labels) on the graph.



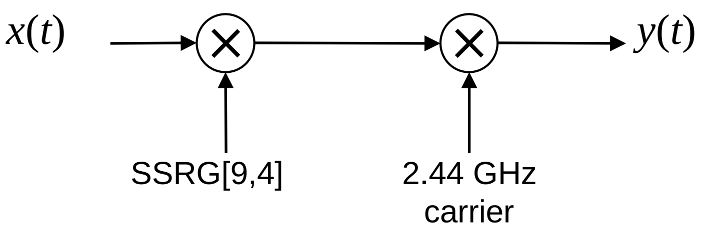
Q
π/4 rotated axes
2√2
1
2
I



y(t)
2√2
√2
−√2
−2√2
t
0.1
0.2
0.5

Ex-13

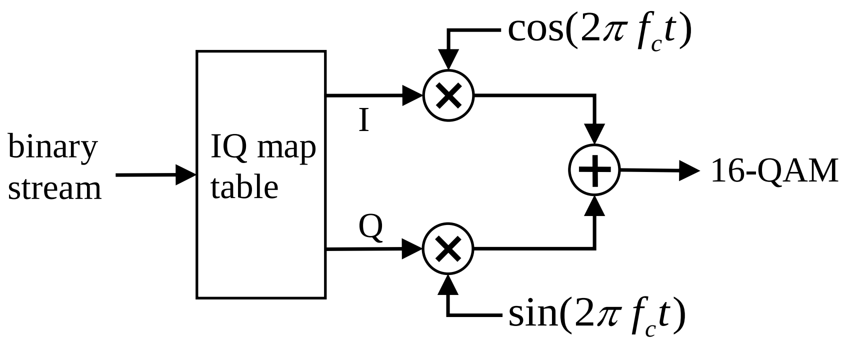
$x(t)$ is a 1 Mbps binary antipodal random rectangular pulse stream. The following transmitter schema with DSSS is given. Chip rate of the m-sequence generator is 511 chips/bit.



Draw the spectrum of $y(t)$

Ex-14

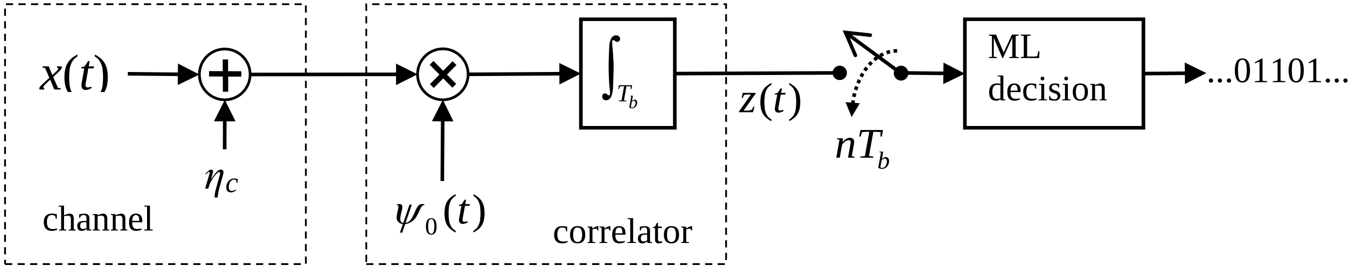
The following IQ-modulator is to be used to obtain 16-QAM.



a) Draw the constellation diagram.
b) Determine entries of the IQ map table (look-up table).

Ex-15

The following BPSK receiver/correlator-detector is given.



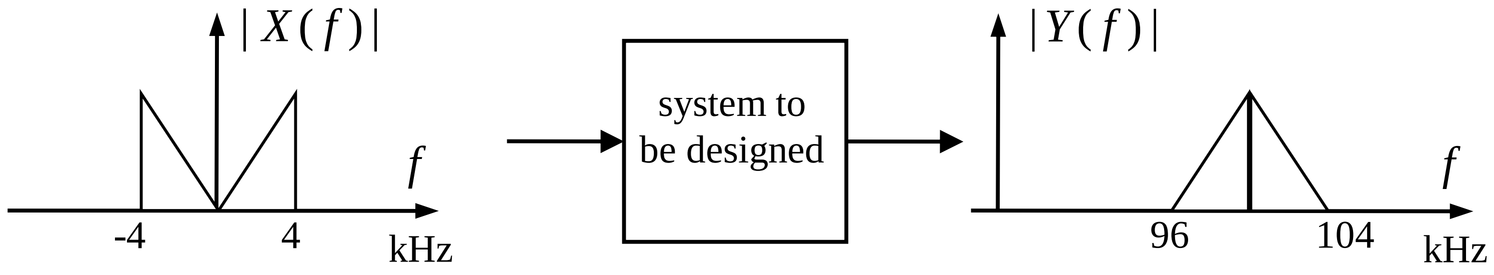
Bit rate is R_b=100 kbps. Carrier frequency is f_c=1 MHz. Local oscillator signal is $\psi_0(t) = \cos(2\pi f_c t)$. The receiver is in full synchronization with the incoming signal.

