Engr325 **Exam #1 Outline** **Winter, 2020**

The exam will be closed book. All necessary paper will be provided for you. Materials that you may use at the test are:

- Your calculator.
- One side of an 8.5"x11" cheat sheet that you may put anything on that you wish. Suggestions include:
  - Lecture material from class;
  - Lab material from lab and lab handouts;
  - Homework specific issues.

Topics covered in our reading, lecture, homework, or lab from which exam questions may come include:

- **Lecture**
  - Course Introduction
    - Reference – Chapter 1
      - Typical instrumentation system components
  - Circuits review
    - Reference – Circuits text book
      - Ohm's law, power, voltage dividers
      - Instrument loading, input and output impedance
  - AC Signals
    - Reference – Chapter 2.3
      - AC Measurement – True RMS, average values
  - Measurement Characteristics
    - Reference – Chapter 1, Lecture notes
      - Measurement terms – resolution, accuracy, precision, etc.
      - Measurement errors and sources
        - Systematic vs. random sources of error
      - Calibration
      - Sensor overview
  - Data Acquisition and Number Systems
    - Reference – Lecture notes
      - Analog vs. digital
      - Waveform characteristics
      - Binary number system
      - Number systems conversion
  - Digital sampling
    - Reference – Chapter 2.4-5
      - Analog-to-Digital conversion
      - Terms – Full scale range (span), sampling rate, resolution, etc.
      - Other terms – Quantization error, aliasing, etc.
  - Data Integrity
    - Reference – Lecture notes
      - Single- vs. differential inputs

- Fourier Series and Fourier Transforms
  - Reference – Chapter 2.4-5
    - Sampling rate and number of samples in the time domain
      - Nyquist frequency and rate
    - Fourier Series
      - Symmetry – Odd, even
    - Frequency spacing in the frequency domain
- Filtering
  - Reference – 6.8
    - Active vs. passive filters
    - Analog vs. digital filters
    - Filter types – low-pass, high-pass, band-pass, and band-stop

- **Lab**
  - Lab #1 – AC and DC Measurements
    - Ohm's law
    - Voltage division
    - Loading effect
    - Sinusoidal and non-sinusoidal voltage measurement
  - Lab #2 – Calibration
  - Lab #3 – Data acquisition
    - Sampling rate, number of samples, arbitrary waveform analysis
  - Lab #4 – The Fourier Transform
    - Aliasing, sampling rate
  - Lab #5 – Mobile device data acquisition and analysis
- **Homework**
  - HW#1 – Basic concepts
  - HW#2 – Matlab and number systems
  - HW#3 – A/D Converter characteristics
    - Sampling rate, bit-depth, full-scale range (span), resolution in terms of bits
    - Terms related to ADC's
  - HW#4 – Sampling and Fourier Series
  - HW#5 – Field trip
  - HW#6 – Matlab mobile app

Notes:
Chapter 7 section 7.5 on voltage measurements defines A/D converter resolution, quantization error, saturation error, and conversion error. Some of your HW problems touched on this. Given the range or span of a converter and the number of bits, be able to determine its voltage resolution. Or conversely, if a certain voltage resolution is needed determine how many bits the converter needs. Pretty certain a question along these lines will appear.

Related to the A/D is determining how fast and long to sample to obtain data that can be transformed to find constituent frequencies using the Fourier transform. Chapter 7 section 7.2 is the relevant reference with theoretical background coming from chapter 2 sections 2.3-4. I will focus on the applied aspect, i.e. how fast to sample as related to frequencies in the signal. Nyquist frequency and Nyquist sampling rate are terms you should know. Also, what determines the frequency scale on a spectral plot, i.e. the plots we created in lab.

Turning to electrical details and concepts, ohms law will go a long way here. Know it. In the first lecture or two, and lab 1, the concept of loading was covered. Chapter 6, section 6.5 covers that. Voltage and current division – for sure.