SECOND SEMESTER 2015-2016

COURSE HANDOUT (PART II)

Date: January 8, 2016

Course No: **EEE G613**

Course Title: **Advanced Digital Signal Processing**

Instructor-in-Charge: **ANANTHAKRISHNA CHINTANPALLI** (Office no: 2201-O)
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1. Course Description:

The course deals with a set of advanced signal processing concepts that are of prime interest in various related applications. It is divided into five modules, wherein, the first module deals with the analyses of stationary and non-stationary signals. This module will cover fourier transform, short-time fourier transform and wavelet transform. As the real signals are non-stationary in nature, it is utmost important to learn and understand these transforms and put them into practice. The analyses of non-stationary signals have received considerable attention over the past two decades, with contribution coming from researchers in electrical engineering, mathematics and physics. The second module will include the topic of speech processing. This module will cover the underlying and fundamental concepts behind the speech production and its recognition. The third module deals with wavelets and multirate signal processing. This module will cover multirate filter bank systems and its relationship with wavelets. Additionally, the application of wavelet transform (e.g., signal denoising, image compression) will also be discussed. The fourth module addresses the topic of stochastic signal processing. This module will cover random processes and decision theory. Finally, the fifth module will include lectures on biomedical signal processing. This topic is a highly-interdisciplinary and has attracted many researchers across various disciplines (e.g., electrical engineering, biology) to solve medical problems using the signal processing and other engineering techniques.

2. Scope and Objective:

To provide underlying concepts behind the time-frequency representations of non-stationary signals, speech processing, multirate filter banks, stochastic signal processing and biomedical signal processing. Additionally, this course will provide the platform for students to learn advance signal processing techniques, which could be relevant for extracting important features of the non-stationary signals, particularly speech signals. As this is a graduate-level course, students will do research-oriented project and assignments in MATLAB to gain hands-on experience along with the concepts gained in the class.

3. **Prerequisites:** Signals and Systems (e.g., INSTR F 243) and Digital Signal Processing (e.g, EEE F434). Familiarity with MATLAB is mandatory.

4. **Reference Text Books:**

There are no prescribed text books for this course. Topics will be derived from the following reference books and additional materials may be provided whenever necessary.

R1: A. V. Oppenheim and R. W. Schafer, *Discrete-Time Signal Processing (3rd edition)*, Pearson, New Delhi, India, 2013. ISBN: 978-93-325-0574-2.

R2: P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Prentice Hall, Englewood Cliffs, New Jersey, USA, 1993. ISBN: 007-6092032502.

R3: G. Strang and T. Nyugen, *Wavelets and Filter Banks*, Wellesley-Cambridge Press, Boston, USA, 1996. ISBN: 978-0961408879.

R4: S. Mallat, *A Wavelet Tour of Signal Processing (3rd edition),* Academic Press, Burlington, USA, 2008. ISBN: 978-0123743701.

R5: L. R. Rabiner and R. W. Schafer, *Digital Processing of Speech Signals,* Prentice Hall, Englewood Cliffs, New Jersey, USA, 1978. ISBN: 978-0132136037.

R6: S. M. Kay, *Fundamentals of Statistical Signal Processing – Detection Theory (Volume II),* Prentice Hall, Upper Saddle River, New Jersey, USA, 1998. ISBN: 978-0135041352.

R7: R. M. Rangayyan, *Biomedical Signal Analysis: A Case-Study Approach,* Wiley-IEEE Press, New York, USA, 2001. ISBN: 978-0-471-20811-2.

5. **Course Plan:**

Module	Lecture No.	Topics to be covered
Introduction	1	Overview of the course
Review of basic signal processing principles	2	Continuous time signals, Sampling theorem, Aliasing, Discrete time sequences and systems
Analyses of stationary and non-stationary signals	3-12	Stationary and non-stationary signals, Fourier transform, Short-time fourier transform, Continuous wavelet transform and Discrete wavelet transform.

Speech processing	13-16	Speech Production, Speech Recognition, Feature extraction techniques
Multirate signal processing	17-21	Basic multirate operations, Quadratic Mirror filter banks (QMFs), Perfect reconstruction, Alias free filter banks, Multi-channel filter banks
Relationship between filter banks and wavelets	22-23	Filter banks, Discrete wavelet transform (1D and 2D)
Application of wavelet transform	24-31	Signal denoising, ECG compression, Image compression, Image denoising
Stochastic signal processing	32-38	Random variables, Maximum likelihood criterion, Neyman-Pearson decision rule, Receiver operating characteristics, Probability of error.
Biomedical signal processing	39-41	Introduction to Biomedical Signals, Event detection: ECG and EEG, Cochlear signal processing.

6. Evaluation Scheme:

Evaluation Component	Durations (Mins)	Weightage (%)	Date, Time and Venue	Remarks
Mid Semester Test	90	25 %	17/3 4:00-5:30 PM	Open Book/Close Book
Research-based MATLAB Assignments	For a week	10 %	To be announced in the class	Individual report and MATLAB code submission in PDF
Final Individual Project	- (note: **start early**)	20 %	Deadline: Apr 13	Project presentation. Individual report and MATLAB code submission in PDF
Comprehensive	180	45 %	11/5 AN	Open Book/Close Book

7. **Office Hours:** Will be announced in the class.

8. **Notices:** (a) Notices regarding the course will be sent in an email. Email group of the class will be created.
(b) Report (along with MATLAB codes) is to be submitted in PDF.
(c) MATLAB codes should also be emailed to the instructor.

9. **Malpractice Regulations:**

The following regulations are supplementary to BITS-wide policies regarding malpractices:

- Any student found involved in mal-practices in working out assignment/project will be awarded a zero for that assignment/project.
- A mal-practice will include but not limited to:

  - Submitting some other student's solution as one's own.
  - Copying some other student's solution (in any form) or MATLAB codes.
  - Seeing other student's solution (in any form) or MATLAB codes.
  - Permitting some other student to see or copy or submits one's own solution.
  - Or other equivalent forms of plagiarism wherein the student does not work out the solution and use some other solution or part thereof (such as downloading it from the LAN or the Web).

10. **Make-up Policy:**

- Prior permission of the Instructor-in-Charge is usually required to take a make-up for a test.
- A make-up test shall be granted only in genuine cases where - in the Instructor's judgment – the student would be physically unable to appear for the test.
- In case of an unanticipated illness preventing a student from appearing for a test, the student must present a Medical Certificate from BITS hospital.
- In case of an unanticipated absence for a test due to a trip out of Pilani, the student must present a letter from his/her Warden or the Chief Warden certifying such absence and the reason(s).
- Requests for make-up for the comprehensive examination – under any circumstances – can only be made to Dean, Instruction Division.
- A make-up will not be granted for other components such as for assignments/project submission and presentation.

Instructor-in-Charge

EEE G613