ELC 406A
Advanced Digital Communication

Lecture 1

Introduction

Dr.Yasmine Fahmy
ELC 406A

Course Information

- Instructors:
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  - Dr. Yasmine Fahmy

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- Office Hour: Wed 12:00 to 2:00

Course Information

- Assessment System:
  - Mid-Term Exam **20%**
  - Matlab Project **10%**
  - Final Exam **70%**

Course Information

Reference:

"Communication Systems" , S. Haykin, 4th Edition, John Wiley & Sons (2001).

Intended Learning Outcomes

- Describe the concepts, features and applications of advanced digital communication systems

(DSL, OFDM, Spread Spectrum, CDMA)

- Know the transmitter and receiver block diagrams of advanced communication systems
- Analyze and compare the parameters of advanced communication systems.

Intended Learning Outcomes

- Understand the anti-jamming abilities of Spread Spectrum
- Understand the use of Spread Spectrum in ranging.
- Compare different multiple access techniques (FDMA, TDMA, CDMA).

Intended Learning Outcomes

- Know the channel parameters.
- Know the effect of the channel parameter on the transmitted signal.
- Compare the channel based on parameters and performance

Intended Learning Outcomes

- Use of MATLAB in handling problems related to advanced digital communication systems.
- Perform experiments in the Lab to demonstrate concepts of advanced digital communication systems.
- Ability to cumulative knowledge.
- Develop skills related to creative thinking, problem solving, oral and written communication.
- Work effectively in team.
- Interactive learning and class participation.

Course Contents (Part 2)

- Direct Sequence Spread Spectrum (DSSS)
- Frequency Hopping Spread Spectrum (FHSS)
- PN sequence generators
- Immunity to jamming
- Multiple Access Techniques (FDMA, TDMA, CDMA)
- Use of SS in ranging
- Synchronization of SS

Merits of Spread Spectrum

- Security: low probability of detection
- Privacy: low probability of comprehend
- Jamming: Anti-jamming immunity

- Multiple Access (Suppress MAI)
- Multipath diversity

- Radar and Navigation

What Is Spread Spectrum?

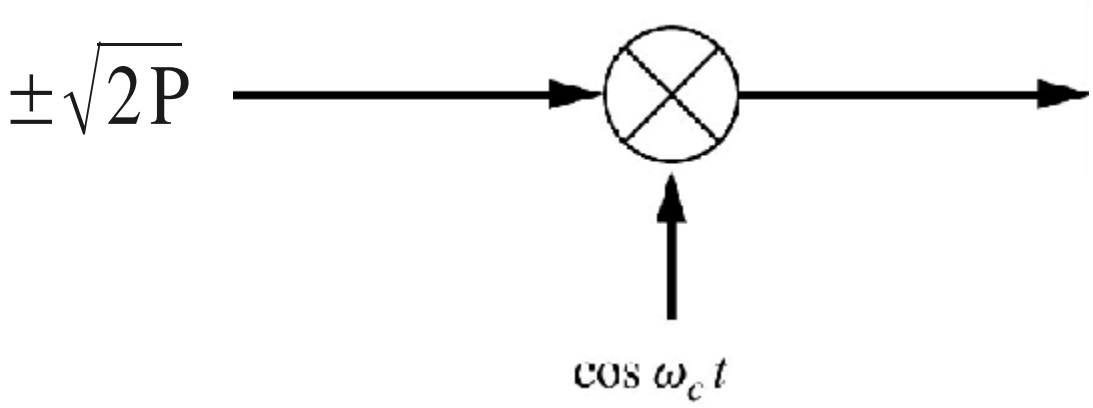
- Data is spreaded at the transmitter to occupy a larger Bandwidth than the minimum Bandwidth required through the use of a code that is independent of the data sequence.
- At the receiver, the received signal is de-spreaded using the same code to recover the original signal.

