COURSE PROFILE

Course Number : EE 470	**Course Title : Digital Communication Systems**
Required / Elective : Elective	**Pre-requisite :** EE370
Catalog Description: Signal Spaces, conversion of continuous time channels into vector channels. Binary and M-ary signalling. Optimum detectors and probability of error. Digital modulation types, PAM, QAM, PSK, FSK, MSK. Differential modulation. Coherent and noncoherent detection. Multiuser communications: spread spectrum, CDMA and OFDM. Fundamental limits in communication: introduction to information theory. Error correcting codes.	**Textbook / Required Material :** Proakis and Salehi. *Fundamentals of Communication Systems*. New Jersey: Pearson Prentice Hall, 2005.
Course Structure / Schedule : (3+0+0) 3 / 6 ECTS	
Extended Description: Digital Communication Systems is a senior level treatment of communication systems, with emphasis on digital communications. The goals of this course are – To develop an understanding of how digital modulators and demodulators work, – To learn how to represent various modulation techniques mathematically, in time and frequency domains, and more generally, in the signal space, – To obtain some insight into the role of random processes in communication system analysis, both as a means of modeling noise, and also as a model for message generation, – To address several key issues such as noise, bandwidth limitation, interference; and to investigate their effects on the performance of communication systems, through error probability analysis. – To explore fundamental limits of communication systems, such as channel capacity. – To learn some practical techniques to combat noise, such as error correcting codes. – To establish an introductory level understanding of multiuser communication techniques.	
Design content : Team project, focusing on design of digital modulator and demodulator hardware.	**Computer usage:** Project, focusing on simulation of modulation and demodulation techniques, error correcting codes, and probability of error analysis using MATLAB.
Course Outcomes **Course Outcomes:** a. Ability to mathematically model digital communication techniques; components, and degrading factors in communication systems [2,6] Relevant Content: Obtaining vector space representation of time signals,	

application of orthonormalization procedures, modeling of noise using random processes, using hypothesis testing for detection problems, probability of error computations, application of Fourier transform to obtain the signal spectrum, computation of entropy using discrete and continuous calculus.

b. Ability to derive optimum detectors, based on maximum likelihood and maximum a-posteriori probability criteria [2,6]

   Relevant Content: Representing the effect of noise in signal space, and on probability distributions, sufficient statistics, using hypothesis testing for detection problems.

c. Ability to evaluate the performance of different digital modulation and coding techniques [2,6]

   Relevant Content: Modeling of communication systems and the effects of noise and dispersion on these systems, derivation of optimum detectors that minimize error probability and suppress intersymbol interference, formulation and quantification of information and redundancy, and their algorithmic use in source and channel coding, probability of error computations, symbol error rate vs bit error rate.

d. Ability to appreciate the need for effective use of scarce resources such as power and bandwidth, and the trade-offs in system design [Outcome 3,6,7]

   Relevant Content: Basic understanding of the widespread and vastly varied use of communications, the need for effective use of scarce resources such as power and bandwidth, and ways to provide that effective use, such design of minimum energy signals, data compression and channel coding. and trade-offs involved while choosing/designing modulation techniques.

e. Ability to analyze and evaluate the performance of basic communication techniques, and to design communication system components to satisfy given requirements. [2,6,7]

   Relevant Content: Evaluation of performance of digital modulation and demodulation techniques, design and implementation of modulators and demodulators with given specifications, optimum receiver design.

f. Ability to design and implement basic modulator and demodulator circuits, simulate modulation and demodulation techniques, and their performance in noise. [7,8]

   Relevant Content: Class project, conducted in teams, involving hardware, and software (MATLAB) components that encourage project management and parallel independent work.

g. Ability to effectively explain the basic principles of communication systems and results of related designs and simulations, via oral and visual tools. [9],

   Relevant Content: Class project presentations and report, midterm examination conducted in the form of an oral-exam.

h. Ability to perform an introductory level analysis in advanced graduate topics [10]

Relevant Content: Some references to advanced topics at graduate level, as related to course material; introduction to topics in detection and estimation, information theory and random processes, serving as stepping stones to graduate programs, and projects which motivate self learning.

i. Ability to use basic circuit design tools, and MATLAB, for modeling, simulation, and design of communication systems [7,11]

Relevant Content: One or more of: design and performance analysis of digital modulators and demodulators, modeling of communication channels, and implementation of some source and channel coding applications using MATLAB.

The contribution of this course to the program outcomes can be rated as follows:

Outcomes 2,6,7,11: SIGNIFICANT

Outcomes 8,9,10: MODERATE

Outcomes 3: SOME

Recommended reading:

Haykin and Moher. *Introduction to Analog & Digital Communications, 2nd Ed*. New Jersey: Wiley, 2007.

Haykin and Moher. *Communication Systems, 5th Ed*. New Jersey: Wiley, 2010.

Bernard Sklar. *Digital Communications, 2nd Ed.* New Jersey: Pearson, 2001.

Teaching Methods:

Pre-readings, lectures and biweekly problem/discussion sessions, individual exercises and projects, group projects.

Assessment Methods:

- Exams (written and oral) [a, b, c, d, e, h].
- Portfolios (programming and design projects, presentations) [f, g, h, i].
- Class surveys, exit surveys [d,g,h].

Student Workload:

Preparatory reading	28 hrs
Lectures,workshop, discussions	48 hrs
Homeworks	18 hrs
Presentations	3 hrs
Projects	48 hrs

Midterm Exam 2 hrs Final Exam 3 hrs **TOTAL …… 150 hrs to match 25 x 6 ECTS**	
Prepared by : Onur Kaya	Revision Date : 03/02/2010