

Communication Theory - 2026

Chapter 2. Signals and Signal Space

이 경 근

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EE / KNU

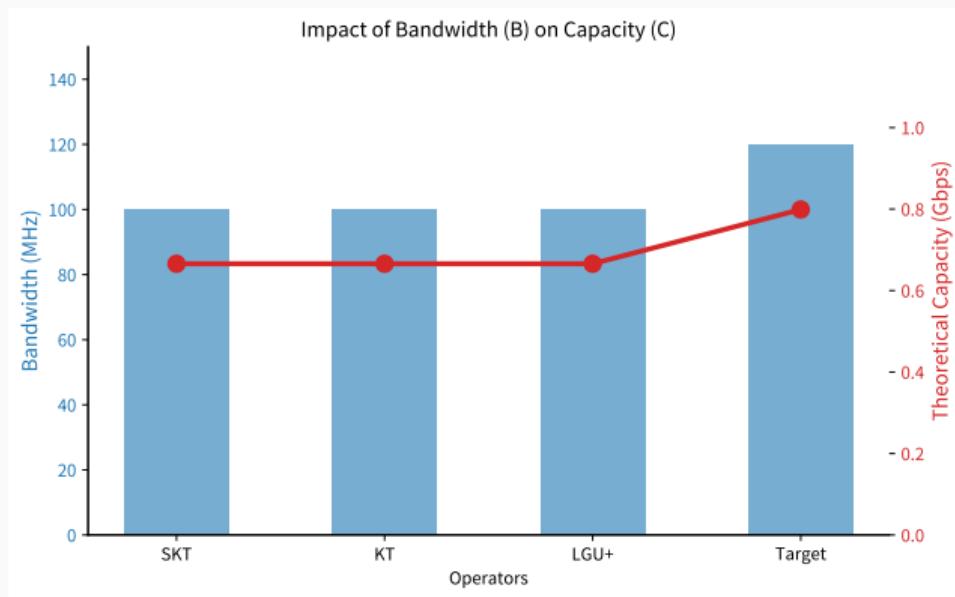
Introduction

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



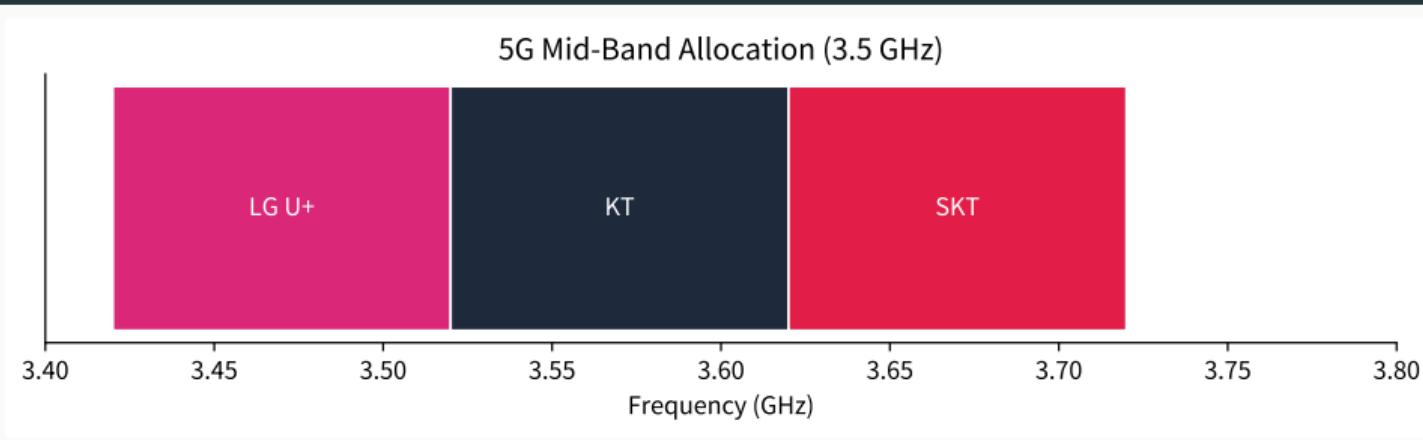
Shannon-Hartley Theorem

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

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



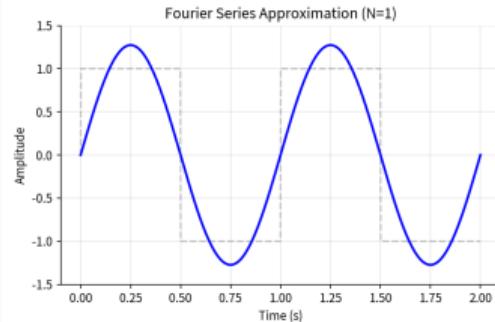
Shannon-Hartley Theorem in Practice

$$C = B \log_2(1 + SNR)$$

