4. Problem Sheet

| Out	Due	Discussion
10. 05. 17	16. 05. 17	19. 05. 17 - 23. 05. 17

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Please solve the problems in groups with two people and submit your solutions before the lecture. The discussion of the problem sheet is in the exercise course after the submission.

Problem 4.1: Modulation 1 *4 points*

Consider the following modulation diagram.
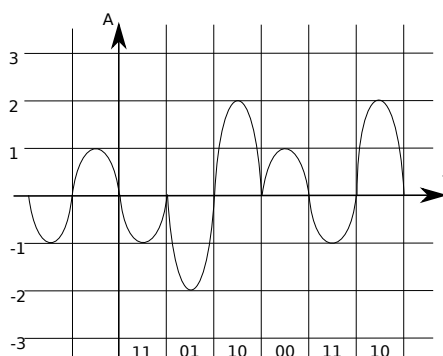
The signal has already been sampled and demodulated. The symbols are depicted in the modulation diagram. Specify the (de-)modulation table for the applied (de-)modulation scheme. Sketch the corresponding constellation diagram.
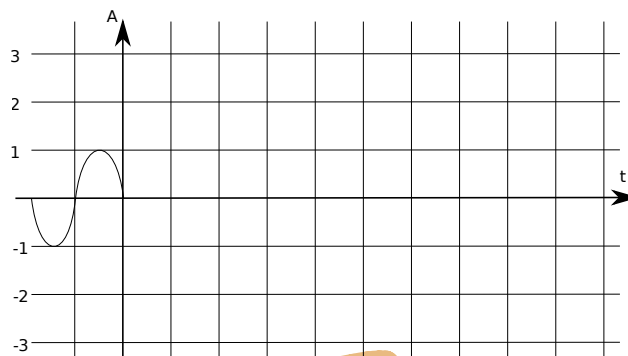
Problem 4.2: Modulation 2 *4+4 = 8 points*

1. Consider a sender transmits the bit sequence `000110010011`. A combination of amplitude shift keying (ASK) and differential phase shift keying (Differential PSK) is applied[1]. The base frequency is f and, for simplicity, each symbol is sent for $\frac{1}{2}T$. The following modulation table is used:
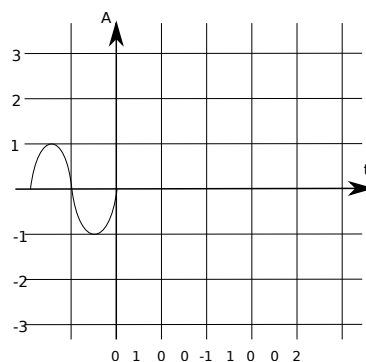
Symbol	Amplitude	Phase Shift
00	1	0
01	2	0
10	1	π
11	2	π

In the following diagram, a sine wave carrier $s(t) = \sin(2\pi ft)$ is depicted for $\frac{1}{f}$ seconds. Modulate the bit sequence on the carrier.

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[1]Differential phase shift keying means that the signal is shifted by the given phase relative to the current value.

2. A receiver has sampled the amplitudes 0, 1, 0, 0, -1, 1, 0, 0, 2 at the times depicted in the following diagram.

0 1 0 0 -1 1 0 0 2

Consider every 3-tupel of bits was encoded as follows:

Symbol	Amplitude	Phase Shift
000	1	0
001	2	0
010	1	$\frac{\pi}{2}$
011	2	$\frac{\pi}{2}$
100	1	π
101	2	π
110	1	$\frac{3\pi}{2}$
111	2	$\frac{3\pi}{2}$

Sketch the wave carrier based on the sampled values. Specify the bit sequence that was transmitted.

Problem 4.3: Baud + Coding   *1+1+1 = 3 points*

Two computer are connected over a medium. One of them want to transmit the bits 1011100100
to the second. Assuming there are four signal levels +1V, +0,5V,-0,5V,-1V for a transmission.

1. Which bit rate can be achieved with a baud rate of 4800?
2. How many different codings are possible? Define one.
3. Make a diagram with the defined coding.

