

UESTC4004

Digital Communications

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Lecture Preview

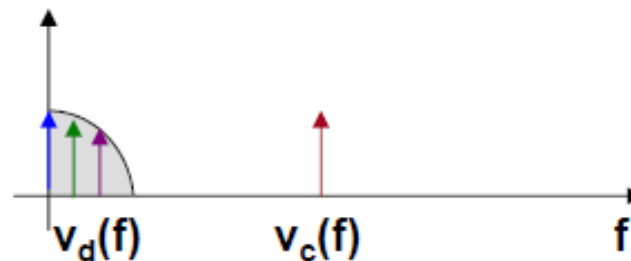
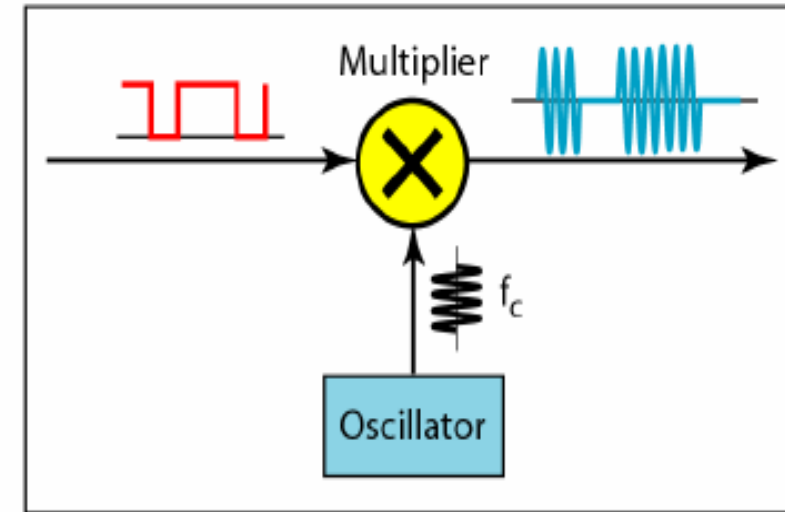
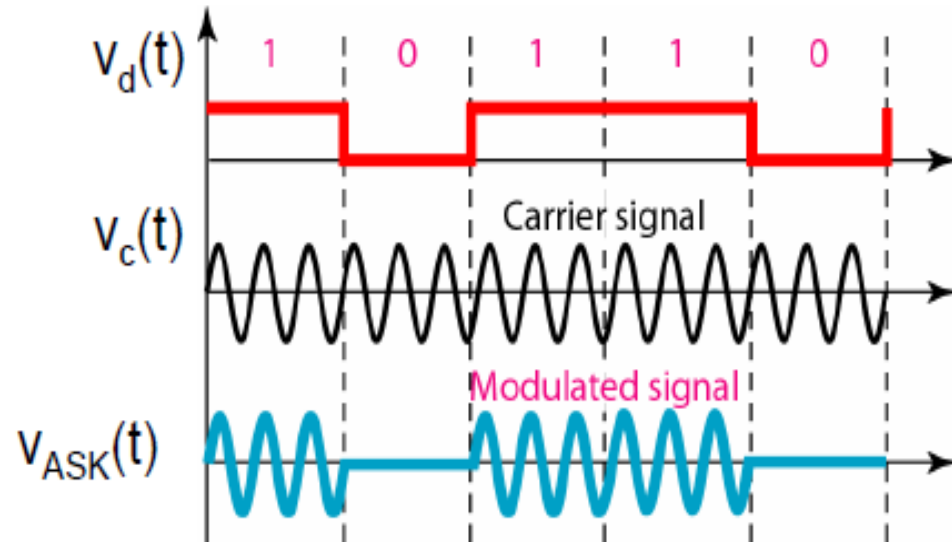
- Baseband vs Passband Communication
 - What is passband communication
 - Why we perform passband communication
 - How the passband communication is made possible
- Binary modulation
 - Amplitude Shift Keying
 - Frequency Shift Keying
 - Phase Shift Keying
- M-ary Modulation
 - Quadrature Phase Shift Keying

Modulation

- The process of 'riding' the information over the carrier.
- Why we perform modulation?
 - Ease of transmission
 - Multiplexing

