Introduction to ME Measurements

1. Course Structure and Requirement
   ➢ (See “ME 618 assignment” and “ME618 rules”)

2. Lab Report Format (General Requirement)
   ● Cover page (one page)
     ➢ Experimental title
     ➢ Author’s name
     ➢ Group #; teammate names, underline leader’s name
     ➢ Date performed; date submitted
     ➢ Instructor’s name; course #

   ● Table of content (one page)
     ➢ Sequential order of content
     ➢ Page # (starts from “introduction”)

   ● abstract (one page)
     ➢ 100~250 words
     ➢ Objectives (what performed)
     ➢ Methodology (how performed)
     ➢ Conclusive findings and remarks

   ● Introduction (less than one page)
     ➢ Application background (examples)
     ➢ Experimental objectives
     ➢ Brief summary of methodology of experiment

   ● Theoretical Principles (Equations/brief explanation)
     ➢ Theory of experimental method
     ➢ Theory of data analysis method
     ➢ No sample calculations!
• Experimental Methodology
  ✓ Experimental system
    ◆ Schematic diagram (with photos of actual system)
    ◆ Brief description of system operation
  ✓ Major measurement system
    ◆ Schematic diagram (with photos)
    ◆ Brief description
  ✓ Maker and model # of major components

• Sample Analysis (one complete set)
  ✓ Step by step example calculation:
    ◆ Use actual data for illustration
    ◆ From original to final (in Table or Fig)
  ✓ Identify software resources if used

• Results and Discussion
  ✓ Itemized presentation
    ◆ Measurement based, or
    ◆ Phenomena or objective based
  ✓ Table or Figure based discussion
    ◆ Figure based (preferred)
    ◆ Complete data (tables) in Appendix
    ◆ Comparison with theory
    ◆ Physical interpretation
  ✓ Error Analysis
    ◆ Error resources identification
    ◆ Quantify error margin (if possible)
  ✓ Suggestions for measurement improvement
    (not required)

• Conclusion
  ✓ Major findings
    ◆ Range of experimental data and error margin
3. Sensor Characteristics

- Resolution (readability)
- Response time or frequency

\[ f = \frac{1}{\tau} \]
Repeatibility  
(Statistical probability) (see lecture-2)

Linearity

Signal-to-Noise Ratio (S/N)
Simple R-C Filter characteristics
Low-pass RC Filter

\[ \frac{C}{R} \frac{de_0}{dt} + \frac{1}{R} e_0 = \frac{e_i}{R} \]

High-pass RC Filter

\[ C \frac{de_0}{dt} + \frac{1}{R} e_0 = C \frac{e_i}{R} \]

\[ \left( \frac{V_0}{V_i} \right)_{LP} = \frac{1}{\sqrt{1 + (f / f_c)^2}} \]

\[ \phi_{LP} = -\tan^{-1}(f / f_c) \]

\[ f_c = \frac{1}{2\pi RC} \quad \text{cut-off frequency} \]
\[
\left(\frac{V_0}{V_i}\right)_{HP} = \frac{RC2\pi f}{\sqrt{1 + (RC2\pi f)^2}} = \frac{f / f_c}{\sqrt{1 + (f / f_c)^2}}
\]

\[
\phi_{LP} = \frac{\pi}{2} - r = \frac{\pi}{2} - \tan^{-1}(f / f_c) = \frac{\pi}{2} + \phi_{LP}
\]

Define \( \frac{V_0}{V_i} (dB) = 20 \log \left( \frac{V_0}{V_i} \right) \)
Monotonic / Non-monotonic Response