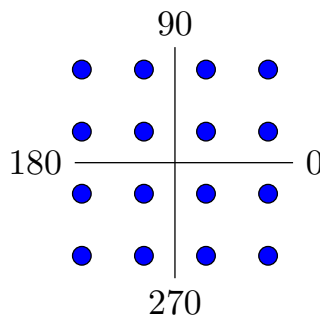## Problem 4.4: Dropping support for analog telephone and ISDN   *2 points*

The telephone company "Magenta" is phasing out support for analog communications and ISDN
and instead deploying VoIP (voice over IP). What is the motivation for this? Why might this
actually be a good thing for most of their customers?

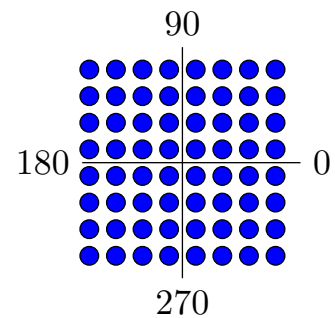## Problem 4.5: Modem bit rates   *1+1+1 = 3 points*
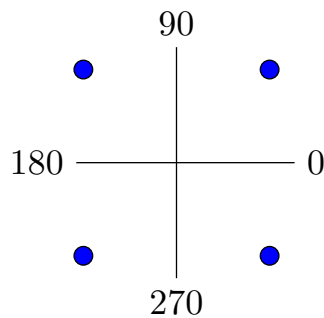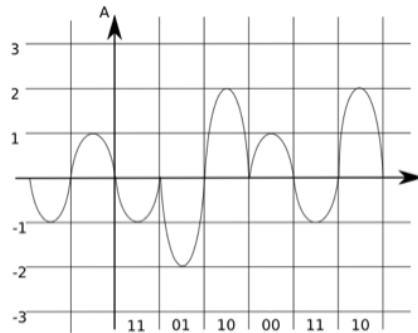

QPSK   QAM-16   QAM-64

Calculate the resulting bitrate of the modulation schemes depicted above when a symbol rate
of 600 baud is used.

a total of 20 points

Blatt 4

4.1. Modulation
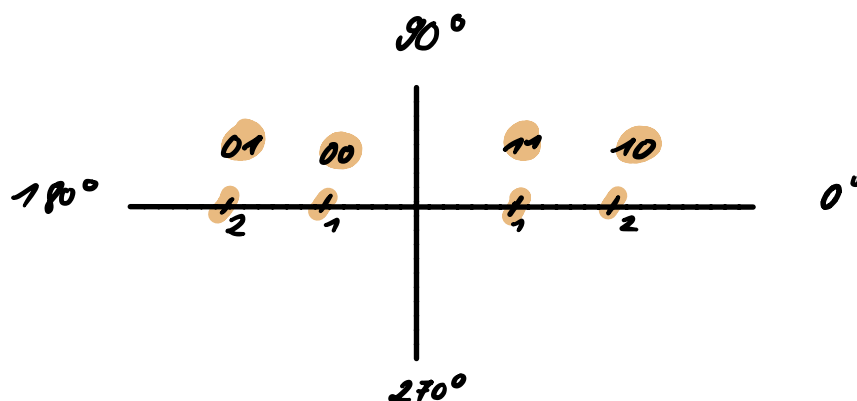
Consider the following modulation diagram.

The signal has already been sampled and demodulated. The symbols are depicted in the modulation diagram. Specify the (de-)modulation table for the applied (de-)modulation scheme. Sketch the corresponding constellation diagram.

