Digital Signal Processing

EE480/ECG680 Spring 2017

http://www.egr.unlv.edu/~b1morris/ee480

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Textbook

Discrete-Time Signal Processing, A. Oppenheim and R. Schafer, 3rd Edition ISBN: 978-0-13-198842-2

Recommended Text

Schaum's Outlines: Digital Signal Processing, M.H. Hayes ISBN: 0-07-027389-8

Grading

Final:	30%	5/09 13:00
Midterms:	50%	2/21, 3/30
Homework:	20%	Weekly

Homework will include Matlab programming problems. Students may study together in groups but all assignments must be completed individually. Homework will be due in class on the designated date. No late homeworks will be accepted unless prior notification and arrangements are made.

Catalog Description

Review of discrete linear system theory including the z-transform, the Fourier transform, discrete and fast Fourier transform. Sampling, reconstruction and multirate systems, IIR and FIR digital filter design including digital filter structures and finite word length effects.

Prerequisites: EE 361

Topics

- Discrete-time signals and systems
  - Linear time-invariant (LTI) systems and properties
  - Difference equation description of LTI systems
  - Discrete-time Fourier transform
- Z-transform
  - Properties of z-transform
  - Properties of the region of convergence (ROC)
  - Inverse z-transform methods of inspection, partial fractions, and power series expansion
- Sampling of continuous-time signals
  - Periodic sampling and reconstruction
  - Multirate systems
- Transform analysis of LTI systems

  - Frequency response and group delay
  - All-pass, minimum phase, and generalized linear phase systems
- Structures for discrete-time systems
  - Block and signal flow graph representation
  - Basic structures for IIR and FIR systems
    - Direct forms, cascade form, parallel form
- Filter design techniques
  - IIR filter design from continuous-time filters
  - FIR filter design by windowing
- Discrete and fast Fourier transforms

Additional course material not present in the textbook will be distributed to the class when needed. Extra problems can be found in the recommended texts. The Schaum series book has a number of worked problem solutions making it a good investment.

Course Objectives and Outcomes (Program) [UULO]
Upon completion of this course, students will be able to:

- Represent and analyze a discrete-time system (1.1, 1.2, 1.6, 1.9, 1.10) [1.1, 1.4, 1.6, 2.3, 2.4]
  - Model an LTI system by linear difference equations
  - Determine the discrete-time Fourier transform of signals and systems
  - Determine the z-transform of a signal and system
- Use sampling techniques to study LTI systems (1.1, 1.2, 1.4, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11) [1.1, 1.4, 1.6, 2.3, 2.4]
  - Determine the sampling constraints necessary for signal reconstruction without aliasing.
  - Use up- and down-sampling of signals in multirate systems to improve signal processing.
- Represent IIR and FIR structures for discrete-time systems (1.1, 1.2, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11) [1.1, 1.4, 1.6, 2.3, 2.4]
- Design IIR and FIR digital filters (1.1, 1.2, 1.4, 1.6, 1.8, 1.10, 1.11) [1.1, 1.4, 1.6, 2.3, 2.4]
  - Transform continuous-time filters into discrete-time IIR filters
  - Use windowing techniques for FIR filtering.
- Represent a finite length sequence by its discrete Fourier transform and compute the fast Fourier transform (1.1, 1.2, 1.4, 1.6, 1.9, 1.10, 1.11) [1.1, 1.4, 1.6, 2.3, 2.4]

Course Policies

- There will be no make-up exams or late homework without prior arrangements.
- Extensions will only be granted for medical emergencies or due to the observance of a religious holiday. The instructor must be notified of the absence prior to the last day of late registration.
- As a university student it is your responsibility to conduct yourself ethically and with integrity as described in the Academic Misconduct Policy. Cheating and plagiarism will not be tolerated. Any student caught cheating will be given an F grade.
  (`http://studentconduct.unlv.edu/misconduct/policy.html`)

Program Outcomes
To achieve these objectives and goals, each graduate of the Electrical Engineering Major will attain the following outcomes before graduation:

1. The appropriate technical knowledge and skills:
   - 1.1 an ability to apply mathematics through differential and integral calculus,
   - 1.2 an ability to apply advanced mathematics such as differential equations, linear algebra, complex variables, and discrete mathematics,
   - 1.3 an ability to apply knowledge of basic sciences,
   - 1.4 an ability to apply knowledge of computer science,
   - 1.5 an ability to apply knowledge of probability and statistics,
   - 1.6 an ability to apply knowledge of engineering,
   - 1.7 an ability to design a system, component, or process to meet desired needs within realistic constraints,
   - 1.8 an ability to identify, formulate, and solve engineering problems,
   - 1.9 an ability to analyze and design complex electrical and electronic devices,
   - 1.10 an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice,
   - 1.11 an ability to design and conduct experiments, as well as to analyze and interpret data.
2. Appropriate interpersonal skills
   - 2.1 an ability to function on multidisciplinary teams,
   - 2.2 an ability to communicate effectively.
3. The knowledge and skills to be responsible citizens
   - 3.1 an understanding of professional and ethical responsibility,
   - 3.2 the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context,
   - 3.3 a recognition of the need for, and an ability to engage in life-long learning,
   - 3.4 a knowledge of contemporary issues,
   - 3.5 a knowledge of the basic content and concepts of the U.S. and Nevada constitutions.

University Undergraduate Learning Outcomes (UULOs)
The five University Undergraduate Learning Outcomes (UULOs) define what all UNLV students should know and be able to do when they graduate. Because students engage with the UULOs in both their general education and academic majors, the UULOs help make the undergraduate experience intentional and coherent.

The UULOs create a purposeful sequence of learning from the first year, to the middle years, to the senior year. Student learning develops through both curricular and co-curricular experiences which expose students to the UULOs in diverse contexts.

UNLV defines specific student outcomes for each UULO.

1. Intellectual Breadth and Lifelong Learning
   Graduates are able to understand and integrate basic principles of the natural sciences, social sciences, humanities, fine arts, and health sciences, and develop skills and a desire for lifelong learning. Specific outcomes for all students include:
   - 1.1 Demonstrate in-depth knowledge and skills in at least one major area.
   - 1.2 Identify the fundamental principles of the natural and health sciences, social sciences, humanities, and fine arts.

1.3 Apply the research methods and theoretical models of the natural and health sciences, social sciences, humanities, and fine arts to define, solve, and evaluate problems.
1.4 Transfer knowledge and skills gained from general and specialized studies to new settings and complex problems.
1.5 Demonstrate lifelong learning skills, including the ability to place problems in personally meaningful contexts; reflect on one's own understanding; demonstrate awareness of what needs to be learned; articulate a learning plan; and act independently on the plan, using appropriate resources.
1.6 Achieve success in one's chosen field or discipline, including applying persistence, motivation, interpersonal communications, leadership, goal setting, and career skills.

2. Inquiry and Critical Thinking
Graduates are able to identify problems, articulate questions, and use various forms of research and reasoning to guide the collection, analysis, and use of information related to those problems. Specific outcomes for all students include:

2.1 Identify problems, articulate questions or hypotheses, and determine the need for information.
2.2 Access and collect the needed information from appropriate primary and secondary sources.
2.3 Use quantitative and qualitative methods, including the ability to recognize assumptions, draw inferences, make deductions, and interpret information to analyze problems in context, and then draw conclusions.
2.4 Recognize the complexity of problems, and identify different perspectives from which problems and questions can be viewed.
2.5 Evaluate and report on conclusions, including discussing the basis for and strength of findings, and identify areas where further inquiry is needed.
2.6 Identify, analyze, and evaluate reasoning, and construct and defend reasonable arguments and explanations.

3. Communication
Graduates are able to write and speak effectively to both general and specialized audiences, create effective visuals that support written or spoken communication, and use electronic media common to one's field or profession. Specific outcomes for all students include:

3.1 Demonstrate general academic literacy, including how to respond to the needs of audiences and to different kinds of rhetorical situations, analyze and evaluate reasons and evidence, and construct research-based arguments using Standard Written English.
3.2 Effectively use the common genres and conventions for writing within a particular discipline or profession.
3.3 Prepare and deliver effective oral presentations.
3.4 Collaborate effectively with others to share information, solve problems, or complete tasks.
3.5 Produce effective visuals using different media.
3.6 Apply the up-to-date technologies commonly used to research and communicate within one's field.

4. Global/Multicultural Knowledge and Awareness
Graduates will have developed knowledge of global and multicultural societies, and an awareness of their place in and effect on them. Specific outcomes for all students include:

4.1 Demonstrate knowledge of the history, philosophy, arts, and geography of world cultures.
4.2 Respond to diverse perspectives linked to identity, including age, ability, religion, politics, race, gender, ethnicity, and sexuality; both in American and international contexts.