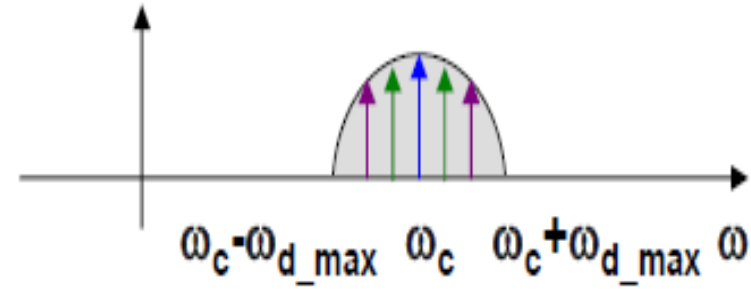
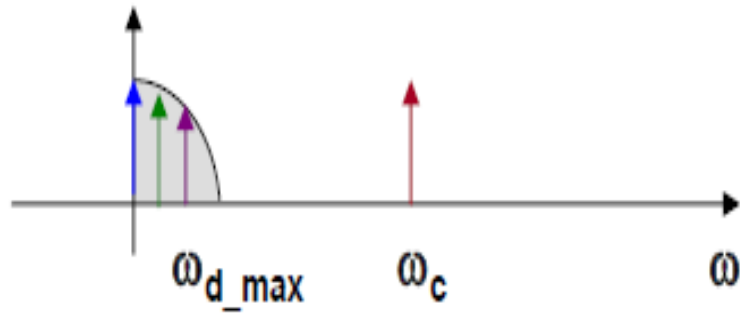
Binary Amplitude Shift Keying (B-ASK)

The amplitude of the modulated signal changes with the change in data bits.



B-ASK

How the spectrum looks like after modulation?



Example: M-ary ASK

- Consider ASK modulation with 4 levels, -3, -1, 1 and 3.
- Plot the 4-ary timing waveform for a random binary sequence. Then modulate the information signal with a carrier of f_c Hz. Represent the modulated signal in both time and frequency domain.

ASK Demodulation and Applications

Demodulation: need to confirm the presence or absence of a sinusoid in a given time interval

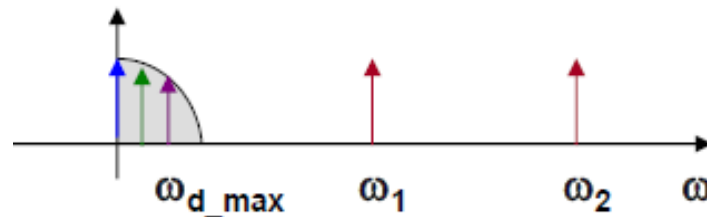
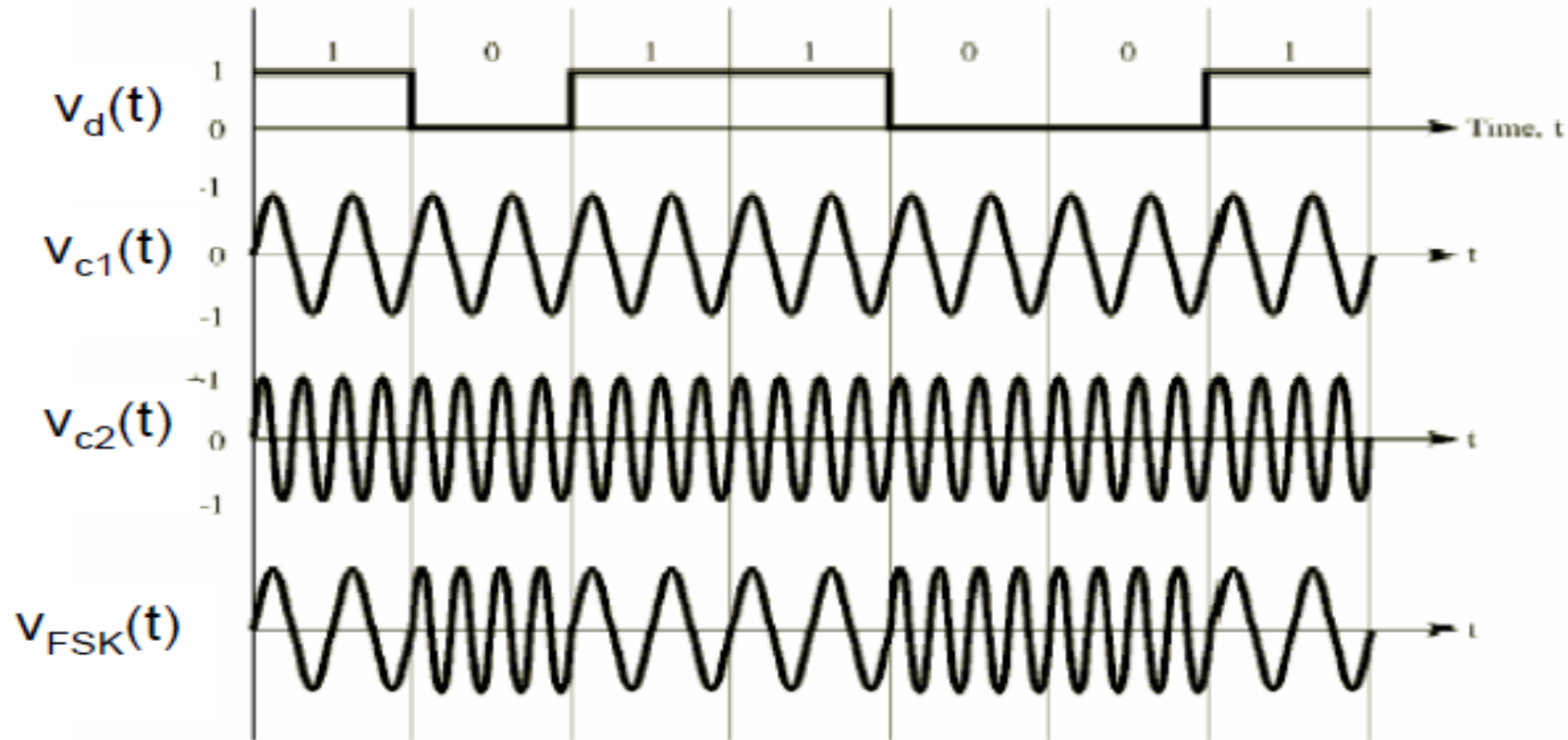
Advantages: simplicity

