Engr325 **Exam #2 Outline** **Winter, 2020**

The exam will be comprehensive and closed book. No materials other than your pen or pencil may be used. Study suggestions include:

- Lecture material from class;
- Lab material from lab, and lab handouts;
- Homework specific issues;
- Student presentation notes;
- Student test questions from in-class project presentations.

Questions may come from topics covered in our reading, lecture, homework, or labs. Topics in **bold** have been covered since the first exam.

- **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, Nyquist criteria
  - 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
- Analog and Digital Filtering
  - Reference – 6.8
    - Active vs. passive filters
    - Analog vs. digital filters
    - Filter types – low-pass, high-pass, band-pass, and band-stop
- **Sensor Overview**
- **Acceleration Sensors and Measurement**
  - **Reference – 12.2**
    - **Types and principles of operation**
- **Strain Gauges and Strain Measurement**
  - **Reference – 11.1-6**
    - **Types and principles of operation**

- **Student Presentations**
  - **Thermocouples**
  - **Resistance Temperature Detectors**
  - **Thermistors**
  - **Pressure Measurement**
  - **Piezo-electric and Piezo-resistive Transducers**
  - **Distance Measurement**
  - **Microelectromechanical Systems (MEMS)**
  - **Force and Torque Measurement**
  - **Acoustical Measurement**
  - **Flow Measurement**
  - **Ultrasonic Measurement**
  - **Hall Effect and Magnetic Sensors**

- **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 Devices
  - **Lab #6 – Acceleration and Vibration Testing**
    - **Time domain and frequency domain (fft's) analysis**
  - **Lab #7 – Motion Analysis**
    - **Video analysis**
    - **Measurement of position, velocity, and acceleration**
    - **Filtering**

        - **Fourier analysis and frequency components**
    - **Lab #8 – Strain Gauges and/or Force Measurement (Extra Credit)**

- **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
    - **HW#7 – Student presentations**