Communication Theory - 2026

CDMA 시스템과 Viterbi 복호화

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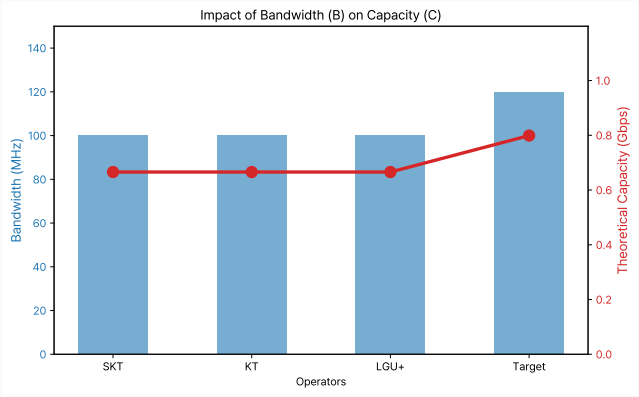
Introduction

Python과 LaTeX의 완벽한 분리(Decoupling)를 통한
안정적인 강의 자료 시스템입니다.

강의 범위 및 시각화 계획 (Lathi Ch 1-7)

- **Ch 1-3:** 신호와 시스템 (Time/Freq Plot)
- **Ch 4-5:** 아날로그 변조 (AM/FM Waveform)
- **Ch 6-7:** 디지털 통신 (Sampling, Constellation)

Chapter 01. Why Bandwidth is Revenue



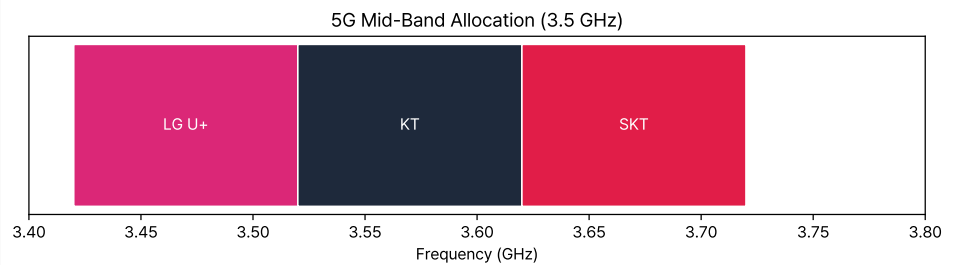
Shannon-Hartley Theorem

$$C = \mathbf{B} \log_2 \left(1 + \frac{S}{N}\right)$$

Key Insight:

- **Bandwidth (B):**
  Capacity와 선형(Linear) 비례
  → "돈으로 대역폭을 사는 이유"
- **Power (*S*):**
  Capacity와 로그(Log) 비례
  → "효율 체감의 법칙"

Practical Application: 5G Spectrum in Korea



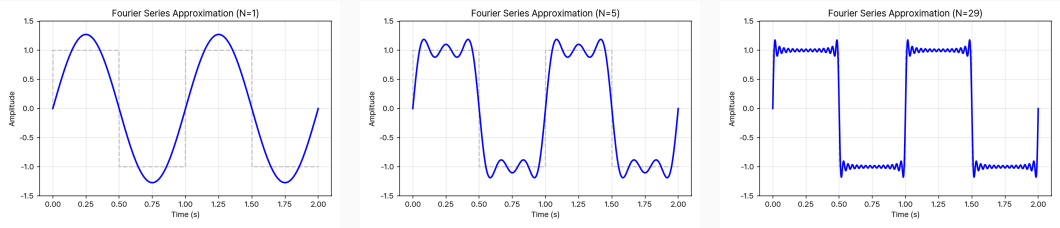
Shannon-Hartley Theorem in Practice

$C = \mathbf{B} \log_2(1 + SNR)$

- **mmWave (28GHz):** B = 800MHz → Ultra-high Capacity
- **Sub-6 (3.5GHz):** B = 100MHz → National Coverage

Observation: 광대역 연속 블록 확보가 스펙트럼 효율의 핵심입니다.

