

**San José State University, College of Engineering,  
Electrical Engineering Department,  
EE253, Digital Signal Processing I, Spring 2017**

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<b>Office Hours:</b>	T & TR 3:00 to 4:00 pm & after class & by appointment.
<b>Class Days/Time:</b>	M & We 4:30 to 5:45 pm
<b>Classroom:</b>	ENG339
<b>Prerequisites:</b>	EE210: Linear Systems, or equivalent (basic knowledge of signals, systems, and transforms)

### **EE253 Website**

Course materials such as the syllabus, major assignment, handouts, etc. may be found on my web page at [[https://groups.yahoo.com/groups/SJSU\\_EE253](https://groups.yahoo.com/groups/SJSU_EE253)]. You are responsible for regular checking of the web site.

### **Course Description**

- 1- Review of time and frequency analysis of discrete-time signals and systems
- 2- Signal conversion from the analog to the digital domains and back.
- 3- The Discrete Fourier Transform (DFT) and its properties.
- 4- The Fast Fourier Transform (FFT) implementation of the DFT. Application to fast computation of convolution and correlation.
- 5- Spectral analysis of deterministic signals. Spectral resolution and leakage.
- 6- Spectrogram analysis of non-stationary signals.
- 7- Analysis of various classical discrete-time filters (LP, HP, BP, BS, comb, notch, multi-notch, allpass filters).
- 8- Design and implementation of FIR filters (LP, HP, BP, BS, Hilbert-transformers, differentiators) using the window and optimal algorithms.
- 9- Design and implementation of IIR filters based on analog filter prototypes and the bilinear transformation. Frequency transformations.
- 10- Introduction to multirate signal processing: decimation, interpolation, and sample rate conversion. Efficient implementations.
- 11- Implications of quantization effects on digital filter design

## Student Learning Outcomes

- LO1: Understand practical limitations on conversion of signals from the analog world to the digital world and back
- LO2: Apply the FFT to reliably move signals between time and frequency domains.  
Analytically characterize achieved spectral resolution and leakage performance.
- LO3: Use frequency domain algorithms to compute convolution and correlation
- LO4: Analyze digital filter specified using polynomial coefficients or poles/zeros . Design simple filters based on direct pole/zero placement in the z-plane.
- LO5: Understand basic algorithms for digital filter design. Effectively use computer-aided design tools (Matlab) to design most filter types.
- LO6: Analyze sensitivity of digital filters realization choices to quantization effects
- LO7: Assess, analytically and/or computationally, achieved filter design performance.
- LO8: Relate studied algorithms to real-life signal processing applications.

## Required & Recommended Texts/Software

### Textbook & Software

1. *Applied Digital Signal Processing*, 1st Ed., D. Manolakis and V. Ingle, Cambridge University Press, 2011.
2. Joyce Van de Vegte, “Fundamentals of Digital Signal Processing”, Prentice-Hall, 2002  
ISBN: 0-13-016077-6
- 3- Class Lecture Notes (available at reproduction cost at the bookstore).
4. The Student Version of Matlab (Release 2007a or later includes the Signal Processing Toolbox among other Toolboxes; the current release is 2011a). Matlab is published by the Mathworks Inc. It’s the computational tool for this course; please see software section below.

### Recommended.

### Other References

1. *Discrete-Time Signal Processing*, 3rd Ed., A. V. Oppenheim & R.W. Schaffer, Pearson, 2010. Referred to as O&S in the class notes. The main text for the course.
2. *Digital Signal Processing Using Matlab*, V. K. Ingle and J.G. Proakis, 3rd Ed., Cengage, 2012 (the 2nd Ed, 2007, should also be OK) . Source of summary reviews, Matlab examples and problems.
3. *Digital Signal Processing*, M H. Hayes, Schaum’s Outline Series, McGraw-Hill, 1999. A moderately priced source of additional solved and unsolved problems.
4. *Digital Signal Processing: A Computer-Based Approach*, 4th Ed., S. K. Mitra, McGraw-Hill, 2011. (A previous textbook for EE253.)
5. *Digital Signal Processing: Principles, Algorithms, and Applications*, R. A. Proakis and D. G. Manolakis, 4th Ed., Prentice-Hall, 2007

6. Digital Signal Processing: System Analysis and Design, 2nd Ed., P.S.R. Diniz, E. A. B. da Silva, and S. L. Netto, Cambridge University Press, 2010.