Spread Spectrum Types

- Direct Sequence Spread Spectrum
  - DS-SS
- Frequency Hopping Spread Spectrum
  - Slow (SFH-SS)
  - Fast (FFH-SS)

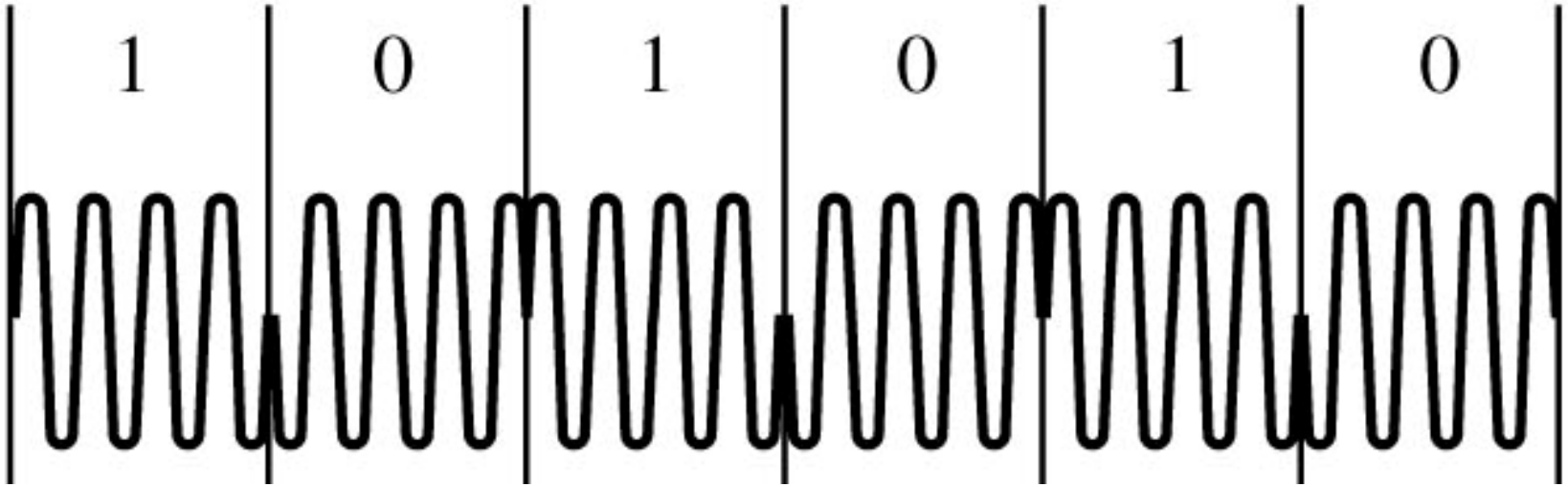
Revision: a simple system

- Transmitter



Revision: a simple system

- Transmitted signal (Time)