Noise part at the output of the correlator is given as "Gaussian with $\sigma^2 = 10^{-11}$

a) Draw the psd of $x(t)$
b) Determine the probability of decision error p_e.

Ex-16

Magnitude spectrums of a baseband signal and the required signal are given as follows.

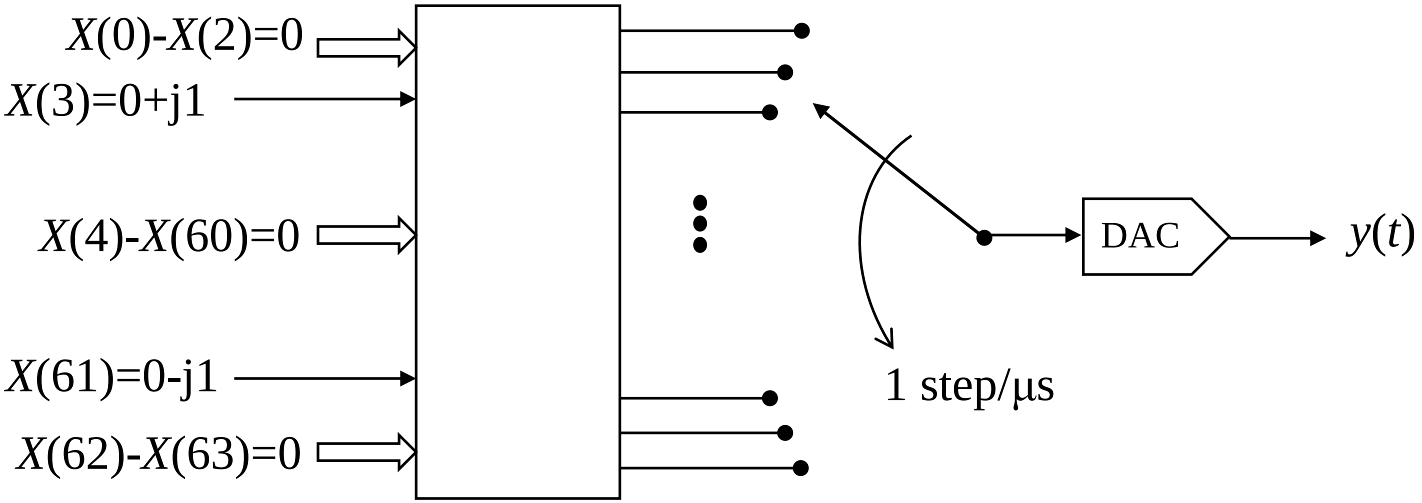


Design the system that does that using adders, multipliers and ideal filters. Give filters' cut-off frequencies.

note: the resulting signal is called "spectrally inverted" signal.

Ex-17

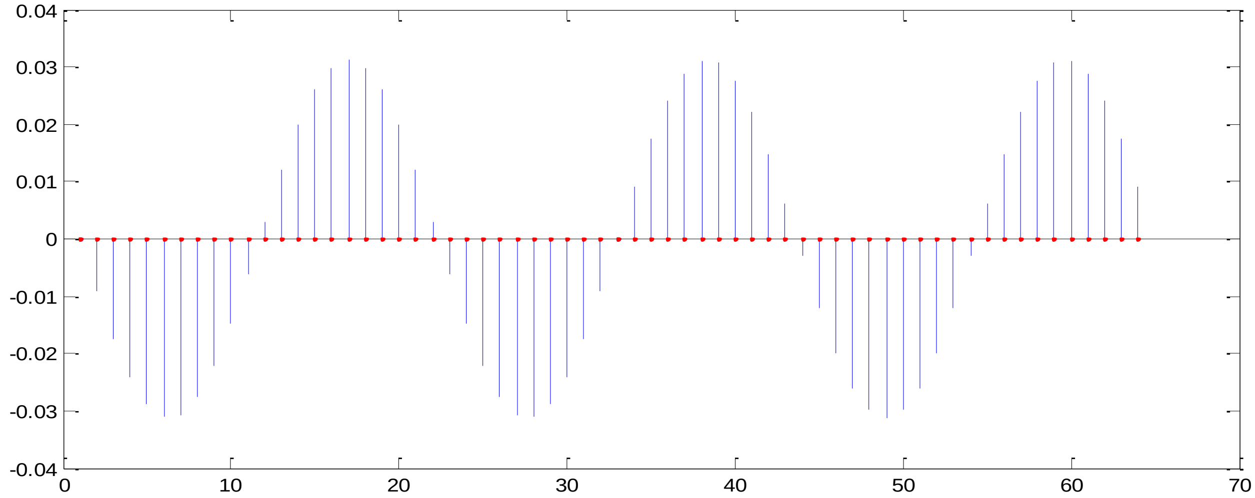
An 64-point IDFT block is given. All inputs except $X(3)$ and $X(61)$ are zeroed. $X(3)$ and $X(61)$ are assigned to 0+j1 and 0-j1 respectively as shown.