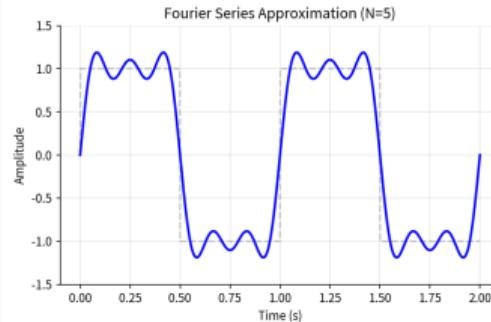
- **mmWave (28GHz):** $B = 800\text{MHz} \rightarrow$ Ultra-high Capacity
- **Sub-6 (3.5GHz):** $B = 100\text{MHz} \rightarrow$ National Coverage

Observation: 광대역 연속 블록 확보가 스펙트럼 효율의 핵심입니다.

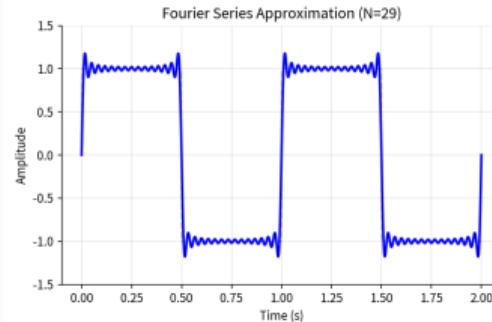
Chapter 2 Preview: The Fourier Series



(a) N=1 (Fundamental)



(b) N=5 (Adding Harmonics)

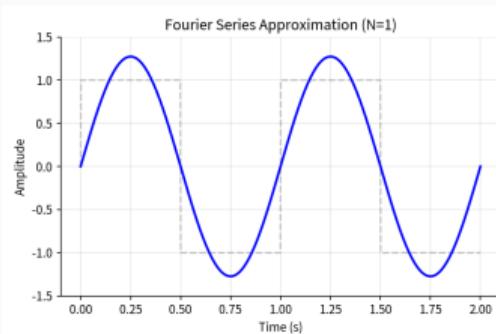


(c) N=29 (Square Wave)

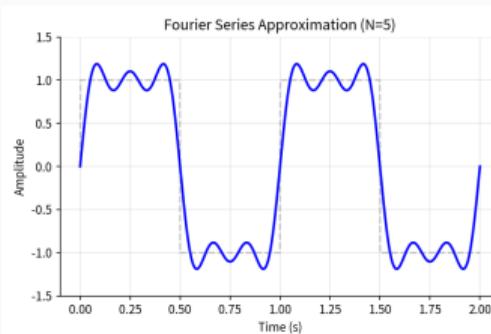
Figure 1. Gibbs Phenomenon visualized using Python