2PSK

2PSK : Equations

- $s_1(t) = \sqrt{2P}\cos(\omega_c t + 2\pi.\theta_1)$

  $s_0(t) = \sqrt{2P}\cos(\omega_c t + 2\pi.\theta_0)$

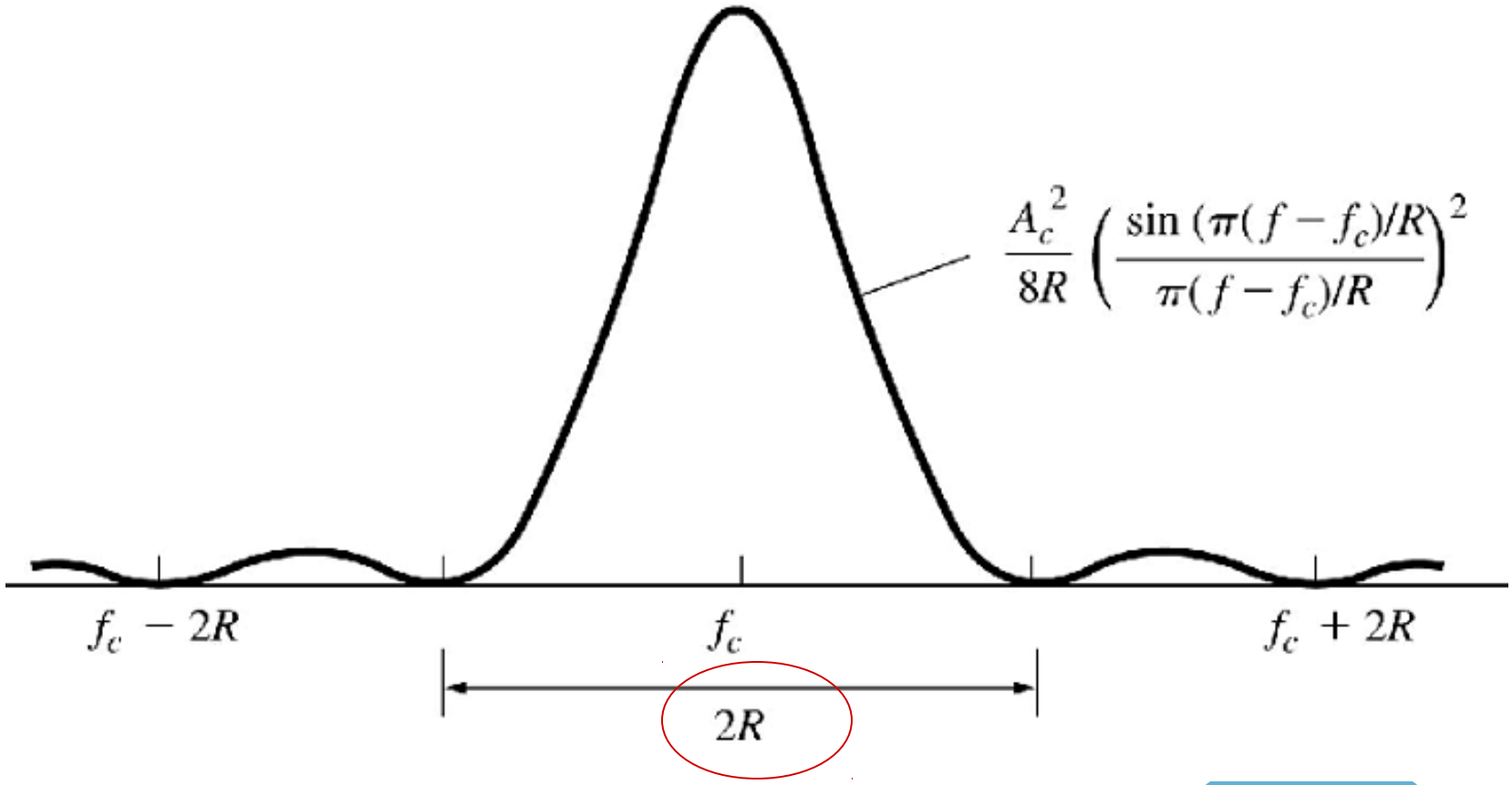
$\theta_1 = 0$

$\theta_0 = \frac{1}{2}$

- $s_1(t) = \sqrt{2P}\cos(\omega_c t)$

  $s_0(t) = \sqrt{2P}\cos(\omega_c t + \pi) = -\sqrt{2P}\cos(\omega_c t)$

2PSK : Power Spectral Density



