# **EE 5141** – Introduction to Cellular and Wireless Communications

Jan.-Apr. 2023 **Outline** Room # ESB-350

1. Why wireless? Analog versus Digital wireless communications; Wireless Technology Standards – Evolution from 2G to 4G mobile cellular access (see Chap.2 in [2]), notions of spectral efficiencies

2. Wireless LoS Link (Large Scale Parameters) – path loss, shadow loss; *Aside*: receiver sensitivity (see Appendix B in [2]), link budget for noise-limited links, relay channels

3. Wireless Multipath Link (Small Scale Parameters) – Doppler spread, delay spread, angular spread; statistical modelling of multipath wireless channels (see Chap. 2 in [1] and also Chap.5 in [2]), Multipath to Multitap models, Simulation of time-varying channel taps for given Doppler spread, 3GPP Winner Model. *Aside*: Outage, link margin and receiver sensitivity

4. Multiple Access Principles– FDMA, TDMA, CDMA, and OFDMA; Downlink vs Uplink; CSMA-CA for adhoc wireless, (see Chap.4 from [1]); Need for ranging and/or power control on uplink

5. Cellular Concept – Why Spatial Reuse, Trunking Efficiency vs Spatial Reuse, (see Chap.3 and Appendix A in [2]). Fractional Frequency Reuse in 4G/5G cellular systems

6. Why Block Modulation? -- Quick look at 2G GSM standard, voice capacity of TDMA cellular, SINR in Cellular TDMA, noise rise and soft-capacity of voice channels 2G DS-CDMA; Also see Chap.4 from [1]. Impact of Uplink and Multipath on variable data-rate support and link budget → Need for OFDM/OFDMA

7. Case study: OFDM Cellular Technology -- quick look at 4G cellular OFDM standards (WiMax and LTE), Transmit configurations, Precoding, Receiver Algorithms (Freq and Time Sync, Channel Estimation, MIMO Combining, LLR based iterative decoding).

8. Intro to popular OFDM Channel Estimation schemes – using wideband or banded pilots; Generalized Block Modulation

9. Capacity of wireless Channels (Chap. 5 in [1]), Multi-antenna communications – Modeling (Chap. 7 in [1]) and Algorithms (parts of Chap. 8 in [1]), impact of Sectoring and/or MIMO on link and system performance

*Evaluation Scheme*: Midsem (25), 3 Computational Assignments (25), Miniproject (10*), and EndSem (40). * Decision to be made by March end, based on performance of the class in the CAs.

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*Text Book*: [1] D. Tse and P. Vishwanath, "Fundamentals of Wireless Communication", Cambridge Press, 2005.
*Reference Book*: [2] T.S. Rappaport, "Wireless Communications – Principles and Practice", Pearson (2nd Ed.), 2002.

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