1. *Course number and name*
   ENGR 451: Digital Signal Processing
2. *Credits and contact hours*
   3 credit hours; three 50-minute lecture sessions/week, or two 1-hr-15-minute lecture sessions/week, depending on semester
3. *Instructor's or course coordinator's name*
   Instructor: Tom Holton, Ph.D.
   Course coordinator: Tom Holton, Professor of Electrical and Computer Engineering
4. *Text book, title, author, and year*
   Holton, T. *Digital Signal Processing Course Notes*: www.sfsu.edu/~ee/451
   a. *Other supplemental materials*
      References:
      - Oppenheim, A.V., Schafer, R.W. and Buck, J.R. (2010): Discrete-time Signal Processing, 3rd Edition. Prentice-Hall.
      - Ifeachor, E.C. and Jervis, B.W. (2001): Digital Signal Processing: A Practical Approach, 2nd Edition. Addison-Wesley.
      - Mitra, S. K. (2010): Digital Signal Processing: A Computer-Based Approach. 4rd ed. McGraw-Hill.
      - Proakis, J.G. and Manolakis, D.G. (2006): Digital Signal Processing, 4th Edition. Macmillan.
5. *Specific course information*
   a. *Brief description of the content of the course (catalog description)*
      Properties of linear time-invariant systems. Convolution. Linear constant-coefficient difference equations. Frequency-domain representation of discrete-time signals. Discrete Fourier series and transform. Sampling and reconstruction of analog signals: aliasing, upsampling and downsampling. z-transforms and inverse z-transforms. Design and implementation of FIR and IIR filters. Minimum-phase, maximum-phase and all-pass systems. Discrete Fourier series and transform. Fast Fourier transform algorithms. Circular convolution. Applications in sound and image processing. Required laboratory with computer simulations using Matlab.
   b. *Prerequisites or co-requisites*
      ENGR 305 (Systems Analysis); ENGR 213 (Introduction to C Programming for Engineers) or CSC 210 (Introduction to Computer Programming) or
      ENGR 290 (Matlab), all with grades of C- or better.
   c. *Indicate whether a required, elective, or selected elective course in the program*
      Required for Electrical Engineering
      Required for Computer Engineering

6. *Specific goals for the course*
   a. *Specific outcomes of instruction, ex. The student will be able to explain the significance of current research about a particular topic.*
      - The student will demonstrate the ability to analyze discrete-time systems to determine their linearity, time invariance, causality and stability.
      - The student will demonstrate the ability to perform convolution.

- The student will demonstrate the ability to determine the frequency response of a discrete-time system.
- The student will demonstrate the ability to determine the impulse response of a discrete-time system.
- The student will demonstrate the ability to design and analyze sampled-data systems.
- The student will demonstrate the ability to analyze discrete-time upsampling and downsampling systems.
- The student will demonstrate the ability to compute z-transforms, inverse transforms and regions of convergence.
- The student will demonstrate the ability to determine the block-diagram representation of FIR and IIR systems from z-transform, impulse response or difference equations.
- The student will demonstrate the ability to design IIR discrete-time filters based on analog filters.
- The student will demonstrate a knowledge of circular correlation and fast Fourier transforms.
- The student will design, debug and test MATLAB algorithms to carry out design and analysis of specified discrete-time problems.

b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

Course addresses ABET Student Outcome(s): a, c, e, k.

7. Brief list of topics to be covered

- Introduce basic concepts of discrete-time signals and systems.
- Properties of linearity, time-invariant systems
- Convolution
- Discrete Fourier transform
- FIR and IIR filters
- Sampling of continuous-time signals (A/D and D/A)
- Upsampling/Downsampling
- z-Transform
- Structures of discrete-time filters
- Discrete Fourier Transform (DFT)
- Fast Fourier transform (FFT)
- Circular convolution