4.3 Apply the concept of social justice.
4.4 Demonstrate familiarity with a non-native language, or experience living in a different culture.
4.5 Function effectively in diverse groups.
4.6 Demonstrate awareness of one's own place in and effect on the world.

5. Citizenship and Ethics
Graduates are able to participate knowledgeably and actively in the public life of our communities and make informed, responsible, and ethical decisions in their personal and professional lives. Specific outcomes for all students include:

5.1 Acquire knowledge of political, economic, and social institutions.
5.2 Identify the various rights and obligations that citizens have in their communities.
5.3 Apply various forms of citizenship skills such as media analysis, letter writing, community service, and lobbying.
5.4 Explain the concept of sustainability as it impacts economic, environmental, and social concerns.
5.5 Examine various concepts and theories of ethics, and how to deliberate and assess claims about ethical issues.
5.6 Apply ethical concepts and theories to specific ethical dilemmas students will experience in their personal and professional lives.

University Policies

Academic Misconduct –Academic integrity is a legitimate concern for every member of the campus community; all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy and are encouraged when faced with choices to always take the ethical path. Students enrolling in UNLV assume the obligation to conduct themselves in a manner compatible with UNLVs function as an educational institution.

An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another, from the Internet or any source, without proper citation of the sources. See the *Student Academic Misconduct Policy* (approved December 9, 2005) located at: `https://www.unlv.edu/studentconduct/student-conduct`.

Copyright – The University requires all members of the University Community to familiarize themselves and to follow copyright and fair use requirements. **You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you nor assume any responsibility for employee or student violations of fair use laws**. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: `http://provost.unlv.edu/copyright`.

Disability Resource Center (DRC) – The UNLV Disability Resource Center (SSC-A 143, `http://drc.unlv.edu/`, 702-895-0866) provides resources for students with disabilities. If you feel that you have a disability, please make an appointment with a Disabilities Specialist at the DRC to discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor before or after class to discuss your accommodation needs.

Religious Holidays Policy – Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor **within the first 14 calendar days of the course for fall and spring courses (excepting modular courses), or within the first 7 calendar days of the course for summer and modular courses**, of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit: `http://catalog.unlv.edu/content.php?catoid=6&navoid=531`.

Transparency in Learning and Teaching – The University encourages application of the transparency method of constructing assignments for student success. Please see these two links for further information:
`https://www.unlv.edu/provost/teachingandlearning`
`https://www.unlv.edu/provost/transparency`

Incomplete Grades – The grade of I – Incomplete – can be granted when a student has satisfacto-

rily completed all course work up to the withdrawal date of that semester/session but for reason(s) beyond the student's control, and acceptable to the instructor, cannot complete the last part of the course, and the instructor believes that the student can finish the course without repeating it. The incomplete work must be made up before the end of the following regular semester for undergraduate courses. Graduate students receiving "I" grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the time indicated, a grade of F will be recorded and the GPA will be adjusted accordingly. Students who are fulfilling an Incomplete do not register for the course but make individual arrangements with the instructor who assigned the I grade.

Library Resources – Students may consult with a librarian on research needs. For this class, the subject librarian is `https://www.library.unlv.edu/contact/librarians_by_subject`. UNLV Libraries provides resources to support students access to information. Discovery, access, and use of information are vital skills for academic work and for successful post-college life. Access library resources and ask questions at `https://www.library.unlv.edu/`.

Tutoring and Coaching – The Academic Success Center (ASC) provides tutoring, academic success coaching and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, visit `http://www.unlv.edu/asc` or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of the SSC (ASC Coaching Spot). Drop-in tutoring is located on the second floor of the Lied Library and College of Engineering TEB second floor.

UNLV Writing Center – One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC-3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 702-895-3908. The student's Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: `http://writingcenter.unlv.edu/`

Rebelmail – By policy, faculty and staff should e-mail students' Rebelmail accounts only. Rebelmail is UNLV's official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students' e-mail prefixes are listed on class rosters. The suffix is always `@unlv.nevada.edu`. **Emailing within WebCampus is acceptable**.

Final Examinations – The University requires that final exams given at the end of a course occur at the time and on the day specified in the final exam schedule. See the schedule at: `http://www.unlv.edu/registrar/calendars`