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

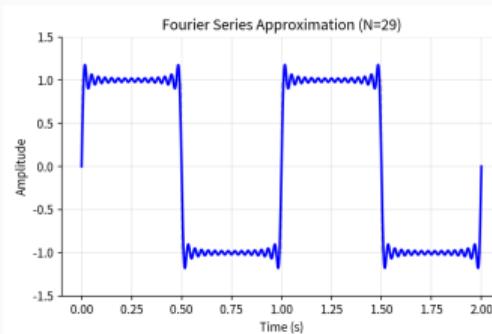
Chapter 2 Preview: The Fourier Series



(a) N=1



(b) N=5

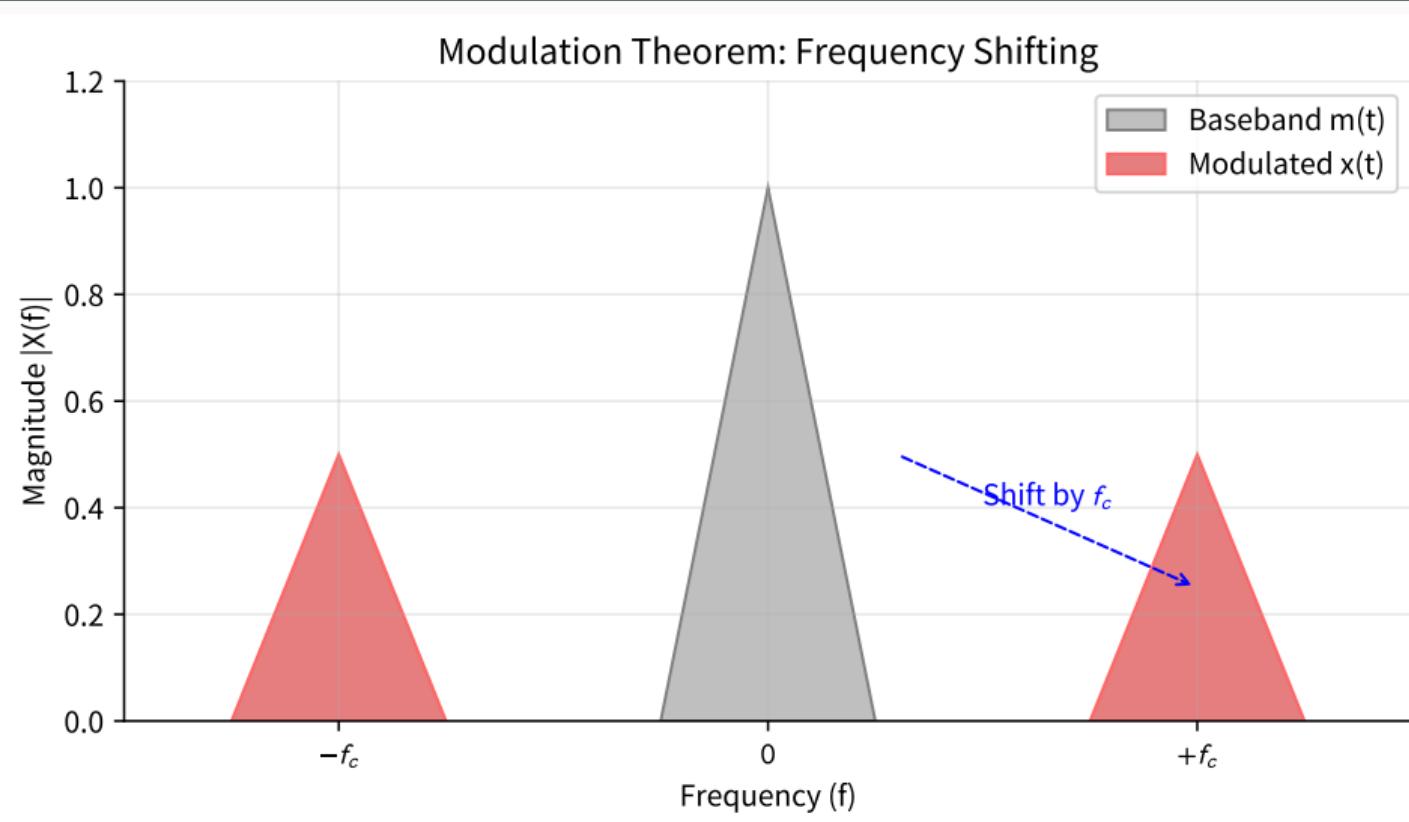


(c) Square Wave

Figure 2. Click here to play Animation

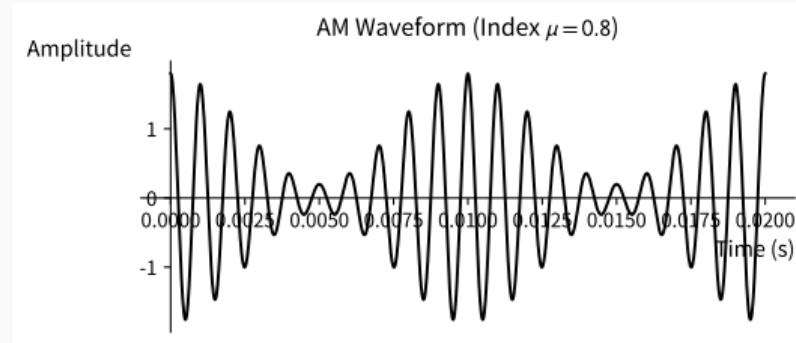
- We will learn how to decompose any signal into simple sine waves.

Chapter 3. Amplitude Modulation (AM)



