

University of North Carolina at Charlotte

Measurement and Instrumentation

PhD Qualifier: Sample

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Instructions: Complete the three of the following five problems. Clearly mark the problems you wish to have graded. The only materials allowed to complete this exam are a pencil/pen and a calculator (if desired).

For each problem answered:

- state all assumptions used in your answers,
- indicate all equations used in calculations.

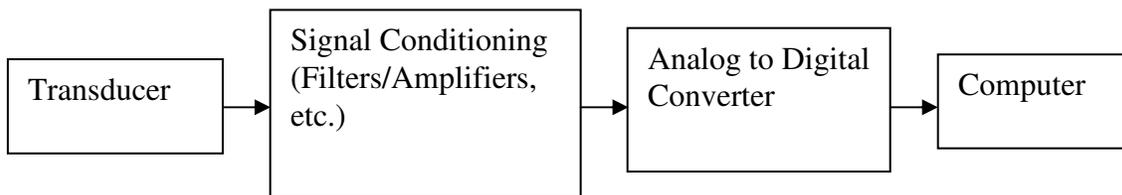
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1. Complete the following regarding the operation and utilization of a phase locked loop.
 - a. Explain the principle of operation.
 - b. Devise and explain a method for the utilization of a phased locked loop in the measurement of the thickness of a thin film that is being deposited onto a piezoelectric element.

2. Explain the operation and characteristics of three different temperature transducers. For each, using sketches of typical performance curves, describe the relationship between temperature and electrical properties. Also, give the typical range of operating temperatures for each transducer.

3. Propose a method for measurement of the following.
 - a. Pressure in a pipe.
 - b. Pressure at the center of the Earth.
 - c. Pressure at the interface of two clamped plates.

4. A typical measurement process will involve the following components serially connected as shown in the following diagram.



Discuss the major sources of uncertainty in each component of this measurement process. Show how to compute the combined uncertainty in the measurement process from the uncertainties of each element.

5. Operational amplifiers are important for signal conditioning. Draw circuits that use operational amplifiers, resistors and capacitors to provide the following functions: (1) amplification; (2) inverted amplification; (3) low-pass filtering; and (4) high pass filtering. For (3) and (4) sketch frequency response functions, and indicate how the characteristics of the frequency response functions are related to the values of the resistors and capacitors in your circuit diagrams.