1. EM375 Engineering Experimentation

2. Credit Hours (3)/Contact Hours (4)

3. Course Director – Luksa Luznik

4. Reference: Doubt Free Uncertainty in Measurement: An Introduction for Engineers and Students; Springer, 2015 – ISBN 978-3-319-12062-1

5. Specific course information

a. A design course that emphasizes the theory and practical considerations associated with contemporary experimental procedures, methods and design strategies. Topics include measurement error and its propagation, equation fitting and plotting, signal acquisition and validation, instrument response and elements of experimental design. Emphasis includes computer aided data reduction, modeling of a system and report writing.
b. Prerequisites: SM212, EM217 and EM232
c. Required Mechanical Engineering Programs

6. Educational objectives for the course

a. calculate probabilities based on the binomial and normal distribution.
b. determine confidence intervals for the statistics determined from measured data.
c. design experiments based on expected statistical outcomes.
d. use MATLAB for the reduction and analysis of experimental engineering data.
e. regress linear and nonlinear experimental data, and determine governing properties from the analysis.
f. identify and categorize errors associated with instruments and measurements, and propagate these errors to the final result.
g. interpret the dynamic performance of measurement systems.
h. develop mathematical simulations based on subsystem, prototype and material testing, and use these simulations to predict the performance of a mechanism.
i. communicate effectively by written report.

7. Specific program outcomes addressed by this course

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Reinforced | X | | | | X | | |
| Mastered | | | | | | X | |

8. Brief list of topics to be covered
    a. Probability and Statistics - Fundamentals
        i. Binomial Distribution
        ii. Poisson Distribution
        iii. Normal distribution
        iv. Student t distribution – confidence intervals
    b. Correlation
    c. Regression Models
        i. Linear regression
        ii. Non-linear regression
    d. Dynamics of Measuring Systems
        i. 0th order systems – Camera's CCD chips and basics of image processing
        ii. 1st order systems (step, ramp and sinusoidal input solutions)
    e. Uncertainty Analysis
        i. Elemental, standard and expanded uncertainties - definitions
        ii. Classification: Type A and B Elemental uncertainties
        iii. Calculation of standard uncertainties
        iv. Calculation of expanded uncertainties
        v. Propagation of uncertainty with multiple measurands
        vi. Uncertainty budget
    f. Project