EE 4770 **Homework 1** **Due: 5 February 1997**

Problem 1: Design a system for converting process variable $x \in [0, 125\,\mathrm{m}]$, the length of magnetic tape wound on a spool, to a floating-point number `length` $= H(x) = x\frac{1}{\mathrm{m}}$. The tape is 15 μm thick and does not shrink or stretch; it is wound tightly on the spool so there is no space between the layers of tape. The inner diameter of the spool (without tape) is 5 mm. The radius of the surface layer of tape can be determined by a mechanical contact free to move radially (so its position is linearly related to the surface-layer radius).

The solution should:

- Specify a transducer to convert the position of the mechanical contact to an electrical quantity. You are encouraged to choose the transducer so that the conditioning circuit is as simple as possible.
- Show the mapping between tape length and surface-layer radius.
- Show the mapping between outer radius and transducer response[1].
- Use a 5-volt, 8-bit, analog-to-digital converter.
- Design the conditioning circuit to make full use of the ADC's dynamic range.
- Show the mapping between ADC output and `length`, H_f.
- Include a schematic showing all component and supply values.
- Include pseudocode for the interface routine; specify values for all constants.

Problem 2: Determine the precision of the value written to `length` in the problem above.

Problem 3: Design a system for converting process variable $x \in [0, 125\,\mathrm{m}]$, the length of magnetic tape wound on a spool, to a voltage $H(x) = x\frac{10\,\mathrm{V}}{\mathrm{m}}$. The tape and mechanical parts are the same as above. The solution should use only analog components. See footnote for hint[2].

[1] Since a variable resistor is the only transducer covered, "transducer response" can be replaced with "transducer resistance."

[2] Hint: Use two variable resistor transducers (measuring the same displacement) and use each in a different inverting amplifier.