The University of Texas at Tyler
Department of Electrical Engineering

EENG 4353.031: Special Topics in EE (Elective)

Adaptive Filters

Syllabus

Catalog Description:

Introduction to discrete-time signal processing, Impulse response, z-transform, FIR, IIR filters, Stochastic Processes, Correlation functions and power spectral density, Wiener Filters, Introduction to gradient search algorithms, steepest-descent algorithm, LMS algorithm, Recursive Least Squares algorithm, Introduction to Noise Cancelation and Echo Cancelation.

Prerequisites: EENG 4311 – Signals and Systems, EENG 4312 – Communication Theory

Credits: (3 hours lecture)

Text(s):

1. Behrouz Farhang-Boroujeny, Adaptive Filters: Theory and Applications, 2nd Edition, ISBN: 978-1-119-97954-8
2. Simon O. Haykin, Adaptive Filter Theory, 5th Edition, ISBN: 978-0-132-67149-1
3. Saeed V. Vaseghi, Multimedia Signal Processing Theory and Applications in Speech, Music and Communications, 1st Edition, ISBN 978-0-470-06201-2.

Additional Material: Lecture Handouts, MATLAB

Course Coordinator: Ali Ghorshi, PhD

Topics Covered: (paragraph of topics separated by semicolons)

Introduction to discrete-time signal processing, Impulse response, z-transform, FIR, IIR filters, Stochastic Processes, Correlation functions and power spectral density, Wiener Filters, Introduction to gradient search algorithms, steepest-descent algorithm, LMS algorithm, Recursive Least Squares algorithm.

Evaluation Methods: (only items in dark print apply):

1. Examinations / Quizzes
2. Homework
3. Report
4. Computer Programming
5. Project
6. Presentation
7. Course Participation
8. Peer Review

Course Learning Outcomes[1]: By the end of this course students will be able to:

1. Introduction to Adaptive Filtering: a historical perspective; a state-of-the-art perspective.
2. Introduction to discrete-time signal processing.
3. Statistical Signal Processing Revision: correlation; ergodicity; means, variances; stationarity; wide sense stationarity; periodogramme; frequency response vs. power spectrum.
4. Explain the Wiener Filter Theory: normal equations; error performance surfaces; orthogonality; minimum mean square errors.
5. Explain the Least Mean Squares (LMS) algorithm: formulation; convergence; stability criteria.
6. Explain the Recursive LMS-IIR Algorithms: output error formulation; equation error formulation; full gradient, simplified gradient.
7. Explain Frequency Domain Adaptive LMS: Architectures, advantages, and disadvantages.
8. Explain Recursive Least Squares (RLS) algorithm: RLS formulation; forgetting factors; practical implementations; QR based RLS; numerical stability and integrity issues.
9. Comparative Analysis: Wiener; LMS-FIR, LMS-IIR. RLS.

10. Applications of adaptive filters: System identification; room acoustics, control systems; inverse system modeling; modems, telecommunications adaptive equalization, echo cancelation; adaptive beamforming (radar, sonar, hearing aids, listening devices); active noise cancelation systems in cars, airplanes, medical systems, communication systems.

[1] *Numbers in brackets refer to method(s) used to evaluate the course learning outcome.*

Relationship to Student Outcomes (only items in dark print apply)[2]: This course supports the following Electrical Engineering Student Outcomes, which state that our students will possess:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics [1-7, 9, 11, 12]
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors [8, 10]
3. an ability to communicate effectively with a range of audiences [16]
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts [13]
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions [14, 15]
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

[2] *Numbers in brackets refer to course learning outcome(s) that address the Program Outcome.*

Contribution to Meeting Professional Component: (in semester hours)

Mathematics and Basic Sciences:		hours
Engineering Sciences and Design:	3	hours
General Education Component:		hours

Prepared By: Edited By:	Ali Ghorshi, PhD	Date:	18 August 2019 21 April 2020 26 December 2020 01 January 2026