Subject: **Digital Signal Processing**

**Summary:** This exam will evaluate the student's undergraduate and junior graduate mature understanding of Digital Signal Processing and its related subject areas. The specific subjects to be addressed are provided as keywords below. The student is expected to understand the basic DSP concepts and their applicability to other fields (e.g. communications, control, speech or image processing).

**Keywords**

- Discrete-time signals and systems
- Sampling of continuous-time signals, A/D and D/A conversion, Nyquist rate
- Discrete-time linear convolution, circular convolution
  - Linear filtering with FFT/IFFT, overlap-save method, overlap-add method
- Fourier analysis and spectral analysis of signals
  - Discrete-time Fourier transform (DTFT), Discrete Fourier transform (DFT)
  - Fast Fourier transform (FFT)
  - Short-time Fourier transform (STFT), spectrogram
- Frequency response, impulse response
- z-transform, inverse z-transform, region of convergence (ROC)
- Transfer functions, pole-zero diagrams
- Frequency selective filters, lowpass, highpass, bandpass, bandstop, all-pass
- Digital filter characteristics
  - FIR, IIR, stability, causality, Type I-IV FIR filters
  - Minimum-phase, maximum-phase, mixed-phase, linear phase, group delay
- Filter structures, direct form I & II, cascade, parallel, lattice, transposed
  - Effects of coefficient quantization, round-off noise analysis, limit cycles
- Digital filter design techniques
  - Infinite impulse response windowing, Gibbs' phenomenon
  - Frequency sampling method, optimal equiripple
  - Impulse invariance method, bilinear transformation method
- Basic concepts of adaptive signal processing:
  - Least Mean Squares (LMS) adaptation and its variations
  - Recursive Least Squares (RLS)
- Multirate signal processing and rate conversion
  - Decimators, interpolators, polyphase decomposition
- Auto-correlation and cross-correlation of signals
- Characterization of discrete random signals and noise
- Spectral estimation, non-parametric vs. parametric,
  - Periodogram, Bartlett, Welch, Blackman & Tukey methods
- DSP programmable processors
  - characteristics, architecture, and internal bus structure
  - special instructions and addressing modes
  - examples of current processors (e.g. Texas Instruments-TMS320 family, Motorola 56xxx family, Analog Devices Inc., ...)