We expect this modulation to be a combination of ASk & differential PSk

→ Specify the (de-)modulation table for the applied (de-)modulation scheme

Symbol	Amplitude	Phase Shift
00	1	π
01	2	π
10	2	0
11	1	0

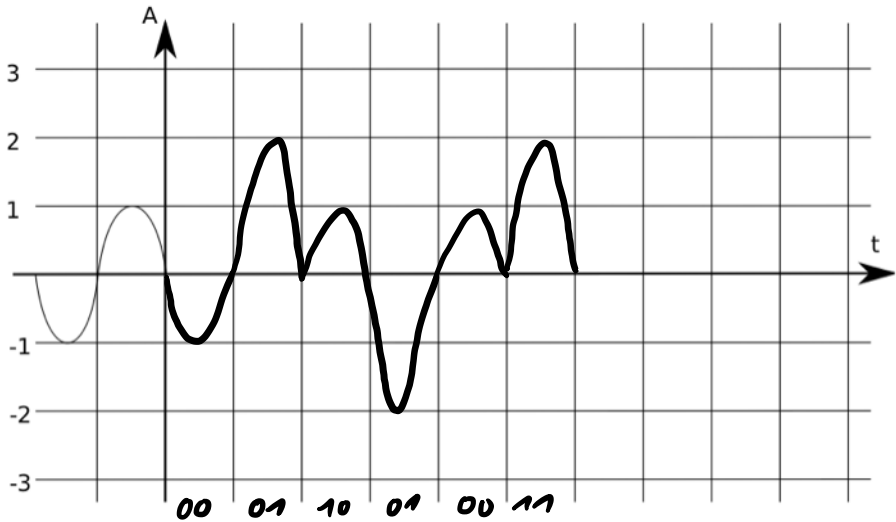→ Sketch the correspoding constellation diagram
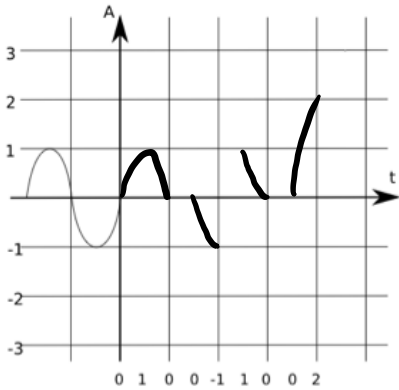
Combination of ASk and PSk :

1. Consider a sender transmits the bit sequence 000110010011. A combination of amplitude shift keying (ASK) and differential phase shift keying (Differential PSK) is applied[1]. The base frequency is f and, for simplicity, each symbol is sent for $\frac{1}{2}T$. The following modulation table is used:

Symbol	Amplitude	Phase Shift
00	1	0
01	2	0
10	1	π
11	2	π

In the following diagram, a sine wave carrier $s(t) = \sin(2\pi ft)$ is depicted for $\frac{1}{f}$ seconds. Modulate the bit sequence on the carrier.

2. A receiver has sampled the amplitudes 0, 1, 0, 0, -1, 1, 0, 0, 2 at the times depicted in the following diagram.

Consider every 3-tupel of bits was encoded as follows:

Symbol	Amplitude	Phase Shift
000	1	0
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Sketch the wave carrier based on the sampled values. Specify the bit sequence that was transmitted.

Problem 4.3: Baud + Coding

$1+1+1 = 3$ points

Two computer are connected over a medium. One of them want to transmit the bits 1011100100 to the second. Assuming there are four signal levels +1V, +0,5V,-0,5V,-1V for a transmission.

1. Which bit rate can be achieved with a baud rate of 4800?
2. How many different codings are possible? Define one.
3. Make a diagram with the defined coding.

