ET 644 Advanced Digital Signal Processing  
Fall 2009 - 3 Credit Hrs.

Instructor:  
Dr. James Z. Zhang

Contact Info:  
Office Hours: Tuesdays & Thursdays: 2:00pm – 5:00pm, Fridays: 3:00pm – 5:00pm or by appointment. Please call or e-mail if these times will not work with you. I can be contacted at the following:  
Office: 828-227-2159  
E-mail: zhang@email.wcu.edu

Office Location:  
164 Belk Building

Meeting Periods:  

CourseEval Dates:  
November 22 – December 06, 2009

Course Description:  
Theory and algorithms for processing of deterministic and stochastic signals. Topics include discrete signals, systems, and transforms, linear filtering, fast Fourier transform, nonlinear filtering, spectrum estimation, linear prediction, adaptive filtering, and array signal processing.

Course Goals:

A. General Course Goals/Objectives:  
Provide the student with a broad, yet strong background in the traditional topics associated with processing of deterministic digital signals, e.g., discrete-time transforms, and linear filtering. Provide student with a strong background in traditional topics associated with processing of stochastic signals, e.g., spectrum estimation and linear prediction. Introduce the student to some of the more recent developments that promise to have a broad impact on digital signal processing, e.g., nonlinear filtering and adaptive filtering.

B. Specific goals and objectives (Knowledge, Skills, and Abilities):

(A) KNOWLEDGE

The students will:
1. An understanding of discrete-time transforms.
2. The ability to design FIR and IIR filters.
4. The ability to apply above knowledge and skills to engineering problems.

Evaluation Strategies: Class discussion, homework assignments and unit tests.

(B) SKILLS

The students will:
1. Be able to use Matlab for signal and filter design and analysis
2. Prepare a formal report of an experiment and present the findings orally

Evaluation Strategies: Mini-design projects assigned in homework problems, ability of writing Matlab scripts and functions.

Prerequisites:  
Graduate Student Standing

Required Text:  
none required. The instructor will provide class-notes based on the reference textbook.

Reference Text:  

Instructional Approach:  
Three lecture/discussion periods per week. Some lecture periods maybe dedicated to Matlab simulation sessions. Open class discussion is an important element of this class. Students are responsible for the content of all reading assignments whether or not the material is covered in class. Additionally all students will be required to utilize the assigned software for project administration.
Assignments: There will be about 10 assignments, 1 Project, 3 term exams, and a final exam. Some the problems sets will involve both hand calculations (calculator ok) and computer generated calculations. All homework solution MUST be typeset by PCTex or other LaTex equivalent software. Late work (no more than one week) accepted with 50% penalty, otherwise will not be accepted.

Project: Each student must complete an applied research project. This project will be completed during the last 4 weeks of class (but do not wait until week 12 to start). A preliminary proposal must be submitted for instructor approval by week 8. The project will be treated as equivalent to 4 weekly problem sets. A format guide for writing the final report will be provided. With minor modifications and proper formatting, it is expected that the final report is publishable in an appropriate media.

Honor Code: Students are expected to comply with the spirit and intent of the University Academic Honesty Policy as stated in the Undergraduate Catalogue. Visit WCU’s Undergraduate Student Handbook for all related policies and procedures. http://www.wcu.edu/studentd/StudentHandbook

Evaluation: Final grades will be based on the following percentages:

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Assignments (10)</td>
<td>4% each</td>
</tr>
<tr>
<td>Project</td>
<td>10%</td>
</tr>
<tr>
<td>Term Exams (3)</td>
<td>30%</td>
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<tr>
<td>Final Exam</td>
<td>20%</td>
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</tbody>
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Grading Scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score Range</th>
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<tbody>
<tr>
<td>A</td>
<td>80-100</td>
</tr>
<tr>
<td>B</td>
<td>70-79</td>
</tr>
<tr>
<td>C</td>
<td>60-69</td>
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<tr>
<td>F</td>
<td>59 &amp; below</td>
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Accommodations for Students with Disabilities: Western Carolina University is committed to providing equal educational opportunities for students with documented disabilities. Students who require disability services or reasonable accommodations must identify themselves as having a disability and provide current diagnostic documentation to Disability Services. All information is confidential. Please contact Disability Services for more information at (828) 227-2716 or 144 Killian Annex.
Lecture Outline (Topics will be selected from the following to construct a 30-lecture semester).

<table>
<thead>
<tr>
<th>Lectures</th>
<th>Topic</th>
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</table>
| 7        | Discrete signals, systems, and transforms  
A. Discrete linear system  
B. Discrete-time Fourier transform (DTFT)  
C. 2-sided Z transform  
D. Discrete Fourier transform (DFT) |
| 5        | Linear Filtering  
A. Finite impulse response filters  
1. Windowed designs (Kaiser)  
2. Equiripple designs  
B. Infinite impulse response filters  
1. Bilinear Z transform  
2. Computer-aided techniques |
| 3        | Fast Fourier transform (FFT) algorithms  
A. Decimation in time  
B. Decimation in frequency  
C. Chirp Z-Transform  
D. Sectioned convolution |
| 3        | Nonparametric methods of power spectrum estimation  
A. Estimation of the autocorrelation sequence for random signals  
B. Smoothing the periodogram: the Blackman-Turkey method |
| 6        | Model-based power spectrum estimation  
A. Autoregressive (AR) spectral estimation  
B. Lattice filter: Burg's method  
C. Signal subspace methods  
D. Applications |
| 9        | Adaptive signal processing  
A. Applications  
B. Least mean square (LMS) adaptive algorithm  
C. Recursive least squares (RLS) lattice filters  
D. Adaptive beamforming |
| 9        | Nonlinear filtering  
A. Rank Order filters  
B. Deterministic and statistical analysis of median filters  
C. Threshold decomposition -- stock filters  
D. Applications |
| 3        | Exams (dates to be announced) |