Wireless communications are present in many services:

- cellular telephone
- WLAN
- paging
- cordless phone
- broadcast
- sensor networks
- ad-hoc networks
- body area networks
- smart devices & IOT
- home area networks

These services have different requirements in terms of:

- data rate
- range and number of users
- mobility
- energy consumption
- use of spectrum
- quality of service: outage, latency

However, they share a common set of technical challenges:

- multipath propagation and fading
- limited spectrum
- limited power/energy
- user mobility
- noise and interference
This course provides the theory of wireless communications:
- understand wireless propagation and channel models
- examine the capacity of wireless communication
- study techniques to combat fading
- study MIMO techniques with multiple antennas
- study multiple access techniques, particularly OFDMA
- examine modern wireless systems with multiple users

The course focuses on a theoretical foundation of wireless communications, but students also have opportunities to work on experimental hardware if they choose to.

An overview of cellular generations and standardization:

- 1G (Analog system): First introduced in US in 1983
  - Voice only system
  - AMPS (Arbo Mobile Phone System) uses FDMA at 800 MHz

- 2G (Digital): TDMA & CDMA (introduced early 1990s)
  - UMTS (Wideband CDMA) based on TDMA at 900 MHz
  - IS-95 is based on CDMA at around 1800, 1900 MHz

- 2.5G: adding more features to 2G systems (1995)
  - allows packet-switch operations (GPRS/EDGE)
  - more digital services

- 3G (Digital): UMTS (WCDMA) and CDMA 2000
  - UMTS: Universal Mobile Telecommunication, Voice
  - Support multimedia services
4G: 3GPP-LTE (Long Term Evolution) around now
- high data rate (LTE-A up to 1 Gbps)
- Convergent standard for 4G
- use OFDMA / OFDM with MIMO and QAM

5G: slated for 2020
- include higher spectrum (mmWave)
- lots of ideas floating around now
- massive MIMO
- new modulation / waveforms? OFDM vs. FBMC / UFMC
  - FBMC - filter bank multicarrier
  - UFMC - universal filter multicarrier
- demonstrated 7.5 Gbps with auto mobility (100 km/h)

Emerging systems/ideas:
- cognitive radio
- SDN - self organizing network
- inter-vehicular networks
- the smart grid
- biomedical networks

An overview of wireless LAN - (WiFi)
- follows IEEE 802.11 standards
- operates in free ISM band (around 2.4 GHz and 5 GHz)
- different versions with varying speed, range
  - 802.11a: high throughput (use MIMO)
  - 802.11ac: Gbit speed
  - 802.11ad: many to 60 GHz
- usually low mobility
- 802.11ac: MU-MIMO, operate at 5 GHz