

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

B-Slot, ESB-128

Aug 13, 2023

1. Introduction (Chap-1 in book) to digital communications, and review of sampling theorem and representation of band-pass signals (Chap-2). [Sampling of band-pass signals; 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 \(Chap-4\)](#),
2. Digital communications thro ideal (band-unlimited) AWGN channels – Single-shot communication, Matched Filter Receiver, Symbol-by-Symbol modulation, Digital 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](#)
3. Digital communications thro band-limited “flat” channels – [Power spectrum of random digital signal \(using the the random binary wave process\)](#), signal design for symbol-by-symbol modulation thro band-limited channels (the Nyquist criterion for pulse-shaping), 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).
4. 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](#)
5. 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.
6. 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, and the idea of 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).*
7. 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](#)*

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(**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 2<sup>nd</sup> Ed*” J.G.Proakis & M.Salehi (Prentice Hall Intl. Edition); either hard-copy or E-book can be followed.

**Assessment Method: (*tentative*)**

Open-book/notes Mid Sem Test: 30 marks; End Sem Paper Presentation: 50 marks; the remaining 20 marks will be awarded based on two take-home computational assignments of 10 marks each.

The TA for this course is Ms. Prasikaa Shree (PhD scholar); we will communicate by Whatsapp or email; Email me at [giri@ee.iitm.ac.in](mailto:giri@ee.iitm.ac.in) for more details. Soft-copies of additional material (if required) would be made available at <http://www.ee.iitm.ac.in/giri/teaching.html>.

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K. Giridhar, ESB-334B, August 13, 2023