



# PRINCIPLES OF COMMUNICATION SYSTEMS - I

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**PRE-REQUISITES** : Basic knowledge of Probability, Calculus

**INTENDED AUDIENCE** : Intended audience is students, practicing engineers, technical and non-technical managers of telecom companies, students preparing for competitive exams with communication engineering subject

**INDUSTRIES APPLICABLE TO** : Most companies in wireless communications area should find this useful. Examples are Qualcomm, Broadcom, Intel etc.

### COURSE OUTLINE :

This course covers fundamental concepts of communication systems, which are essential for the understanding of advanced courses in digital/ wireless communication systems. Beginning with various basic tools such as Fourier Series/ Transform, the course will also cover several important modulation techniques such as Amplitude Modulation, Frequency Modulation, Phase Modulation etc. Sampling process and Quantization, including Nyquist criterion and reconstruction of the original signal from the sampled signal will be dealt with in the later parts of the course. Further, the course will also cover concepts in probability and random variables/ processes and is designed to serve as a basic course towards introducing the students to various aspects of probability from the perspective of modern digital and wireless communications. Thus, it will focus on basic concepts in probability, random variables and random processes, while also illustrating digital/ wireless communication specific examples to better bridge the gap between theory and application. This course is suitable for all UG/PG students and practicing engineers/ managers who are looking to enhance their knowledge of the fundamental principles underlying various communication systems as well as students preparing for their college/ university/ competitive exams.

### ABOUT INSTRUCTOR :

Prof. Aditya K. Jagannatham (<http://home.iitk.ac.in/~adityaj/index.html>) received his Bachelors degree from the Indian Institute of Technology, Bombay and M.S. and Ph.D. degrees from the University of California, San Diego, U.S.A.. From April '07 to May '09 he was employed as a senior wireless systems engineer at Qualcomm Inc., San Diego, California, where he worked on developing 3G UMTS/ WCDMA/HSDPA mobile chipsets as part of the Qualcomm CDMA technologies division. His research interests are in the area of next-generation wireless communications and networking, sensor and ad-hoc networks, digital video processing for wireless systems, wireless 3G/4G cellular standards and CDMA/OFDM/MIMO wireless technologies. He has contributed to the 802.11n high throughput wireless LAN standard and has published extensively in leading international journals and conferences. He was awarded the CAL(IT)2 fellowship for pursuing graduate studies at the University of California San Diego and in 2009 he received the Upendra Patel Achievement Award for his efforts towards developing HSDPA/HSUPA/HSPA+ WCDMA technologies at Qualcomm. Since 2009 he has been a faculty member in the Electrical Engineering department at IIT Kanpur, where he is currently an Associate Professor, and is also associated with the BSNL-IITK Telecom Center of Excellence (BITCOE). At IIT Kanpur he has been awarded the P.K. Kelkar Young Faculty Research Fellowship (June 2012 to May 2015) for excellence in research. His popular video lectures for the NPTEL (National Programme on Technology Enhanced Learning) course on Advanced 3G and 4G Wireless Mobile Communications can found at the following YouTube link ( NPTEL 3G/4G ).

### COURSE PLAN :

**Week 1** : Basic tools for communication, Fourier Series/Transform, Properties, Autocorrelation, Energy Spectral Density, Parsevals Relation

**Week 2** : Amplitude Modulation (AM), Spectrum of AM, Envelope Detection, Power Efficiency, Modulation Index

**Week 3** : Double Sideband Suppressed Carrier (DSB-SC) Modulation, Quadrature Carrier Multiplexing (QCM), Demodulation, Costas Receiver

- Week 4** : Single Sideband Modulation (SSB), Hilbert Transform, Complex Pre-envelope/ Envelope, Demodulation of SSB, Vestigial Sideband Modulation (VSB)
- Week 5** : Angle Modulation, Frequency Modulation (FM), Phase Modulation (PM), Modulation Index, Instantaneous Frequency
- Week 6** : Spectrum of FM Signals, Carsons Rule for FM Bandwidth, Narrowband FM Generation, Wideband FM Generation via Indirect Method, FM Demodulation
- Week 7** : Introduction to Sampling, Spectrum of Sampled Signal, Aliasing, Nyquist Criterion, Signal Reconstruction from Sampled Signal, Pulse Amplitude Modulation
- Week 8** : Quantization, Uniform Quantizers – Midrise and Midtread, Quantization noise, Lloyd Max Quantization Algorithm, Non uniform Quantizers, Delta Modulation, Differential Pulse Code Modulation (DPCM)
- Week 9** : Basics of Probability, Conditional Probability, MAP Principle
- Week 10**: Random Variables, Probability Density Functions, Applications in Wireless Channels
- Week 11**: Basics of Random Processes, Wireless Fading Channel Modeling
- Week 12**: Gaussian Random Process, Noise, Bit-Error and Impact on Wireless Systems