### **Software: Matlab & the Signal Processing Toolbox**

Matlab is used as the computational platform for class examples and homework problems. Matlab and many of its Toolboxes are available on the PCs in room ENG 387. The lab operates on an open door policy. Check availability times posted on the lab door. You may also consider purchasing the Student Version of Matlab (\$100) for private use at school and home. This is perhaps the most time flexible way to do the computational assignments and Project. The Student Version Release R2007a and later includes the Signal Processing Toolbox. Check the web site <http://www.mathworks.com/academia/> for more information. You may order the Matlab Student Version on the web or may purchase it directly from the Spartan Bookstore, Textbooks Department.

Source code for the m-files in Manolakis Ingle textbook is available from the publisher's website (copy and paste the link below in your browser)

<http://www.cengagebrain.com/shop/ISBN/9781111427375?cid=APL1>.

If you are not familiar with Matlab, an introduction can be found at

<http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.html> and a DSP introduction at <http://www.mathworks.com/access/helpdesk/help/toolbox/signal/>. See also the Student Version Manual. Several good Matlab tutorials are also available on various websites (some links will be posted on the class website). Google 'Matlab tutorial'. Electronic versions (html and pdf) of Matlab and all Toolboxes manuals can be accessed at the Mathworks website above. Matlab has very good 'help' facility that you should invoke to learn more about specific commands and functions.

*You will need to learn and use Matlab to get the most out of this course.*

### **Dropping and Adding**

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's [Catalog Policies](#) section at <http://info.sjsu.edu/static/catalog/policies.html>. Add/drop deadlines can be found on the [current academic calendar](#) web page located at [http://www.sjsu.edu/academic\\_programs/calendars/academic\\_calendar/](http://www.sjsu.edu/academic_programs/calendars/academic_calendar/). The [Late Drop Policy](#) is available at <http://www.sjsu.edu/aars/policies/latedrops/policy/>. Students should be aware of the current deadlines and penalties for dropping classes.

Information about the latest changes and news is available at the [Advising Hub](#) at <http://www.sjsu.edu/advising/>.

## Assignments and Grading Policy

<b>Grading:</b>	Homework & Quizzes & projects (10%)	25%
	Midterm Exam #1:	22%
	Midterm Exam #2:	23%
	Final Exam:	30%

### Notes on Evaluation:

1. **If you turn in assignments late, maximum of 10% credits** will be given. Solutions to the homework assignments and all other info are posted in group site. Everyone must join in this site to get necessary info (Exam sol, Qz sol, HW assignments & sol, and other announcements).
2. **If 75% of combined HW, quizzes, & attendance are not done by end of semester, you will get F grade automatically.**
3. HW has to have cover page given in the group site otherwise you will not get any credits or deducted up to 100 percent. Final solutions on HW and exam must be boxed. Otherwise you will not get credits. Only one side of page must be used in the HWs. (No HW sending through an email will be accepted.) HW should be clean, legible, stapled on top left corner and proper paper should be used.
4. All exams are closed book and note. Only one 8.5 x 11 cheat sheet (both pages) is allowed for each exam (3 midterm exams). You can bring all three cheat sheets in the final exam (3 cheat sheet for the final exam).
5. **No make-up exams (no excuse will be accepted-that is why you get one extra exam), quizzes, HW (no acceptance through an email), Attendance at all. No incomplete grades will be given.** HW must be turned in on a given date only, otherwise it will not be accepted. Most likely, one quiz will be given once a week.
6. **If unreasonable or out of common sense behavior happens in the class, one will be asked to leave from the class and will be given "F" grade.** (No feet on a table or chair, taking hat off, no cellphone use or web surfing, no talking with neighbors). And I will drop you from the class if the class is disturbed unreasonably with my right.
7. **Attendance will be checked randomly (will be considered as one HW)** and will be counted as part of HW & Qz grading.
8. **No food** is allowed (Water is ok). It is mandatory to have a scientific calculator by within two weeks of semester and you need to carry it all the time. All the exams and quizzes are done in the class and only allowed to use pencil and eraser (no pen)
9. Grading criteria (Example: 74% results in a grade of C+):  
0<F<57<D-<60<D<64<D+<67<C-<70<C<74<C+<77<B-<80<B<84<B+<87<A-<90<A<100