1) The bit rate is the product of the baud rate and the bits transported per symbol
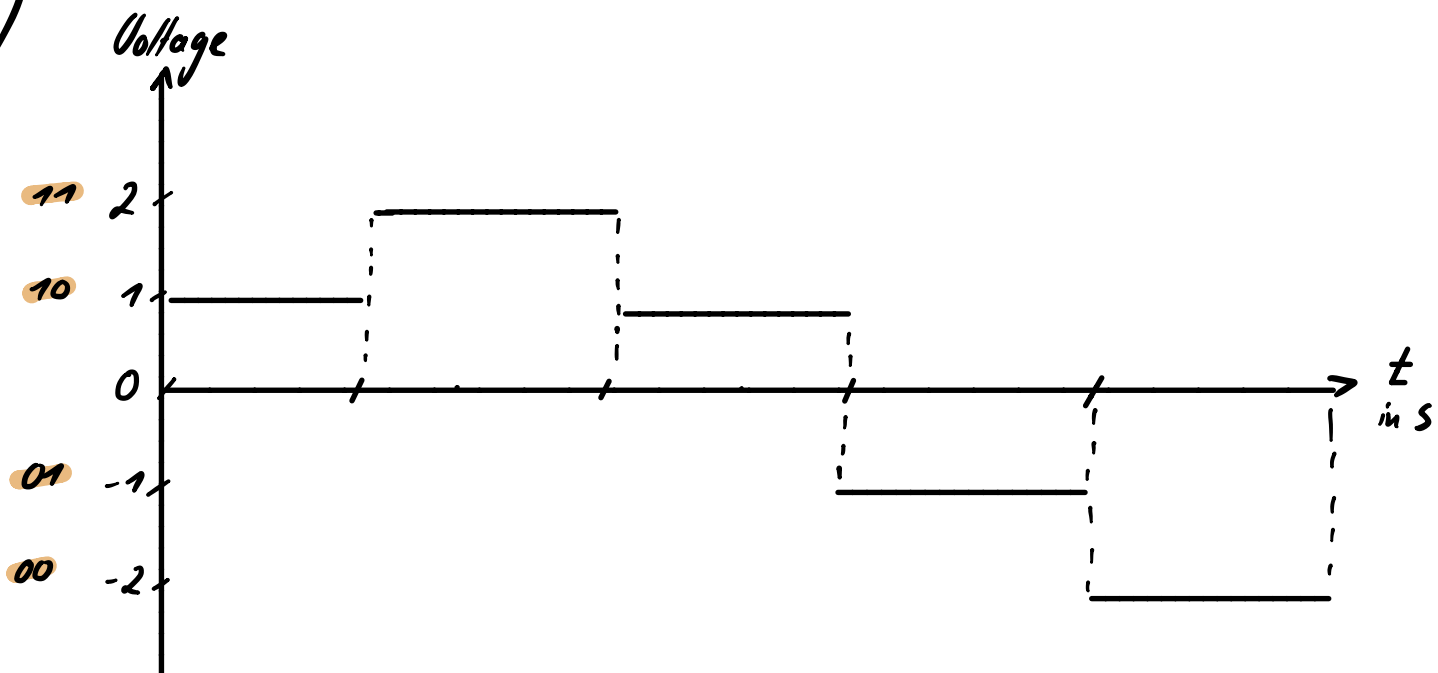
$$ \quad 4800 \cdot 2 = 9600 $$

So $\quad$ 9600 bit/s

2)

Voltage	1V	0,5V	-0,5V	-1V
Value	11	10	01	00

3)

Problem 4.4: Dropping support for analog telephone and ISDN   *2 points*

The telephone company "Magenta" is phasing out support for analog communications and ISDN and instead deploying VoIP (voice over IP). What is the motivation for this? Why might this actually be a good thing for most of their customers?

With the change to VoIP the high bandwith network of "Magenta" will be expanded, because it's needed for VoIP. So the customer will have a higher bit rate for his internet connection.

Because the VoIP technology is based on the internet, the intercontinental communication is much easier and the price for those type of calls will probably fall.

The motivation for Magenta is, to eliminate PSTN (Public Switched Telephone Network) because it's expensive. Right now they have to supply the customer with PSTN and a broadband internet connection. With VoIP they only need to supply a broadband internet connection, which is less expensive.

4.5)

QPSK $\rightarrow$ 2 bits   per symbol

QAM-16 $\rightarrow$ 4 bits per symbol

QAM-64 $\rightarrow$ 6 bits per symbol

BAUD RATE = 600 baud

2.   QPSK $\rightarrow$ 1200 bps

QAM-16 $\rightarrow$ 2400 bps

QAM-64 $\rightarrow$ 3600 bps