METROPOLITAN STATE UNIVERSITY OF DENVER
Office of Academic and Student Affairs

REGULAR COURSE SYLLABUS

College of: Professional Studies

Department: Engineering and Engineering Technology

Prefix & Course Number: CPE 4320 **Crosslisted With*:** _____

Course Title: Digital Filter Design

Transcript Course Title (30 characters): Digital Filter Design

Check All That Apply: Required for Major: X Required for Minor:_____ Specified Elective: _____

Required for Concentration: _____ Elective: _____ Service Course: _____

To receive Title IV financial aid funds, all institutions of higher education must comply with the federal definition of a credit hour. The Higher Learning Commission requires institutions to maintain policies and procedures for verifying compliance with this definition.

> ***Federal Credit Hour Definition:*** *A credit hour is an amount of work represented in intended learning outcomes and verified by evidence of student achievement that is an institutionally-established equivalency that reasonably approximates not less than:*
> *(1) one hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work each week for approximately fifteen weeks for one semester or trimester hour of credit, or ten to twelve weeks for one quarter hour of credit, or the equivalent amount of work over a different amount of time; or (2) at least an equivalent amount of work as required in paragraph (1) of this definition for other activities as established by an institution, including laboratory work, internships, practica, studio work, and other academic work leading toward to the award of credit hours. 34CFR 600.2 (11/1/2010)*

Credit Hours: 3 (2+2) **Schedule Type**: B **Grade Mode**: L

Face-to-Face or Equivalent Hours per course:

Lecture 30 Lab 30 Internship _____ Practicum _____ Other (please specify type and hours):_____

Additional Student Work Hours per course: 90

Variable topics umbrella course: **No** X **Yes** _____ If yes, number of credits/repeats allowed _____

Specified repeatable course: **No** X **Yes** _____ If yes, number of credits/repeats allowed _____

Prerequisite(s): CPE 2350 and CPE 3400 (with a grade of "C" or better for all prerequisites)

Corequisite(s): _____

Prerequisite(s) or Corequisite(s): _____

APPROVED:

Department Chair **OR** Program Director Date

Dean **OR** Associate Dean Date

Associate VP, Academic and Student Affairs Date

*If crosslisted, attach completed Course Crosslisting Agreement Form

Prefix and Course Number:

Banner Enforced Coding:
Prerequisite(s): CPE 2350 and CPE 3400 (with a grade of "C" or better for all prerequisites)
Corequisite(s): _____
Prerequisite(s) or Corequisite(s): _____

Registration restrictions: Level _____ **Class** _____**Program/Major** _____ **Student attribute** _____

Catalog Course Description:
This course introduces digital filters as applied in digital signal processing and sampled data control systems.

Specific Variable Topics Course Description (if applicable, umbrella course description included above):

Required Reading and Other Materials will be equivalent to:
Manolakis, Proakis (2007). *Digital Signal Processing 4th edition* or latest edition. Upper Saddle Hill, NJ: Prentice Hall.

Specific, *Measurable* Student Behavioral Learning Objectives:
Upon completion of this course the student should be able to:
1. Determine when to choose digital or analog filters using criteria such as
    a. Content of noise spectra
    b. Distance between analog data and the computer
    c. Likelihood of design changes
    d. Cost of components vs. cost of software development
    e. Time available for processing results
2. Design simple classical filters, which are recursive and non-recursive
3. Apply computer programs to accomplish
    a. Fourier analysis
    b. Fast Fourier Transform
    c. Discrete Fourier Transform
    d. Power Spectra

Detailed Outline of Course Content (Major Topics and Subtopics) **or Outline of Field Experience/Internship (experience, responsibilities and supervision):**

I. Sinusoids
    A. Review of Sine and Cosine Functions Response
    B. Sinusoidal Signals
    C. Sampling and Plotting Sinusoids
    D. Complex Exponentials and Phasors
    E. Phasor Addition

II. Spectrum Representation
    A. The Spectrum of a Sum of Sinusoids
    B. Periodic Waveforms
    C. Time-Frequency Spectrum

III. Sampling and Aliasing
    A. Sampling
    B. Spectrum View of Sampling
    C. Discrete-to-Continuous Conversion
    D. The Sampling Theorem

IV. FIR Filters
- A. Discrete-Time Systems
- B. The General FIR Filter
- C. Implementation of FIR Filters
- D. Linear Time-Invariant (LTI) Systems
- E. Convolution and LTI Systems

V. Frequency Response of FIR Filters
- A. Sinusoidal Response of FIR Systems
- B. Steady State and Transient Response
- C. Graphical Representation of the frequency response
- D. Filtering sampled continuous-time signals

VI. Z-transform
- A. Definition of the Z-transform
- B. Properties of the Z-transform
- C. The Z-transform as an operator
- D. Convolution and the Z-transform
- E. Relationship between the Z-domain and the w-domain
- F. Useful filters
- G. Practical Bandpass filter design

VII. IIF Filters
- A. The general IIR difference equation
- B. Time-domain response
- C. System function of an IIR filter
- D. Poles and Zeros
- E. Frequency response of an IIR filter
- F. The Inverse Z-transform and some applications

VIII. Spectrum Analysis
- A. Spectrum analysis by filtering
- B. Spectrum analysis of periodic signals
- C. Spectrum analysis of sampled periodic signals
- D. Spectrum analysis of non-periodic signals
- E. The Fast Fourier Transform (FFT)

Evaluation of Student Performance:

1. Examinations
2. Lab Reports
3. Written Assignments