PSK : Transmission Bandwidth

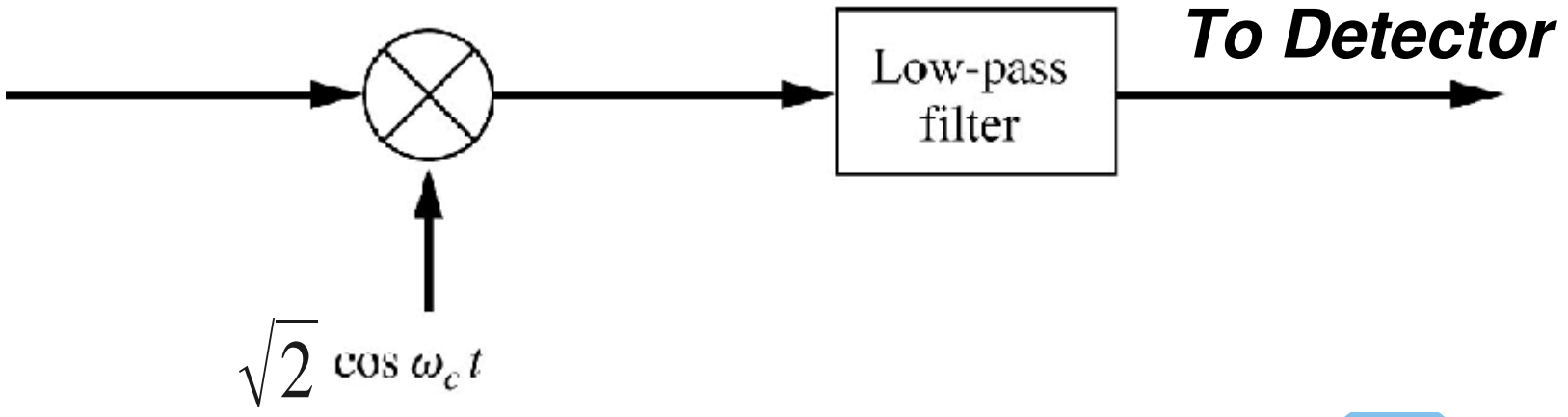
$$BW = (1 + \eta) R$$

$$BW = BW$$

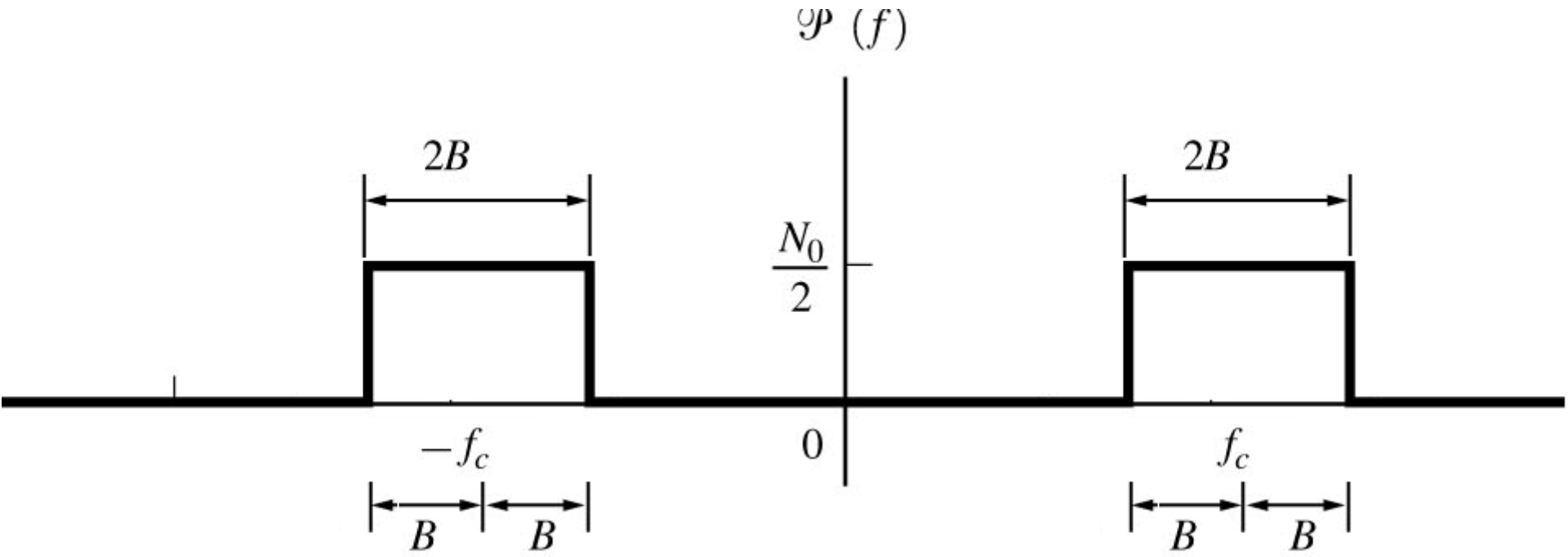
2PSK : Demodulator

$$x_i(t) = \pm\sqrt{2P}\cos(\omega_c t)$$

$$r_i(t) = \pm\sqrt{2P}\cos(\omega_c t) + n(t)$$



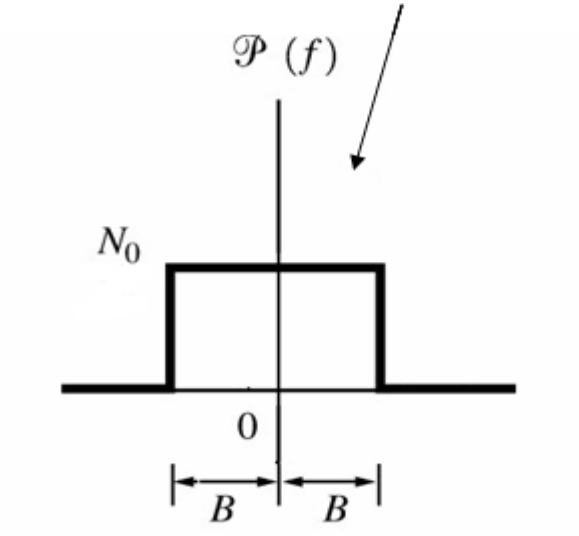
BandPass AWGN

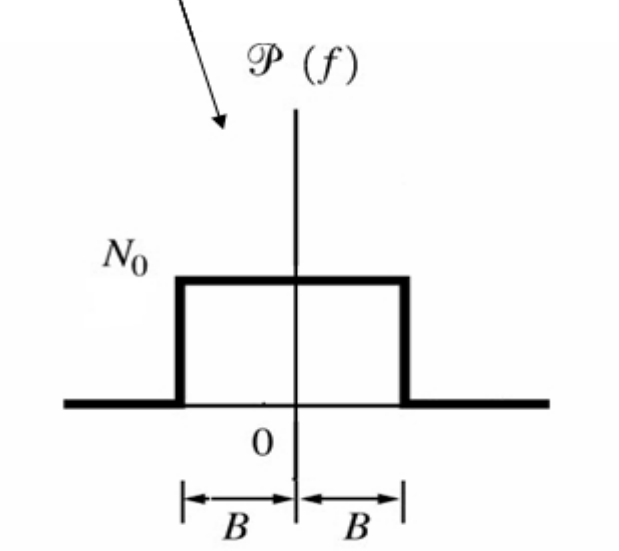