### Exams & Term Project:

All exams are in-class. Two 8.5x11 front & back summary sheets *in your own handwriting* are allowed. No other photocopied problem solutions or any other course material is allowed. A term project that deals with an in depth study of a relevant application, including computer simulations or DSP board implementation, is mandatory

### **Homework:**

Homework is crucial for the understanding of the course material. Homework will be assigned regularly. Part will be fully graded and the rest will be checked for completeness. Solutions for only the analytical part of the problems will be provided. Part of the homework will require using Matlab. Please try to solve the homework problems on your own. This is critical if you are to understand the course material and to do well in the exams. Please note that the 5% for the homework can move your grade across grade boundaries (from B to B+ or A- to A, ... etc).

### **Numerical Grade to Letter Grade Conversion:**

95% and above	A+
90-94%	A
86-89%	A-
82-85%	B+
78-81%	B
74-77%	B-
70-73%	C+
66-69%	C
62-65%	C-
58-61%	D+
54-57%	D
50-53%	D-
below 50%	F

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Information about the latest changes and news is available at the [Advising Hub](http://www.sjsu.edu/advising/) at <http://www.sjsu.edu/advising/>.

### **Consent for Recording of Class and Public Sharing of Instructor Material**

[University Policy S12-7](http://www.sjsu.edu/senate/docs/S12-7.pdf), <http://www.sjsu.edu/senate/docs/S12-7.pdf>, requires students to obtain instructor's permission to record the course and the following items to be included:

- “Common courtesy and professional behavior dictate that you notify someone when you are recording him/her. You must obtain the instructor's permission to make audio or video recordings in this class. Such permission allows the recordings to be used for your private, study purposes only. The recordings are the intellectual property of the instructor; you have not been given any rights to reproduce or distribute the material.”

- It is suggested that the greensheet include the instructor's process for granting permission, whether in writing or orally and whether for the whole semester or on a class by class basis.
- In classes where active participation of students or guests may be on the recording, permission of those students or guests should be obtained as well.
- "Course material developed by the instructor is the intellectual property of the instructor and cannot be shared publicly without his/her approval. You may not publicly share or upload instructor generated material for this course such as exam questions, lecture notes, or homework solutions without instructor consent."

### **Academic integrity**

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at <http://www.sjsu.edu/senate/S07-2.htm>, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at [http://www.sa.sjsu.edu/judicial\\_affairs/index.html](http://www.sa.sjsu.edu/judicial_affairs/index.html). Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

### **Campus Policy in Compliance with the American Disabilities Act**

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. [Presidential Directive 97-03](http://www.sjsu.edu/president/docs/directives/PD_1997-03.pdf) at [http://www.sjsu.edu/president/docs/directives/PD\\_1997-03.pdf](http://www.sjsu.edu/president/docs/directives/PD_1997-03.pdf) requires that students with disabilities requesting accommodations must register with the [Accessible Education Center](http://www.sjsu.edu/aec) (AEC) at <http://www.sjsu.edu/aec> to establish a record of their disability.

### **Accommodation to Students' Religious Holidays**

San José State University shall provide accommodation on any graded class work or activities for students wishing to observe religious holidays when such observances require students to be absent from class. It is the responsibility of the student to inform the instructor, in writing, about such holidays before the add deadline at the start of each semester. If such holidays occur before the add deadline, the student must notify the instructor, in writing, at least three days before the date that he/she will be absent. It is the responsibility of the instructor to make every reasonable effort to honor the student request without penalty, and of the student to make up the work missed. See [University Policy S14-7](http://www.sjsu.edu/senate/docs/S14-7.pdf) at <http://www.sjsu.edu/senate/docs/S14-7.pdf>.

### **Student Technology Resources**

Computer labs for student use are available in the [Academic Success Center](http://www.sjsu.edu/at/asc/) at <http://www.sjsu.edu/at/asc/> located on the 1st floor of Clark Hall and in the Associated Students Lab on the 2nd floor of the Student Union. Additional computer labs may be available in your department/college. Computers are also available in the Martin Luther King Library. A wide variety of audio-visual equipment is available for student checkout from Media Services

located in IRC 112. These items include DV and HD digital camcorders; digital still cameras; video, slide and overhead projectors; DVD, CD, and audiotape players; sound systems, wireless microphones, projection screens and monitors.

