SYLLABUS:

Date / Revision 23 May 2015 / 02 May 2017 / PP
Faculty Life Sciences (LS)
Study Program Biomedical Engineering (BME)

SUBJECT: Digital Signal Processing

1 Basic Information

1.01	**Subject Name**	**Digital Signal Processing**
1.02	**Semester**	5
1.03	**Level**	*1*
1.04	**SKS**	3
1.05	**Mandatory / Curriculum**	*D-02*
1.06	**Subject Code**	DSPR
1.07	**Subject Code**	BME-D-ELEC-117
1.08	**Year**	2017 (7)
1.09	**Quality Control**	Final Test, OFSE, see evaluation
1.10	**Limitations**	Min 12 and Max 32 students in one class
1.11	**Combined with**	None
1.12	**Pre-requisite**	Physics and Laboratory, Electrical Engineering and Laboratory, Engineering Math, Applied Math
1.13	**Responsible**	Dr. Tutun Nugraha
1.14	**Revision**	15-05-2017/pp

2 Description of Subject

Digital Signal Processing (DSP) is concerned with the digital representation of signals and the use of microprocessors and computers to analyze, modify, and extract information from signals. The digital signals found in most popular applications of DSP are derived from analog signals that have been sampled at regular intervals and converted into digital form.
The first part of this course covers the fundamentals of discrete-time signals and systems. Students will study key DSP operations such as convolution, filtering, and discrete Fourier transforms. Even during this early stage they will practice some applications of the theory covered in class. Then students will progress to digital filter design and spectral analysis, which are the two major branches
of DSP. Matlab/Scilab software will be used as a tool in designing of digital filter, such as IIR–Filter and FIR-Filter.

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3 Objectives

- This course is the continuation of various concepts given in sthe course ignal and systems, as well as the basic concepts given in previous courses including basic electrical engineering and lab, as well as electronic devices and circuits.

4 Competency

Through this subject students will understand various concepts relevant to digital signal processing, which includes

- Describe the Sampling Theorem and how this relates to Aliasing and Folding.
- Determine if a system is a Linear Time-Invariant (LTI) System.
- Take the Z-transform of a LTI system
- Determine the frequency response of FIR and IIR filters.
- Understand the relationship between poles, zeros, and stability.
- Determine the spectrum of a signal using the DFT, FFT, and spectrogram.
- Design, analyze, and implement digital filters in Matlab/SciLab.
- Explain the typical features of a digital signal processing chip.

5 Learning Approach / Methodology

- Lectures/ Class contact (time-tabled) supplemented with interactive questions and answers to build the projects;
- Tutorial/Laboratory/Practice Classes: preview of materials, revision and/or reports writing;
- Student Study Effort: homework/assignment; preparation for test/quizzes/ examination.
- Writing assignments/preseantations

6 Evaluation

5.1	**Absence maximum**	25%
5.2	**Participation in Discussion**	20 Points
5.3	**Homework / Classwork**	-
5.4	**Presentation /Simulation**	-
5.5	**Daily Quiz**	20 Points
5.6	**Final Examination**	60 Points
	Total	100 Points

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7 Text Book and Reference

1	**Main Text Book:** • "DIGITAL SIGNAL PROCESSING 4ED", Author: John G. Proakis and Dimitris G. Manolakis, Publisher: Pearson Internal Edition,2014, ISBN: 928-1-292-02573-5
2	**Supplement Textbooks:** • "Digital Signal Processing: Fundamentals and Applications, 2Ed", Author: Li Tan and Jean Jiang, Publisher: Academic Press- Elsevier, ISBN: 978-0-12-415893-1 • "Digital Signal Processing using Matlab – 3Ed", Author: Robert J. Schilling and Sandra L. Harris, Publisher: Cengage Learning, 2017, ISBN: 978-1-305-63519-7

