ME 449/549 Learning Objectives Spring 2006

Temperature Measurement

At the end of Week 1 you should be able to

1. Use the thermocouple welder to fabricate thermocouple junctions.
2. Solder extension wires a the thermocouple.
3. Construct a thermocouple circuit using an ice point reference junction.
4. Construct a thermocouple circuit using a floating zone box reference junction.
5. Convert the resistance of a YSI 44006 thermistor to temperature.
6. Convert thermocouple emf to temperature for thermocouple circuits
   (a) with a conventional ice-point reference junction,
   (b) with a separate ice-point reference junction,
   (c) with a zone box reference junction at an arbitrary temperature.
7. List the advantages and disadvantages of using thermocouples for temperature meausurement.
8. List the advantages and disadvantages of using thermistors for temperature meausurement.

Velocity Measurement

At the end of Week 2 you should be able to

1. Compute the velocity of the fluid approaching a Pitot probe given the reading of a manometer connected to the probe.
2. Explain why we did not use a Pitot probe to measure the velocity in the wind tunnel.
3. Explain the conceptual difference between measuring velocity at a point and measuring the volumetric flow rate in a duct.
4. Describe the operating principle of the thermal anemometer used in the lab.
5. Sketch the ideal (desired) velocity profile in the wind tunnel, including the correct boundary values.
6. Explain the significance of using Re_x instead of Re_{D_h} to characterize the flow in the small wind tunnels.

Flow Rate Measurement with the Flow Bench

At the end of Week 3 you should be able to

1. Identify the key components of the flow bench and explain their role in making measurements and controlling the flow rate.
2. Describe how to adjust the flow rate through the device under test (DUT).
3. Convert voltage to pressure for the pressure transducers on the flow bench.
4. Use the equations

$$Q = C_d A_n \sqrt{\frac{2\Delta p}{\rho(1-\beta^4)}}$$

$$C_d = 0.9986 - \frac{7.006}{\sqrt{\mathrm{Re}_n}} + \frac{134.6}{\mathrm{Re}_n}$$

   to compute the flow rate through a long radius nozzle. In other words, given values of d_n, Δp, ρ, and β, compute Q.

5. Properly connect the upstream pressure transducer to the plenum pressure tap for fan curve and system curve measurements.
6. Obtain the least squares curve fit value of c in the equation $\Delta p = cQ^2$, where Δp is the pressure drop across a screen, and Q is the volumetric flow rate through the screen. Note that c can be computed from a simple formula involving a ratio of sums.
7. Convert c in $\Delta p = cQ^2$ to a minor loss coefficient K_L in $h_L = K_L V^2/(2g)$, where h_L is the head loss (with the dimension of length).
8. Describe the purpose, and possible side effects, of using a plate to limit the flow area when loss coefficients for perforated plates are measured.
9. Describe the effect of changing the input voltage on a DC fan.

Uncertainty Analysis:

At the end of Week 4 you should be able to

1. Write the analytical expression for the uncertainty δR given a data reduction formula of the generic form $R = f(x_1, x_2, \ldots, x_n)$. Apply this expression for δR to any analytical formula for R.
2. Combine uncertainties from *independent* sources, e.g. δT_{rand}, δT_{cal}, and δT_{inst}.
3. Develop the computational procedure for uncertainty analysis using the sequential perturbation method: Given $R = f(x_1, x_2, \ldots, x_n)$, write down the procedure for computing δR. Apply this procedure for δR to a specific formula for R.
4. Identify the role of the standard deviation of a series of sensor readings when an uncertainty analysis is performed.

Data Acquisition:

At the end of Week 5 you should be able to

1. Explain the role of a multiplexer
2. Describe the effect of increasing or decreasing the number of bits in the analog to digital conversion process.