## **SJSU Peer Connections**

Peer Connections, a campus-wide resource for mentoring and tutoring, strives to inspire students to develop their potential as independent learners while they learn to successfully navigate through their university experience. You are encouraged to take advantage of their services which include course-content based tutoring, enhanced study and time management skills, more effective critical thinking strategies, decision making and problem-solving abilities, and campus resource referrals.

In addition to offering small group, individual, and drop-in tutoring for a number of undergraduate courses, consultation with mentors is available on a drop-in or by appointment basis. Workshops are offered on a wide variety of topics including preparing for the Writing Skills Test (WST), improving your learning and memory, alleviating procrastination, surviving your first semester at SJSU, and other related topics. A computer lab and study space are also available for student use in Room 600 of Student Services Center (SSC).

Peer Connections is located in three locations: SSC, Room 600 (10th Street Garage on the corner of 10<sup>th</sup> and San Fernando Street), at the 1st floor entrance of Clark Hall, and in the Living Learning Center (LLC) in Campus Village Housing Building B. Visit [Peer Connections website](http://peerconnections.sjsu.edu) at <http://peerconnections.sjsu.edu> for more information.

## **SJSU Writing Center**

The SJSU Writing Center is located in Clark Hall, Suite 126. All Writing Specialists have gone through a rigorous hiring process, and they are well trained to assist all students at all levels within all disciplines to become better writers. In addition to one-on-one tutoring services, the Writing Center also offers workshops every semester on a variety of writing topics. To make an appointment or to refer to the numerous online resources offered through the Writing Center, visit the [Writing Center website](http://www.sjsu.edu/writingcenter) at <http://www.sjsu.edu/writingcenter>. For additional resources and updated information, follow the Writing Center on Twitter and become a fan of the SJSU Writing Center on Facebook. (Note: You need to have a QR Reader to scan this code.)



## **SJSU Counseling Services**

The SJSU Counseling Services is located on the corner of 7<sup>th</sup> Street and San Fernando Street, in Room 201, Administration Building. Professional psychologists, social workers, and counselors are available to provide consultations on issues of student mental health, campus climate or psychological and academic issues on an

individual, couple, or group basis. To schedule an appointment or learn more information, visit [Counseling Services website](http://www.sjsu.edu/counseling) at <http://www.sjsu.edu/counseling>.

## **EE Department Honor Code**

*The Electrical Engineering Department will enforce the following Honor Code that must be read and accepted by all students.*

*“I have read the Honor Code and agree with its provisions. My continued enrollment in this course constitutes full acceptance of this code. I will NOT:*

- *Take an exam in place of someone else, or have someone take an exam in my place*
- *Give information or receive information from another person during an exam*
- *Use more reference material during an exam than is allowed by the instructor*
- *Obtain a copy of an exam prior to the time it is given*
- *Alter an exam after it has been graded and then return it to the instructor for re-grading*
- *Leave the exam room without returning the exam to the instructor.”*

## **Measures Dealing with Occurrences of Cheating**

- *Department policy mandates that the student or students involved in cheating will receive an “F” on that evaluation instrument (paper, exam, project, homework, etc.) and will be reported to the Department and the University.*
- *A student’s second offense in any course will result in a Department recommendation of suspension from the University.*



# EE253

## Digital Signal Processing I, Fall, 2016

*Tentative Course Schedule (subject to change with fair notice)*

Week	Topics, Readings, Assignments, Deadlines
1	Introduction Time and frequency representation of discrete-time signals and systems
2	A/D & D/A conversion; sampling theorem
3	DFS, DTFT, and DFT properties of the DFT
4	Fast convolution & correlation
5	DFT computation using the DIT and DIF FFT; special applications
6	Spectra of sinusoids; resolution and leakage Midterm I
7	Time-varying spectra; the short time Fourier transform (STFT)
8	The Z-transform
9	Canonical realizations [chapters 13]
10	Example discrete-time systems; LP, HP, BP, BS, notch, comb, allpass
11	Linear Phase FIR filters
12	FIR filter design: window method & Frequency sampling Midterm II
13	FIR filter design: Optimum (Parks-McClellan) method
14	IIR filter design; impulse invariance & bilinear transformation IIR filter design; Butterworth, Chebyshev and elliptic designs
15	Digital filter implementation Quantization & round-off effects
Final Exam	