8 Content / Topics of Lecture

Week	Content/ Topics of Lecturing	Text Book Chapter	Remark
1	**Introduction to Digital Signal Processing** (2 x 50 minutes): • Signal, System, and Signal Processing, Basic elements of digital signal • processing system, Advantages Digitals over analog signal processing • Classification of signals: Multi-channel and multi-dimensional signals, • CT-signals vs. DT-signals, Continuous valued vs. discrete valued • signals, Deterministic vs. random signals • Analog-to-Digital and Digital-to-Analog Conversion	Proakis, Manolakis, Chapter 1	1 x 3 x 50 minutes
2	**Discrete Time Signal** • Discrete-Time Signals and Discrete-Time Systems • Analysis of Discrete-Time Linear Time-Invariant systems • Discrete-Time Systems Described by Difference Equations • Implementation of Discrete-Time Systems • Correlation of Discrete-Time Signals	Proakis, Manolakis, Chapter 2	1 x 3 x 50 minutes
3	**The z-Transform and Its Application to the Analysis of LTI Systems** • The z-Transform • Properties of the z-Transform • Rational z-Transforms • Inversion of the z-Transform • Analysis of Linear Time Invariant Systems in the z-Domain The One-sided z-Transform	Proakis, Manolakis, Chapter 3	1 x 3 x 50 minutes
4	**Frequency Analysis of Signals and Systems:** • Discrete-Time Signals • Frequency Analysis of Continuous-Time Signals • Frequency Analysis of Discrete-Time Signals • Frequency-Domain and Time-Domain Signal Properties • Properties of the Fourier Transform for	Proakis, Manolakis, Chapter 4	1 x 3 x 50 minutes

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5	**Frequency-Domain Analysis of LTI Systems** • Frequency-Domain Characteristics of Linear Time-Invariant Systems • Frequency Response of LTI Systems • Correlation Functions and Spectra at the Output of LTI Systems • Linear Time-Invariant Systems as Frequency-Selective Filters • Inverse Systems and Deconvolution	Proakis, Manolakis, Chapter 5	1 x 3 x 50 minutes
6	**Sampling and Reconstruction of Signals** • Ideal Sampling and Reconstruction of Continuous-Time Signals • Discrete-Time Processing of Continuous-Time Signals • Analog-to-Digital and Digital-to-Analog Converters • Sampling and Reconstruction of Continuous-Time Bandpass Signals • Sampling of Discrete-Time Signals • Oversampling A/D and D/A Converters	Proakis, Manolakis, Chapter 6	1 x 3 x 50 minutes
7	**The Discrete Fourier Transform: Its Properties and Applications** • Frequency Domain Sampling: The Discrete Fourier Transform • Properties of the DFT • Linear Filtering Methods Based on the DFT • Frequency Analysis of Signals Using the DFT • The Discrete Cosine Transform	Proakis, Manolakis, Chapter 7	1 x 3 x 50 minutes
8	**MIDTERM SEMESTER BREAK**		
9	**Efficient Computation of The DFT: FFT Algorithms** • Efficient Computation of the DFT: FFT Algorithms • Applications of FFT Algorithms • A Linear Filtering Approach to Computation of the DFT • Quantization Effects in the Computation of the DFT Basic BioReactor sizing for waste water treatment	Proakis, Manolakis, Chapter 8	1 x 3 x 50 minutes
10	**Implementation of Discrete-Time Systems** • Structures for the Realization of Discrete-Time Systems • Structures for FIR Systems • Structures for IIR Systems • Representation of Numbers • Quantization of Filter Coefficients • Round-Off Effects in Digital Filters	Proakis, Manolakis, Chapter 3	1 x 3 x 50 minutes
11,12	**Design of Digital Filers** • General Considerations • Design of FIR Filters • Design of IIR Filters From Analog Filters • Frequency Transformations	Proakis, Manolakis, Chapter 9	2 x 3 x 50 minutes

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13, 14	**Multirate Digital Signal Processing** • Decimation by a Factor D • Interpolation by a Factor I • Sampling Rate Conversion by a Rational Factor I/D • Implementation of Sampling Rate Conversion • Multistage Implementation of Sampling Rate Conversion • Sampling Rate Conversion of Bandpass Signals • Sampling Rate conversion by an Arbitrary Factor • Applications of Sampling Rate Conversion • Digital Filter Banks • Two-Channel Quadrature Mirror Filter Bank • M-Channel QMF Bank	Proakis, Manolakis, Chapter 10	2 x 3 x 50 minutes
15	**Adaptive Filters** • Applications of Adaptive Filters • Adaptive Direct-Form FIR Filters-The LMS Algorithm • Adaptive Direct-Form FIR Filters-RLS Algorithms • Adaptive Lattice-Ladder Filters	Proakis, Manolakis, Chapter 11	1 x 3 x 50 minutes
16, 17	**Final Examination**		

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