

**Digital Signal Processing  
Fall, 2019**

**Lecture: on M W F, 13:00 – 13:50 in MSEC 101**

**Lab: on M W R, 14:00 – 17:00 in Workman 187**

**Instructor:** Sihua Shao

**Office:** Workman 209

**Phone:** (575)835-5932

**E-mail:** [sihua.shao@nmt.edu](mailto:sihua.shao@nmt.edu)

**Office Hours:** 13:00 – 14:00 on Thursday and 14:00 – 16:00 on Friday or by appointment

**Teaching Assistant:** Daniel Mills

**Office:** Workman 196

**E-mail:** [daniel.mills@student.nmt.edu](mailto:daniel.mills@student.nmt.edu)

**Office Hours:** by appointment

**Course Description:** Digital signal processing (DSP) uses a sequence of numbers to represent samples of a continuous variable in a domain such as time, space and frequency. Due to its flexibility and economical implementation, DSP has been adopted in a wide range of applications. This course will cover the principles of digital signal processing. Topics include: discrete-time signals and systems, z-transform, infinite and finite impulse response filters, discrete and fast Fourier transforms, multi-rate processing, spectral estimation, and implementation of real-time DSP algorithms on state-of-the-art hardware.

**Pre-requisites/Co-requisites:** *EE 311 (Signals and Linear Systems) and EE 351 (Microcontroller)*

**Place in Curriculum:** This is a senior level required course for majors in Electrical Engineering.

**Course Learning Outcomes:**

After completion of this course, students are expected to be able to:

- Analyze discrete-time signals using Fourier series and Fourier transform.
- Analyze and design discrete-time systems using z-transform.
- Perform discrete Fourier transform of discrete-time signals.
- Design FIR and IIR filters to meet expected system specifications.
- Design difference equations to meet expected system specifications.
- Implement digital filters using MATLAB and on DSP board.
- Use computer and digital signal processor to create, analyze and process signals.
- Understand the limitations of digital signal processing.

**Program Learning Outcomes:** <https://www.nmt.edu/academics/eleceng/undergrad/index.php>

**Course Requirements:**

Textbook: *Proakis and Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 4th Edition, Prentice Hall, 2007.*

**Grading:**

- |                        |    |        |    |       |
|------------------------|----|--------|----|-------|
| • Lecture: 75%         | A  | 90-100 | C  | 70-72 |
| ○ Homework: 10%        | A- | 86-89  | C- | 66-69 |
| ○ Quizzes: 20%         | B+ | 83-85  | D+ | 63-65 |
| ○ 2 Midterms: 20% each | B  | 80-82  | D  | 60-62 |
| ○ Final: 30%           | B- | 76-79  | F  | <60   |
| • Lab: 25%             | C+ | 73-75  |    |       |

There will be no make-up exams or quizzes except in the case of extraordinary circumstances. Homework is due one week after the assigned date (e.g., if homework 1 is assigned on Aug. 28, then it is due on Sep. 4). Students may work together on homework, but must turn in individual assignments that CANNOT BE IDENTICAL.

**Academic Honesty:** New Mexico Tech's Academic Honesty Policy for undergraduate and graduate students is found in the student handbook, which can be found at: <http://www.nmt.edu/student-handbook>. You are responsible for knowing, understanding, and following this policy.

**Reasonable Accommodations:**

New Mexico Tech is committed to protecting the rights of individuals with disabilities. Qualified individuals who require reasonable accommodations are invited to make their needs known to the Office of Counseling and Disability Services (OCDS) as soon as possible. To schedule an appointment, please call 835-6619.

**Counseling Services:**

New Mexico Tech offers mental health and substance abuse counseling through the Office of Counseling and Disability Services. These confidential services are provided free of charge by licensed professionals. To schedule an appointment, please call 835-6619.

**Respect Statement:** New Mexico Tech supports freedom of expression within the parameters of a respectful learning environment. As stated in the New Mexico Tech Guide to Conduct and Citizenship: "New Mexico Tech's primary purpose is education, which includes teaching, research, discussion, learning, and service. An atmosphere of free and open inquiry is essential to the pursuit of education. Tech seeks to protect academic freedom and build on individual responsibility to create and maintain an academic atmosphere that is a purposeful, just, open, disciplined, and caring community."

**Title IX Reporting:**

Sexual misconduct, sexual violence and other forms of sexual misconduct and gender-based discrimination are contrary to the University's mission and core values, violate university policies, and may also violate state and federal law (Title IX). Faculty members are considered "Responsible Employees" and are required to report incidents of these prohibited behaviors. Any such reports should be directed to Tech's Title IX Coordinator (Dr. Peter Phaiah, 20D Brown Hall, 575-835-5187, [titleixcoordinator@nmt.edu](mailto:titleixcoordinator@nmt.edu)). Please visit Tech's Title IX Website ([www.nmt.edu/titleix](http://www.nmt.edu/titleix)) for additional information and resources.

**Tentative Lecture Schedule:**

| <b>Date</b>                 | <b>Chapter</b> | <b>Topic</b>                             |
|-----------------------------|----------------|--|
| Aug. 19, 21, 23             | Chap. 1        | Review of Signals and Systems            |
| Aug. 26, 28, 30             | Chap. 2        | Discrete-time Signals and Systems        |
| Sep. 2                      | Holiday        |  |
| Sep. 4, 6, 9                | Chap. 2        | Discrete-time Signals and Systems        |
| Sep. 11, 13, 16, 18, 20, 23 | Chap. 3        | z-transform                              |
| Sep. 25                     |                | Midterm 1                                |
| Sep. 27, 30; Oct. 2         | Chap. 4        | Frequency Analysis of Signals            |
| Oct. 4, 7, 9                | Chap. 5        | Frequency-domain Analysis of LTI Systems |
| Oct. 11, 14, 16, 21         | Chap. 7        | Discrete Fourier Transform               |
| Oct. 18                     | Holiday        |  |
| Oct. 23, 25                 | Chap. 8        | Fast Fourier Transform                   |
| Oct. 28, 30; Nov. 1, 4      | Chap. 9        | Implementation of Discrete-time Systems  |
| Nov. 6                      |                | Midterm 2                                |
| Nov. 8, 11, 13, 15, 18, 20  | Chap. 10       | Design of FIR and IIR Filters            |
| Nov. 22, 25, 27             | Chap. 11       | Multi-rate Digital Signal Processing     |
| Nov. 29                     | Holiday        |  |
| Dec. 2, 4, 6                | Chap. 14       | Power Spectral Estimation                |
| Dec. 9                      |                | Final                                    |

**Tentative Lab Schedule:**

| <b>Date</b>     | <b>Lab Topic</b>                                  |
|-----------------|---|
| Aug. 26, 28, 29 | Using Cypress FM4 with Keil MDK IDE               |
| Sep. 4, 5, 9    | Generating a Tone                                 |
| Sep. 11, 12, 16 | Data Acquisition                                  |
| Sep. 18, 19, 23 | Aliasing  |
| Sep. 25, 26, 30 | IIR Filters by Pole-Zero Placement                |
| Oct. 9, 10, 14  | FIR Filter  |
| Oct. 23, 24, 28 | Sounds effects                                    |
| Nov. 6, 7, 11   | IIR Filter Design and Fixed Point Implementations |
| Nov. 20, 21, 25 | FM Mod/Demod                                      |