BandPass AWGN

- Quadrature Representation

$$n(t) = n_c(t)\cos(\omega_c t) - n_s(t)\sin(\omega_c t)$$





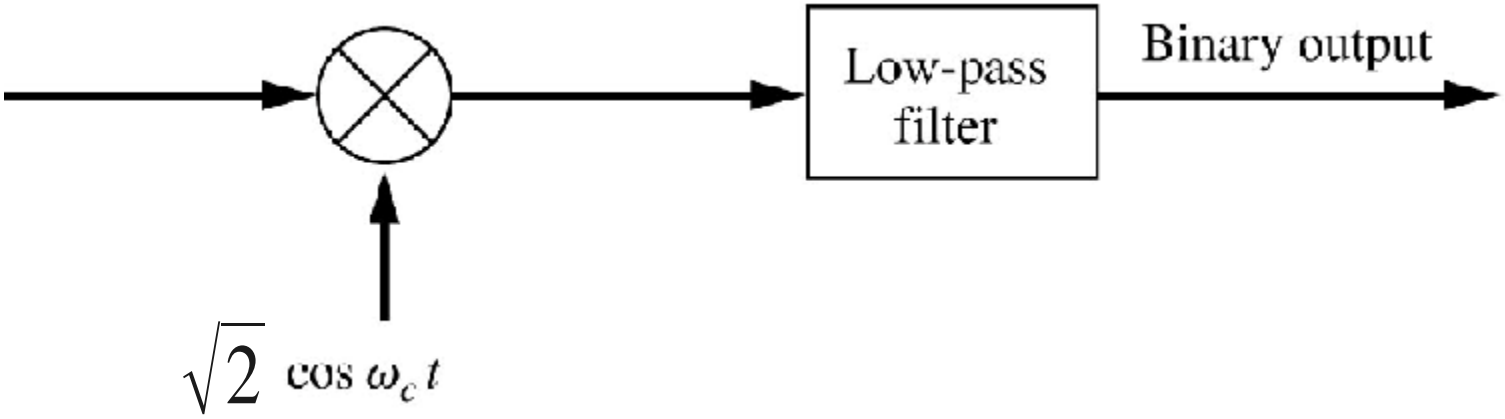
2PSK : Demodulator equations

$$x_i(t) = \pm\sqrt{2P}\cos(\omega_c t)$$

$$r_i(t) = \pm\sqrt{2P}\cos(\omega_c t) + n(t)$$

$$r_i(t) = \pm\sqrt{2P}\cos(\omega_c t) + n_c(t).\cos(\omega_c t) - n_s(t).\sin(\omega_c t)$$