Chapter 4. Amplitude Modulation

Time Domain

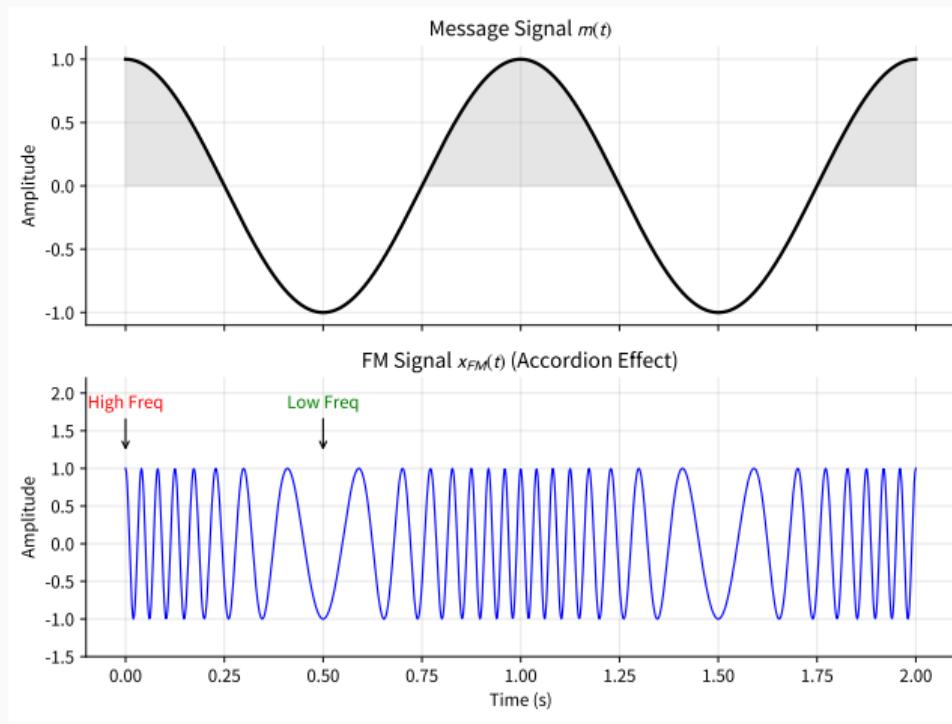


Frequency Domain



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

Chapter 4. Frequency Modulation (FM)

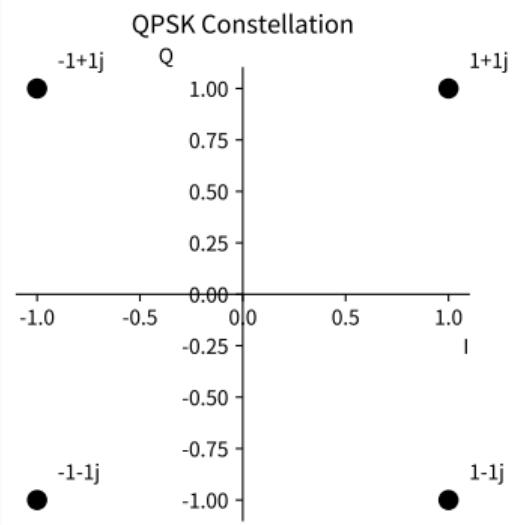


The "Accordion" Effect

- **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
- $C = B \log_2 \left(1 + \frac{S}{N}\right)$
- 통신 이론의 핵심 개념들을 시각적으로 이해