

# NICTA Canberra Node Advanced Course: *Turbo Receiver Design*

**Title of the course:** Turbo Receiver Design

**Course Director:** Dr. Mark Reed (ANU Adjunct Fellow)

**Formal Description of course:** This course provides a detailed study of digital signal processing concepts applied to communication systems. Specifically it studies the baseband signal processing technique for iterative receiver design, in the context of the “turbo principle”, and better known as turbo receivers. Topics covered include detection criteria, decoding methods, transmitter configurations, wireless channel modelling, receiver design and analysis techniques.

**Informal Description of course:** The outcome of the course for interested students is a fundamental understanding of how to design and analyse efficient receivers, how to use the “turbo principle” to mitigate interference and what the key design steps are. The course uses practical system examples but tries to illustrate the underlying principle and the application of this principle. By gaining an insight into this the student will be able to apply the technique to a multitude of new real-world problems and system configurations, including systems that use antenna arrays, direct-sequence code-division multiple-access (DS/CDMA), continuous phase modulation (CPM), intersymbol interference (ISI) channels and the like.

**Curriculum:**

The proposed course outline is: -

- History of the Turbo Principle
- Detection Criteria
  - ML Detection
  - MAP Detection
- Decoding Methods
  - ML Sequence Estimation
  - MAP Decoding
  - Turbo Decoding and Interleavers
  - Low Density Parity Check Codes/Decoding
- Transmitter Configurations
  - Uplink of DS-CDMA Systems
  - Continuous Phase Modulation
  - Space Division Multiple Access
  - Magnetic Recording Systems
  - MIMO modelling
  - Space-time Code Modelling
  - OFDM and MC-CDMA Modelling
- Wireless Channel Modelling
  - Wireless Channels
  - ISI Channels
  - Multiple Access Techniques
- Receiver Design
  - MAP Receivers
  - Low Complexity IC Receivers

- Channel Considerations
- Analysis Techniques
  - EXIT Chart Analysis for decoders and receivers
  - Variance Method for decoders and receivers
- Further Considerations
  - Timing Acquisition
  - Channel Tracking
  - Timing Tracking

**Presenters:** Mark Reed

**Dates and Locations:** Nominally, `start date`, daily, 10am-12pm in lecture room RSISE building

**Completion date of course:** `start date+2weeks`

**Notification date of course:** `start date+8weeks`

**Workload:** 20 hours of lectures, 40 hours of assignments reading and preparation for lectures. No formal examination.

**Assumed knowledge of course:** Basic probability theory (expectation, variance), undergraduate linear algebra (bases, matrix theory)

**Prerequisites, entry requirements:** Knowledge of basic probability and statistics at undergraduate level, communication systems at undergraduate level, undergraduate engineering degree.

**Assessment procedures:** Four assignments in each of the four modules.

**Assignment options for the course:** Four assignments handed out during the course. A pass will be dependent on satisfactory performance in the assignments

**Examiners:** Prof. Rodney Kennedy (RSISE,ANU) and Dr Mark Reed (ANU Adjunct)

**Fees:** Nil