2PSK : Demodulator equations



$$r_i(t).\sqrt{2}\cos(\omega_c t) = \pm 2\sqrt{P}\cos^2(\omega_c t)$$
$$+\sqrt{2}n_c(t).\cos^2(\omega_c t) - \sqrt{2}n_s(t).\sin(\omega_c t).\cos(\omega_c t)$$

2PSK : Demodulator equations

$$d_i = \frac{\sqrt{2}}{T}\int r_i(t).\cos(\omega_c t).dt$$

$$= \frac{\pm 2\sqrt{P}}{T}\int \cos^2(\omega_c t).dt$$

$$+\frac{\sqrt{2}}{T}\int n_c(t).\cos^2(\omega_c t).dt$$

$$-\frac{\sqrt{2}}{T}\int n_s(t).\sin(\omega_c t).\cos(\omega_c t).dt$$

2PSK : Demodulator equations

$$d_i = \frac{\sqrt{2}}{T} \int r_i(t).\cos(\omega_c t).dt$$

$$= \pm\sqrt{P} + \frac{1}{\sqrt{2}.T} \int n_c(t).dt + \text{zero}$$

2PSK : Demodulator

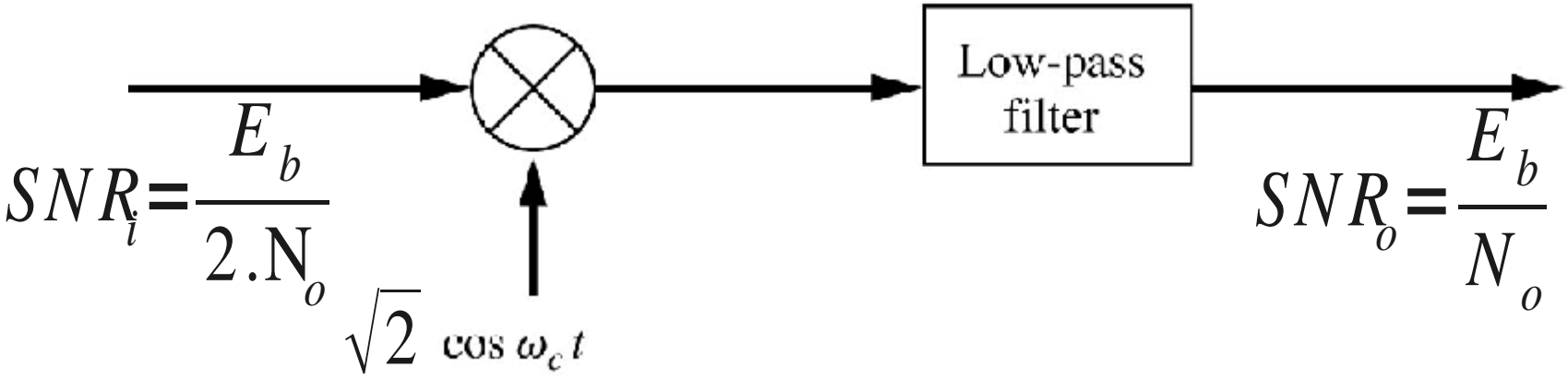
- $r_i(t) = \pm\sqrt{2P}\cos(\omega_c t) + n(t)$

$$SNR_i = \frac{P.T_b}{2.N_o}$$

- $d_i = = \pm\sqrt{P} + \frac{1}{\sqrt{2}.T}\int n_c(t).dt$

$$SNR_o = \frac{P.T_b}{N_o}$$

2PSK : Demodulator



$$P_e = \frac{1}{2} erfc\left(\sqrt{\frac{E_b}{N_o}}\right) = Q\left(\sqrt{\frac{2E_b}{N_o}}\right)$$

Activities for next lecture

- Think about:
  - 4 PSK
  - DS-SS