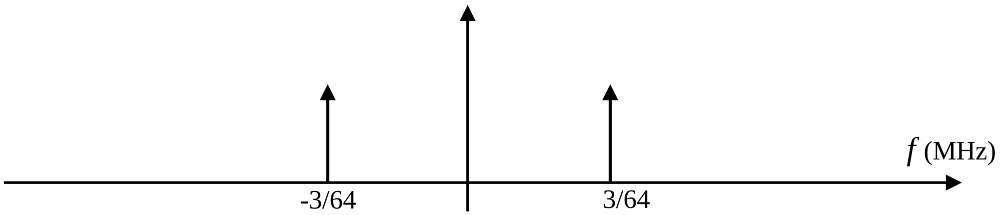


a) Draw $y(t)$ when the mux switch is rotated 1 step(sample) per μs indefinitely
b) Draw $y(t)$ when the mux switch is rotated 2 step(sample) per μs indefinitely
c) Draw the spectrum of $y(t)$ (show frequencies)

Using Matlab/Octave : Since Matlab indexes start from 1 instead of 0, we should increment the indexes to get the Matlab array indexes.

```
x=zeros(64,1);x(4)=1i;x(62)=-1i; y=ifft(x);
figure;stem(real(y),'marker','none');
hold on;stem(imag(y),'marker','none','color','red');
```



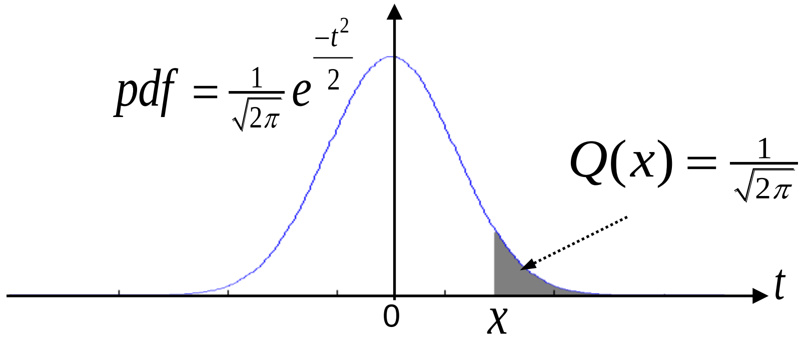


$Q(x)$ Function

$$erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-u^2} du$$

$$Q(x) = \frac{1}{2} - \frac{1}{2} erf\left(\frac{x}{\sqrt{2}}\right)$$

$$pdf = \frac{1}{\sqrt{2\pi}} e^{\frac{-t^2}{2}}$$



$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^{\infty} e^{\frac{-t^2}{2}} dt$$

Examples:

Given x=2.575 ; 2.575-2.5=0.075, find the cell with column 2.5 and row 075; Find Q(2.575)= 0.00501200

Given $Q(x)$= 0.0378 ; Find closest number in table as 03794894. Combine its column and row values as x=1.5+0.275=1.775

x	1.	1.5	2.	2.5	3.	3.5	4.	4.5	5.
000	15865525	06680720	02275013	00620967	00134990	00023263	00003167	00000340	00000029
025	15268159	06362955	02143368	00578491	00124317	00021174	00002849	00000302	00000025
050	14685906	06057076	02018222	00538615	00114421	00019262	00002561	00000268	00000022
075	14118736	05762822	01899327	00501200	00105251	00017511	00002301	00000238	00000019
100	13566606	05479929	01786442	00466119	00096760	00015911	00002066	00000211	00000017
125	13029452	05208128	01679331	00433245	00088903	00014448	00001854	00000187	00000015
150	12507194	04947147	01577761	00402459	00081635	00013112	00001662	00000166	00000013
175	11999736	04696712	01481506	00373646	00074918	00011892	00001490	00000147	00000011
200	11506967	04456546	01390345	00346697	00068714	00010780	00001335	00000130	00000010
225	11028761	04226374	01304062	00321507	00062986	00009766	00001195	00000115	00000009
250	10564977	04005916	01222447	00297976	00057703	00008842	00001069	00000102	00000008
275	10115462	03794894	01145296	00276009	00052831	00008000	00000956	00000090	00000007
300	09680048	03593032	01072411	00255513	00048342	00007235	00000854	00000079	00000006
325	09258558	03400051	01003598	00236403	00044209	00006539	00000763	00000070	00000005
350	08850799	03215677	00938671	00218596	00040406	00005906	00000681	00000062	00000004
375	08456572	03039636	00877448	00202014	00036908	00005331	00000607	00000054	00000004
400	08075666	02871656	00819754	00186581	00033693	00004810	00000541	00000048	00000003
425	07707860	02711468	00765419	00172228	00030740	00004336	00000482	00000042	00000003
450	07352926	02558806	00714281	00158887	00028029	00003908	00000429	00000037	00000003
475	07010627	02413407	00666181	00146494	00025543	00003519	00000382	00000033	00000002