MTE 7101 Digital Communications

Course objective:

In the last few decades, digital communication has drastically improved our quality of life. Amenities such as fax machines, pagers, cell phones, and internet, are now considered indispensable. None of them are possible without digital communication.

This course explores elements of the theory and practice of digital communications. The course will

- Model and study the effects of channel impairments such as noise and distortion, on the performance of communication systems;
- Introduce signal processing, modulation, and coding techniques that are used in digital communication systems.

AIM:

- To thoroughly cover digital communications theory including information theory, source and channel coding, modulation and multiple access principles and techniques as well as the recent advances in Digital communications, including MIMO and OFDM.
- To study pulse modulation and discuss the process of sampling, quantization and coding that are fundamental to the digital transmission of analog signals.
- To learn baseband pulse transmission, which deals with the transmission of pulse-amplitude, modulated signals in their baseband form.
- To learn error control coding which encompasses techniques for the encoding and decoding of digital data streams for their reliable transmission over noisy channels.

Detailed Course Content:

Introduction:

- **Review of Probability Theory**; Probability space, random variables, density functions, independence; Expectation, conditional expectation, Baye's rule; Stochastic processes, autocorrelation function, stationarity, spectral density
- **Analog-to-digital conversion**: Sampling (ideal, natural, sample-and-hold); Quantization, PCM;

Communication System:

- **Source coding** (data compression): Measuring information, entropy, the source coding theorem; Huffman coding, Run-length coding, Lempel-Ziv;

- **Communication channels**: Band limited channels The AWGN channel, fading channels
- **Receiver design**: General binary and M-ary signaling; Maximum-likelihood receivers; Performance in an AWGN channel; The Chernoff and union/Chernoff bounds; Simulation techniques; Signal spaces
- **Modulation**: PAM, QAM, PSK, DPSK, coherent FSK, incoherent FSK
- **Channel coding**: Block codes, hard and soft-decision decoding, performance; Convolutional codes, the Viterbi algorithm, performance bounds; Trellis-coded modulation (TCM)

Digital Signaling:

- **Signaling through band limited channels**: ISI, Nyquist pulses, sequence estimation, partial response signaling; Equalization
- **Signaling through fading channels:** Rayleigh fading, optimum receiver, performance; Interleaving
- **Synchronization**: Symbol synchronization; Frame synchronization; Carrier synchronization

Multicarier & Multi user communications:

- Medium Access Schemes -TDMA, FDMA, CDMA technique;
- MIMO, OFDM and others

Teaching and Learning Pattern

The teaching of students will be conducted through lectures, tutorials, short classroom exercises, case studies, group discussions among the students and projects aimed at solving real life problems. The lecture material will be availed to the students in advance to enable them have prior reading. Solving real life problems in each theme or a number of topics will enhance the students' understanding of the problem based learning techniques.

Assessment method

Assessment will be done through coursework which will include assignments, class room and take home tests, project work and presentations and a written examination. Course work will carry a total of 40% and written examination carries 60%. Coursework marks will be divided into; Assignments 5%, Tests 10% and Practical/project Work 25%.

References:

1. J.G. Proakis, “Digital communications”, 4th edition
2. BP Lathi, “Modern Digital and Analog Communication Systems”
3. L. W. Couch, “Digital and Analog Communication”
4. Simon Haykins, “Communication Systems”

Popoulis, “Probability, Random Variable and Stochastic Processes”