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Wireless Networks

Contact Hours: 75 (48 lecture hours + 27 hours of lab sessions)

Lecture Contents:

Telecommunication Fundamentals: Signal digitisation & coding**:** Sampling, quantisation, coding, quantisation noise and SNR/q; Reconstitution and regeneration; BER; Channel noise and SNR; Bit Rate, bandwidth, information content, channel capacity; Recovery of digital signals – power and bit rate, binary vs. multi-level digital communication.

Data Communication: Baseband communication: Spectrum control, spectrum of digitally modulated signals, NRZ, RZ, Manchester, AMI; Nyquist pulse shaping for bandlimited channels, Raised cosine pulse shaping; Eye diagram; Timing recovery; Shannon's capacity theorem; Optimum receiver principles, matched filter; BER; Signal bandwidth; Passband communication: Amplitude/frequency/phase shift keying, BPSK, QPSK & QAM; Error Control Coding: ARQ & FEC, block codes, convolutional codes, TCM.

Source Coding: Digital representation of signals; Linear PCM, log PCM, A-law; Principles of low-bit rate speech coding; Overview of G.xxx speech coding standards; Overview of image and video coding.

Communication Link Engineering: Power, attenuation and signal to noise Ratio; Antenna pattern and spread loss; Channel attenuation and fading; Digital microwave link budget; Repeaters and regenerators.

Wireless & Cellular Communication: Radio propagation: Multipath propagation, free space loss, fading, delay spread; Cellular fundamentals: Frequency reuse and planning, cochannel interface, sectored antennas, handoff between cells; Capacity of access networks: Channel capacity vs. Erlang capacity, spectral efficiency.

GSM (Global System for Mobile communication): Frame and slot structure; Implications of the air-interface definitions on receiver design, traffic and control channels; Network elements -MSC, HLR, VLR, BSC, BTS; GSM network Interfaces - between base stations, MSC and PSTN; Call handling in GSM - handoff between base stations, call setup and release sequence.

DECT (Digital Enhanced Cordless Telephone): Air interface, framing & slotting; Multi-carrier TDMA; Dynamic channel selection

Principles of Spread Spectrum and CDMA: Separation of overlapping signals; Orthogonality, DSCDMA, asynchronous CDMA, FDM, orthogonal FDM; Synchronous CDM, orthogonal FHSS, Frequency; Hopping, fading channels, spread spectrum, CDMA; Spreading codes: Gold codes, long codes, short codes, orthogonal codes - Walsh codes; CDMA standards.

3GPP W-CDMA: Introduction to IS-95, comparison with W-CDMA (wide-band CDMA); W-CDMA standard – physical layer, channels, codes, services; Key features and improvements; Transmitter and receiver algorithms.

Lab Experiments:

1. Sampling and quantisation
2. SNR improvement techniques
3. A-law coding of speech
4. Huffman coding
5. Matched filtering and timing offset estimation
6. Echo cancellation
7. Gold codes for W-CDMA
8. Fading Channel simulation
9. Adaptive equalisation for multipath channel