Disadvantages: very susceptible to noise interference because noise affects the amplitude

Applications: used to transmit digital data over optical fibre

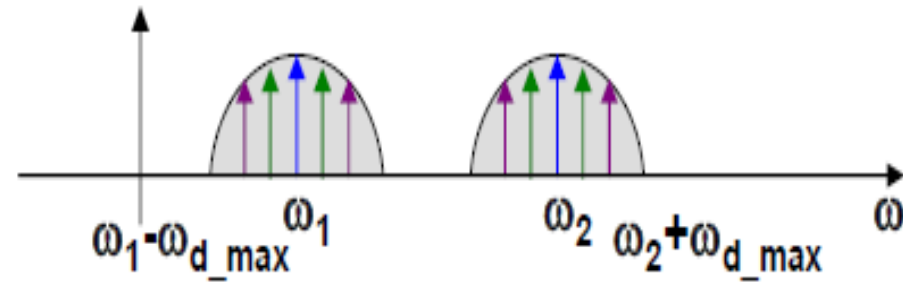
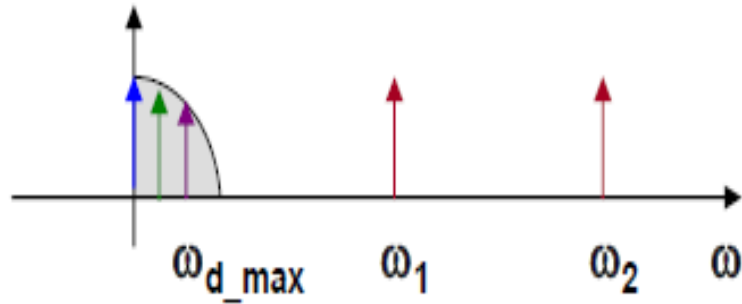
Binary Frequency Shift Keying (B-FSK)

The frequency of the modulated signals changes with the change in data bits.



B-FSK

How the spectrum looks like after modulation?



Example: M-ary FSK

- Consider 4-ary FSK with f_{c1} , f_{c2} , f_{c3} and f_{c4} .
- Plot the 4-ary timing waveform for a random binary sequence. Then modulate the information signal using 4-ary FSK. Represent the modulated signal in both time and frequency domain.