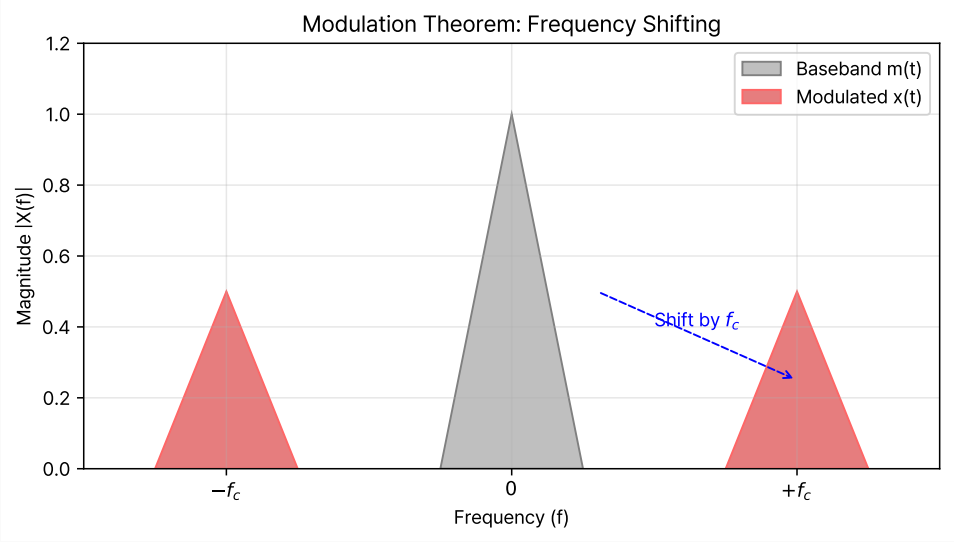
Chapter 2 Preview: The Fourier Series



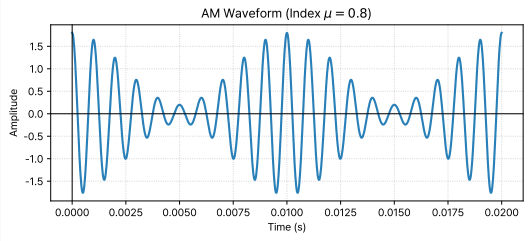
(a) N=1 (Fundamental) **(b)** N=5 (Adding Harmonics) **(c)** N=29 (Square Wave)

Figure 1: Gibbs Phenomenon visualized using Python

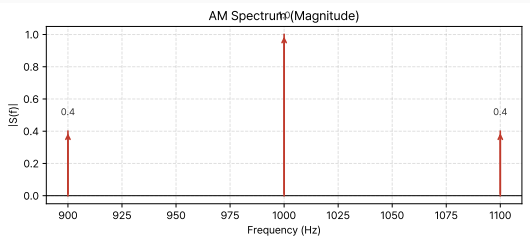
- We will learn how to decompose any signal into simple sine waves.


Modulation Theorem: Frequency Shifting
Baseband m(t)
Modulated x(t)
Shift by f_c
Magnitude |X(f)|
1.2
1.0
0.8
0.6
0.4
0.2
0.0
$-f_c$
0
$+f_c$
Frequency (f)

Time Domain

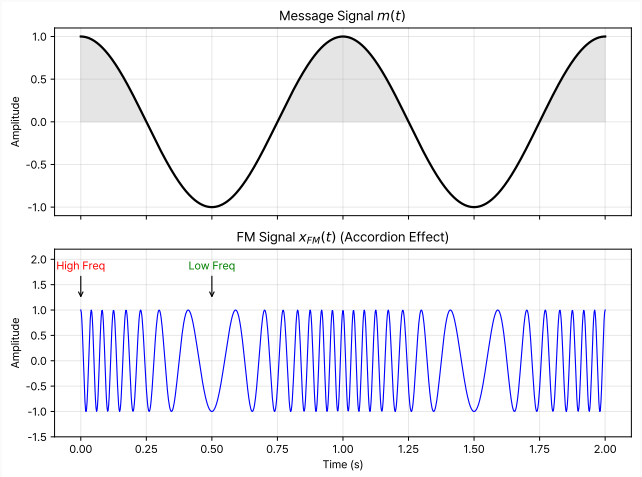


Frequency Domain



AM 신호는 시간 영역의 포락선(Envelope)과 주파수 영역의 측파대(Sidebands)로 해석됩니다.

Chapter 4. Frequency Modulation (FM)



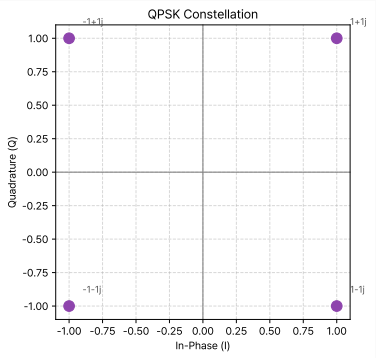
The "Accordion" Effect

- **High Amplitude:**
  → 주파수가 높아짐
  (파형이 촘촘해짐, Compressed)

- **Low Amplitude:**
  → 주파수가 낮아짐
  (파형이 느슨해짐, Relaxed)

Insight: 진폭(*Amplitude*)은 일정하므로 잡음(*Noise*)에 강합니다.

Chapter 7. Digital Modulation (QPSK)



QPSK 특징:

- 2 bits per symbol
- 4개의 위상 상태
- 대역폭 효율성 증대

강의 Recap.

- Python을 통한 신호 생성 및 시각화
- LaTeX Beamer로 안정적인 프레젠테이션 제작
- $C = \mathbf{B} \log_2 \left(1 + \frac{S}{N}\right)$
- 통신 이론의 핵심 개념들을 시각적으로 이해