ME318L F2006: Final Homework

Part 1 (5 points)

Select the correct answer. More than one choice may apply.

1. An industrial scale has a known systematic uncertainty of 0.3 kg and a standard deviation of ±0.2 kg. Based only on this information, the total uncertainty of a single measurement is
   - 0.5 kg
   - 0.42 kg
   - 0.36 kg
   - 0.25 kg

2. The strain gauge shown here is best used to measure
   - Uniaxial loading
   - Biaxial loading with known direction of axes
   - Loading with unknown direction of axes
   - Growth rate of mutant chickens

3. A Calendar-Van Dusen equation...
   - Is used to measure temperature for RTDs based on resistance
   - Can be used for either “European” or “US” calibration curve
   - Is a correlation, not an analytical result
   - Requires the user to supply the temperature in degrees Celsius

4. A geometric interpretation of the Strouhal number $St$ is...
   - $L/D$, where $D$ is cylinder diameter and $L$ distance between two successive vortices
   - Same as above, but the vortices must be shed on the same side of the cylinder
   - $fD/V$, where $f$ is shedding frequency and $V$ flow speed

5. OSHA general industry PEL (permissible exposure limit) for CO$_2$ is...
   - 700 ppm
   - 5000 ppm
   - 5000 ppb
   - 0.12 ppm
Part 2. Solve these problems (5 points each)

A force transducer is used to measure the angular velocity \( \omega \) of a shaft based on the centrifugal force on a small mass \( m = 0.1 \pm 0.0005 \) kg attached to the shaft at a distance \( r = 0.02 \pm 0.00002 \) m from its axis of rotation using the formula \( F = mr\omega^2 \). Find \( \omega \) and its uncertainty, knowing that the measured value of \( F \) is 500N±0.1%.

A metal strip has the dimensions 20.32×2.54×0.16 cm. It is subjected to an axial load (in the direction of its longest dimension) of 4500 N. Two strain gauges are attached to the strip, one in the direction of the loading, the other in the transverse directions. The gauges are reading 1150 and -290 \( \mu \)-strain correspondingly. Find the Young's modulus and Poisson's ratio for the material.

A critical flow nozzle with a throat diameter 2 mm measures the flow of hydrogen to an atmospheric pressure burner. The pipe diameter is 1 cm, the upstream temperature for hydrogen is 20°C, the specific heat ratio is \( \gamma = 1.4 \) for hydrogen. Assuming that the discharge coefficient is 1, find the minimal pressure for the hydrogen supply to maintain critical flow through the nozzle. Also find the mass and volumetric flow rate (the latter in SCMM) if the hydrogen supply pressure is 3 atm gauge.

Part 3. Will be credited 3 points ONLY if the perfect score for parts 1-2 is attained.

A machined entrance cone venturi tube (ASME standard) is fit in a water pipe (5.25 cm diameter). Find the water flow rate if the minimum diameter of the venturi is 3 cm and the pressure drop 14 kPa.