FSK Demodulation and Applications

Demodulation: need to determine which of the two possible frequencies is present at a given time

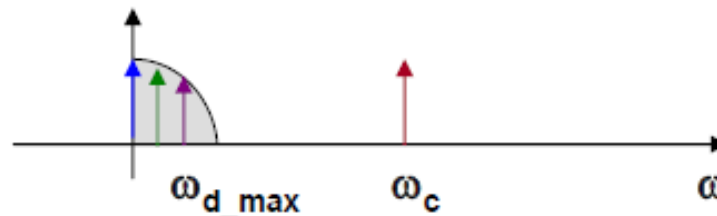
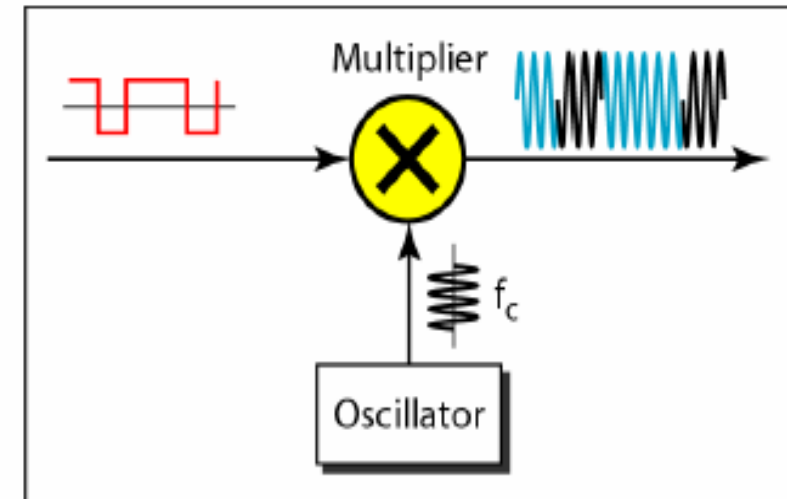
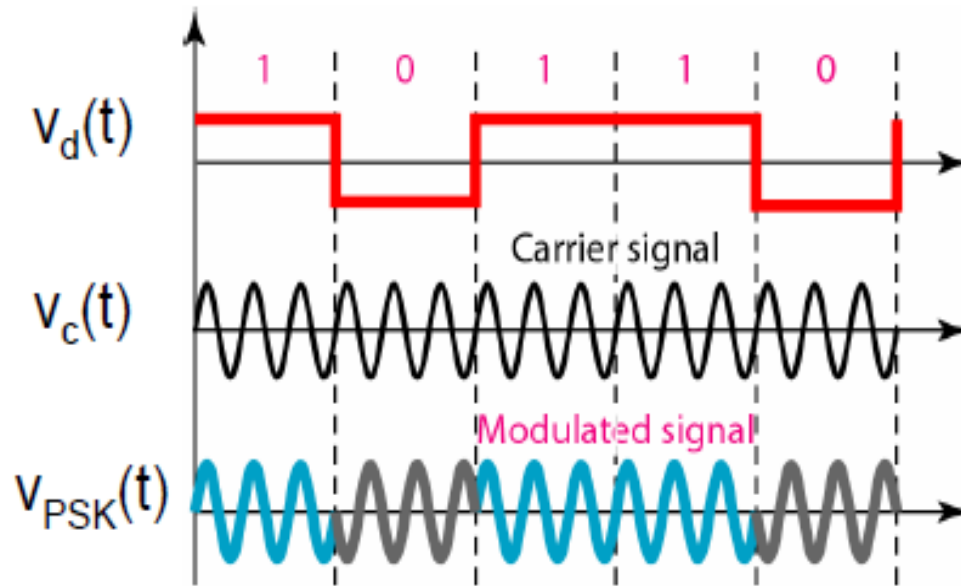
Advantages: less susceptible to errors than ASK. Receiver looks for specific frequency changes over a number of intervals so amplitude(noise) spikes can be ignored.

Disadvantages: uses twice the bandwidth as compared to ASK

Applications: over voice lines, in high frequency radio transmission etc.

