SECOND SEMESTER JAN. 2020

Course Handout (Part- II)

Date: 06-01-2020

Course No. : **EEE G622**

Course Title : **Advanced Digital Communication.**

Instructor-in-Charge : **SAINATH BITRAGUNTA**

1. Course description:

This graduate level course deals with the design and performance analysis of digital and wireless communication systems. The course initially covers review on probability, real and complex random variables, and random process, which is a very useful mathematical tool for understanding, designing, and analyzing wireless communication systems. The design and performance analysis of optimum receivers for AWGN channels will be discussed. Symbol error probability (SEP) for various modulation schemes will be investigated. The signal design for band-limited channels will be discussed.

Furthermore, digital communication over fading channels will be discussed assuming mainly Rayleigh fading. Various diversity and combining techniques to overcome problems of fading and shadowing will also be covered. This course also provides discussion on the key principles and signal processing in orthogonal frequency division multiplexing (OFDM) based wireless communication systems. Further, MIMO-OFDM, which has applications in 4G and wireless LANs will also be introduced. Introduction to software defined radio (SDR) and emerging trends in wireless communication will be covered briefly.

Note: The pre-requisite of communication Systems of BITS or equivalent is presumed for this graduate level course.

2. Scope and Objective:

The course mainly covers mathematical tools and advanced techniques to design and analyze advanced digital communication systems. This course will be a stepping stone to learn advanced courses namely advanced wireless communication systems, advanced coding techniques.

After completion of the course students are expected to model, design, and analyze advanced digital communication systems. Furthermore, they should be able to perform Monte-Carlo simulations using MATLAB and/or Simulink to validate system analysis. Students will also be given assignments or projects on topics in advanced digital communication system design, modeling and simulation. Students registering in this course are expected to have knowledge in basic engineering mathematics and a decent understanding of signals and systems and basic communication systems.

3. Text books:

[T1]. "Digital Communications," by John G. Proakis, 5th edition, McGraw Hill, 2008.

4. References:

[R1]: "Principles of communication engineering," by Wozencraft & Jacobs, John Wiley, 1965.

[R2]: "Principles of digital communication," by Viterbi & Omura, McGraw-Hill, 1979.

[R3]: "Digital communication over fading channels," M.K.Simon & M.-S. Alouini, second edition, 2005.

[R4]: "Wireless communication," Andrea Goldsmith, second edition, Cambridge press, 2010.

[R5]: "Probability, random variables, stochastic processes, " Papoulis & Pillai, Tata McGraw-Hill, 2002.

5. Course plan:

Lecture No.	Topic	Learning Objective	Reference(s)
1-2.	Introduction & Historical background	Introduction to digital communication systems.	T1/R1
3 -7	Probability & Random processes	Probability and real and complex random variables. Description of random processes; random processes and linear systems. Power spectrum of stochastic processes; Gaussian and white processes and bandpass processes.	T1/R1/R5
8-9	Signal space representation of digitally modulated signals	Gram-Schmidt procedure, the concepts of representing digitally modulated signals and represent their energy in terms of Euclidean distance.	T1/R2
10-15	Optimum receivers	Design of optimum receivers for channels perturbed by AWGN channels. Correlation type demodulator and matched filter type demodulator.	R1/T1
16-18	Symbol error probability (SEP) and bounds	Computation of symbol error probability for QPSK, M-ary PSK, QAM signals etc.	T1/R1
19-22	Continuous phase modulation, coded modulation	Basics of CPM, MSK,GMSK, TCM	T1
23-27	Digital communication through fading channels	Fading, pathloss, and, shadowing	T1/R3/R4
28-33	Diversity and combining	Time, frequency, and space diversity; maximal ratio combining (MRC)	T1/R3/R4
34-37	Outage and SEP analysis	Performance analysis of digital wireless	T1/R3/R4

		systems in terms of outage, SEP	
38-40	Orthogonal frequency division multiplexing (OFDM), multi antenna systems	Introduction to OFDM, basics of MIMO, transmit-receive diversity	T1/R3/R4
41-42	Miscellaneous topics (introduction only)	Software defined radio (SDR), Cognitive radio (CR), Cooperative communication, Massive MIMO, quantum communications	IEEE Papers

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Venue	Remarks
Assignments (Theory & lab)	-	10	-	-
Mid-semester test	90 min	30		Closed book (CB)
Quiz	40 min. (each)	10	To be announced in the class.	CB
Seminar & report	15 min per student	10	To be announced in the class.	CB
Comprehensive	180 min.	40		Open book (OB)

7. Chamber Consultation Hour: To be announced in the class.

8. Course Notice: To be posted online.

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