

Department of Electrical Engineering, IIT Madras
EE 4140: Digital Communication Systems

B-Slot, ESB-128

July 24, 2022

1. Introduction (Chap-1 in book) to digital communications, and review of sampling theorem and representation of band-pass signals (Chap-2).
2. Overview of random processes – Random variable and random process, Gaussian, white, stationary processes, circular Gaussian random variable, auto-correlation and power spectral density, WSS random signal transmitted through LTI system, band-pass processes (Chap-4), [the random binary wave process](#).
3. Digital communications thro (band-unlimited) AWGN channels – Signal representation, PAM, PSK, and QAM signals, multi-dimensional signals, optimum receiver for AWGN measurement models, probability of error P_e for symbol detection (Sec. 7.1 thro 7.6 in Chap-7), [approximate \$P_e\$ using Union bound, Chernoff bound, \$P_e\$ for fading channels](#)
4. Digital communications thro band-limited “flat” channels – Power spectrum of random digital signal, symbol-by-symbol modulation based signal design for band-limited channels (Nyquist criterion), partial response signals (Sec. 8.1 thro 8.3 in Chap-8). Timing and frequency synchronization for linearly modulated digital signals (from Sec. 7.8 in Chap-7).
5. Digital communications thro distorting channels – Channel equalization, maximum likelihood sequence detection and the [Viterbi algorithm](#) (Sec. 8.6 and only some parts of Sec. 8.5 in Chap-8), [and practical \(fractionally-spaced, adaptive\) receivers for ISI channels, MAP sequence estimation and symbol detection](#)
6. Source coding preview – Source coding theorem, only Sec. 6.1 to 6.3 in Chap-6, and a “touch” of Sec.6.6 & 6.7.
7. Channel coding preview – Channel capacity theorem and understanding AWGN channel capacity, [random coding argument](#), simple block coding and syndrome decoding, convolutional codes and MLSE; a brief look at trellis coded modulation, *concatenation and interleaving of simple codes to make a more powerful code* (touching upon nearly all topics the various sections in Chap-9 with the exception of sections 9.6 and 9.10).
8. Wireless communications preview – *Noise figure and receiver sensitivity, link budget, wireless repeaters and regenerators, wireless multipath fading channel*; [Why the evolution from single-carrier symbol-by-symbol modulation to multi-carrier block modulation, and broadband cellular communications measurement models](#)

(**Note:** The topics in [blue](#) color are not from the text book, and topics in *italics* will be covered if sufficient time is available.)

Text Book:

“*Communication Systems Engineering 2nd Ed*” J.G.Proakis & M.Salehi (Prentice Hall Intl. Edition); either hard-copy or E-book can be followed.

Assessment Method: (*tentative*)

Mid Sem Quiz: 20 marks; End Sem Exam: 40 marks; the remaining 40 marks will be awarded based on 4 assignments of 10 marks each, which would include simulation problems that have to be submitted from time to time.

The contact details of the TAs for this course will be shared; we will communicate by Whatsapp or email; currently, I do not plan to use Moodle. Email me at giri@ee.iitm.ac.in for more details. Soft-copies of additional material will be made available at <http://www.ee.iitm.ac.in/giri/teaching.html>.

K. Giridhar, ESB-334B, July 24, 2022