Contents

[Lecture on 1.2]

1 Introduction

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1.1 Motivation and Introduction

1. Signals travel without wires
   (a) In this module, signals travel as radio waves (optical and acoustic systems ignored)
2. Applications are mostly in communications
   (a) Signals modulated to carry information
   (b) Many familiar applications such as radar, navigation, etc.

Example: Modern smart phone has approximately 9 distinct wireless systems. Try identifying them?

- NFC
- Cellulars
  - 2G
  - 3G
  - 4G
  - 5G
- GPS
- Bluetooth

- WiFi
- UWB
- Lidar

Advantages of Wireless

- Mobility
- Good for one-to-many transmissions
- Cheap

Increasingly used for high capacity point-to-point links (cheaper than wired) (e.g. to serve remote areas)

Advantages of Wired

- Very little leakage
- No interference
- Multiple systems can operate adjacently without issue

but considerably more overheads. Suitable for super high capacity lines (eg. fibre-optic transatlantic cables)

1.2 The Wireless Spectrum

The EM spectrum is a shared and limited resource.
Mostly regulated by government agencies.

Frequencies must be carefully given out, but can be reused at different locations as we will see.

Overview of a wireless system:

- Start with raw data
- Source coding (compression)
- Channel coding (error detection & error correction)
- Modulation
- TX
- RX
- Demodulation
- Channel decoding
- Source decoding

This module is mainly about modulation and TX/RX, the rest is information theory.

1.3 Basics of Wireless Transmitter

Amplifier to increase signal power enough to drive the antenna

Multiple Access

- CSMA: Listen to the channel, send if it's clear
- FDMA: Frequency divided MA
- TDMA: Time divided MA

1.4 Assessment & Delivery

Component	**Timing**	**Weight**
Lab Assignments	Varied (4 labs)	25%
Online BS quizzes	?	25%
Final Exam		50%

Open book final with emphasis on design and problem solving

1.5 Module Outline

- (1) Radio Link Design
  - Link budget?
  - How far? How much power?
- (2) Non-linear System
- (3) Frequency Generation and Synthesis
- (4) Transmitter Design
  - Requirements and specifications
  - Transmitter architecture choices
- (5) Noise
  - Sources of noise
  - Noise analysis, low-noise design
- (6) Receiver Design
  - Requirements and specifications
  - Receiver architecture choices
- (7) Transceiver Design

  - Transmitter and receiver combined!
- (8) Antennas and Propagation
  - Review of antenna theory
  - Practical antennas and propagation of radio waves
- (9) System-Level Issues and Examples

1.6 Textbooks

Purely optional, module notes should be sufficient.

- "Microwave and RF Design of Wireless Systems"
  by David M. Pozar
- "Antennas"
  by John D. Kraus