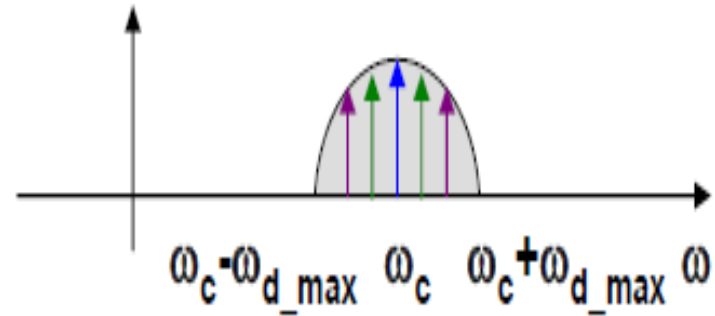
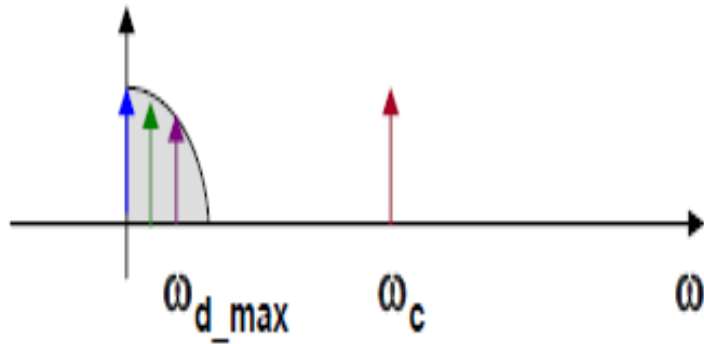
Binary Phase Shift Keying (BPSK)

The modulated signal's phase changes with the change in data bits.



BPSK

How the spectrum looks like after modulation?



PSK

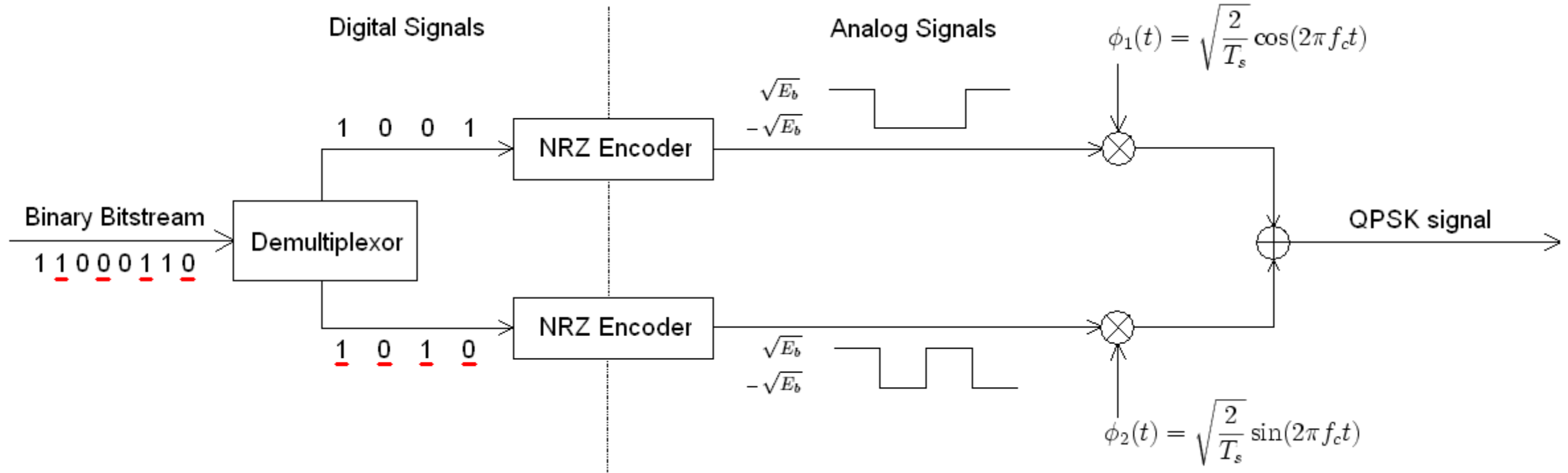
Demodulation: demodulator must determine the phase of the received sinusoid with respect to some reference phase

Advantages: less susceptible to errors than ASK, while it occupies the same bandwidth as ASK. It means more efficient use of bandwidth is possible compared to FSK which may result in higher data rates.

