Department of Electrical Engineering, IIT Madras
EE 3005: Communication Systems

1. Introduction

2. Review of Signals and Systems: Linear time-invariant systems, Fourier series, Fourier transform, Bandwidth, Baseband and passband signals, complex baseband representation of passband signals

3. Analog Modulation: Amplitude Modulation (AM) -- Double Sideband - Suppressed carrier AM, Conventional AM, Single sideband AM, Vestigial sideband AM, Quadrature AM, Angle Modulation -- Phase modulation (PM), Frequency modulation (FM), FM spectrum, *Phase-locked loops*

4. Signal space representation -- Gram-Schmidt orthogonalization, orthogonal expansion of signals and approximation, vector representation, representation of channels

5. Review of Probability -- Probability basics, Random variables, Random vectors, Independence of random variables, Moments, correlation matrix, covariance matrix, Gaussian random vectors -- Scaling and translation, Standard Gaussian, Joint Gaussianity, linear transformation of jointly Gaussian random vectors

6. Random processes -- Basic definitions, Second-order statistics, Wide-sense stationarity and stationarity, Power spectral density, Gaussian random processes, Noise modeling, Filtering, Projection of Gaussian noise onto a signal space, *Cyclo-stationary RPs, Levinson-Dubin Algorithm, Generation of random processes with specified correlations*

7. *Binary modulation on the additive white Gaussian noise channel, Reduction to binary hypothesis testing*

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*

Note: The topics in blue color are not from the text-book, and topics in *italics* will be covered if sufficient time is available; else you can read them up from the text-book.)

Text Book: Upamanyu Madhow, "*Introduction to Communication Systems*," Cambridge University Press, 2014. Chapters 1 thro 6.

Assessment Method: *(tentative)*

Two quizzes for 20 marks each, one take-home computational assignment for 10 or 15 marks and the End Sem would be for the remaining marks.

The lead TA for this course is my PhD scholar, Ms. Prasikaa Shree (prasikaasriram@telwise-research.com); there are 5 more TAs (MTech students Jayesh, Deepak, Nitin, Vishnu, and Vishal) who will also be helping us out. We will communicate by Whatsapp or email; Email me at 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.

K. Giridhar, ESB-334B, January 20, 2025