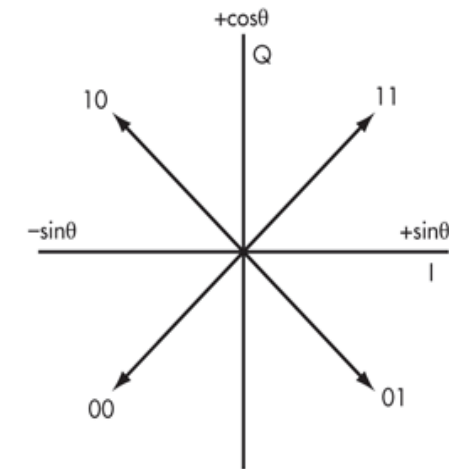
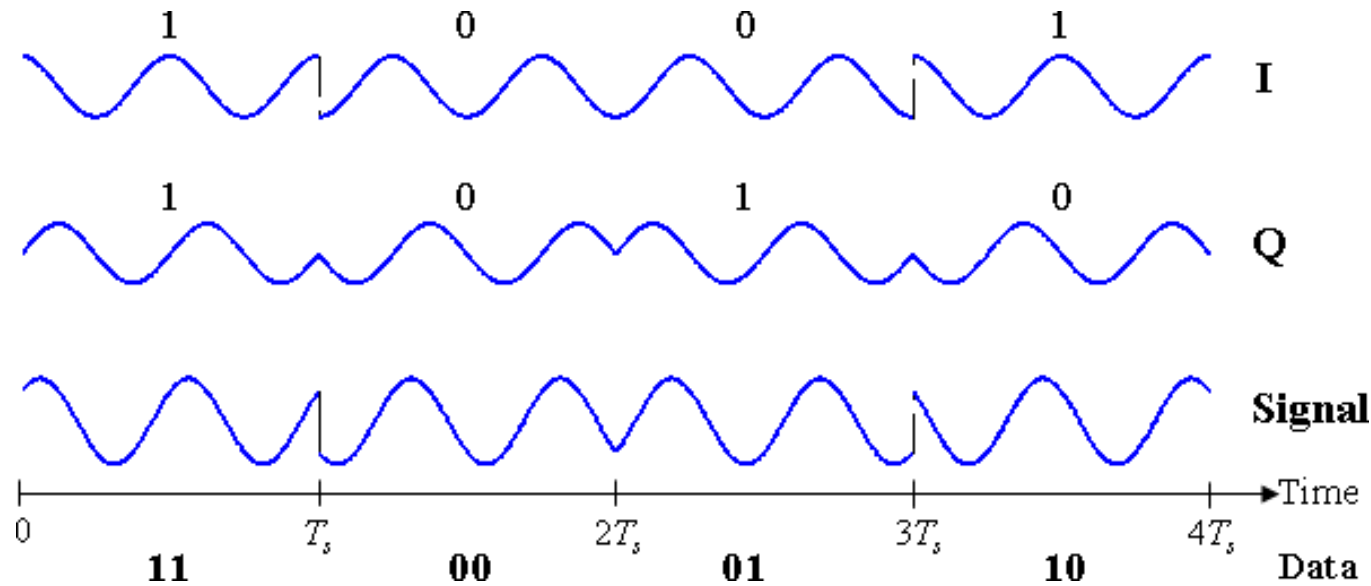
Disadvantages: more complex signal detection/recovery process than ASK and FSK

Applications: variants of PSK are used in several wireless systems including WLAN, Bluetooth etc.

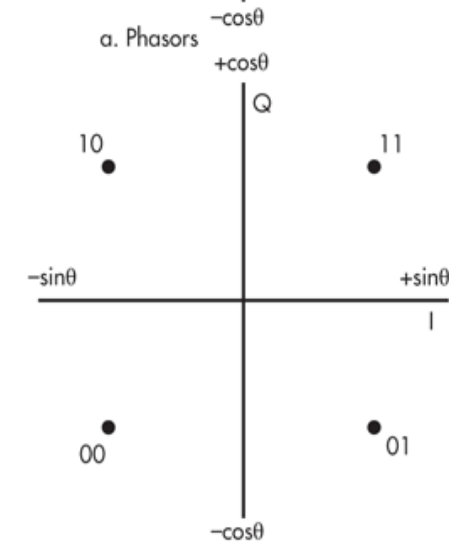
4-ary PSK or QPSK (Quadrature Phase Shift Keying)



QPSK – Constellation Diagram



a. Phasors



Input bits	Output phase
00	-135°
01	-45°
10	$+135^\circ$
11	$+45^\circ$

b. Table

Note:
 $\theta = 2\pi f t$

QPSK

- **Advantages:** higher data rate than BPSK (2 bits per symbol interval), while bandwidth occupancy remains the same.
- 4-PSK can be easily extended to 8-PSK or more.
- However, higher rate PSK schemes are limited by the ability of equipment to distinguish small differences in phase.

Review Questions

- What is binary modulation?
- How ASK is different than PSK?
- Is FSK better than ASK with regards to bandwidth utilisation?
- Make the constellation diagram from BPSK.