ME 360: FUNDAMENTALS OF SIGNAL PROCESSING, INSTRUMENTATION, AND CONTROL

Experiment No. 3
Noise Reduction Techniques, Instrumentation Amplifiers, and Strain Gage Measurements
Data Sheet

5.1 EFFECT OF SHIELDING ON ELECTROMAGNETICALLY COUPLED NOISE (5 PTS)

	Peak-to-peak Noise Level	
Shield	Normal	Close to AC Power Cord
Ungrounded		
Grounded		

Observations:

5.2 EFFECT OF CONDUCTOR TWISTING ON INDUCTIVELY COUPLED NOISE (5 PTS)

Loop	Peak-to-peak Noise Level
Untwisted	
Twisted	

Observations:

5.3 INSTRUMENTATION AMPLIFIER GAIN, COMMON MODE GAIN, AND OFFSET (20 PTS)

Amplifier Offset Voltage Measurement ($V_+ = V_- = 0$ V)	
Offset Voltage [V] = $V_{offset} = V_{out}$	

Amplifier Common Mode Gain and CMRR ($V_+ = V_- = 0$ V, 5 V)	
Input Voltage V_{in} [V]	
Output Voltage (5-V supply off) V_{off} [V]	
Output Voltage (5-V supply on) V_{on} [V]	
Common Mode Gain [–] = $G_{CM} = (V_{on} - V_{off}) / V_{in}$	
CMRR [dB] = $20 \log_{10} (G / G_{CM})$	

Gain Resistor R_G [Ω]		$G_{calc} = 1 + 49.4\ k\Omega / R_G$	

Amplifier Normal Mode Gain (sinusoid with 0.1 $V_{p\text{-}p}$ amplitude and 0 VDC offset)			
Input RMS $V_{rms,in}$ [V]		Output RMS $V_{rms,out}$ [V]	
RMS Normal Mode Gain [–] = $G_{rms} = (V_{rms,out} - V_{offset}) / (V_{rms,in})$			
Calculated Gain Error = 100 % $(G_{calc} - G_{rms}) / G_{rms}$			

Typical and Maximum Values from AD620AN Specification Sheet			
Typical Gain Error (G = 1) [%]		Maximum Gain Error (G = 1) [%]	
Typical Output Offset (±15 V) [µV]		Maximum Output Offset (±15 V) [µv]	
Typical CMRR (G = 1) [dB]		Minimum CMRR (G = 1) [dB]	

Observations:

Using the logarithmic identity $log_b(x\,y) = log_b(x) + log_b(y)$, determine how many dB a multiplication factor of 1000 corresponds to (don't forget to multiply by 20). Explain during which calculation step above that this factor is relevant. (5 pts)

Is your measured $V_{rms,in} = \frac{0.1\,V}{\sqrt{8}}$? What would cause this measurement to be off by a factor of 2? (5 pts)

5.4 NATURAL FREQUENCY AND DAMPING RATIO OF VIBRATING BEAM (30 PTS)

Geometric Properties of Beam and Calculation of Natural Frequency			
Length L [m]		Diameter D [m]	0.0127
Density ρ [kg/m^3]	2700	Modulus E [Pa]	6.9×10^{10}
Calculated Natural Frequency [rad/s] = $\omega_{n,calc} = 0.14 \frac{D}{L^2} \sqrt{\frac{E}{\rho}} 2\pi$			

Measured Natural Frequency and Damping Ratio			
First Chosen Peak Voltage V_1 [mV]		Second Chosen Peak Voltage V_2 [mV]	
First Chosen Peak Time t_1 [ms]		Second Chosen Peak Time t_2 [ms]	
Cursor Δt [ms]		Cursor frequency f_{cursor} [Hz]	
N = Number of Periods between chosen Peaks			
Measured Damped Natural Frequency [rad/s] ω_d			
Damping Ratio ζ			
Measured Natural Frequency [rad/s] $\omega_{n,meas}$			
Calculated-Measured Difference [%]= 100 % $\times \frac{\omega_{n,calc} - \omega_{n,meas}}{\omega_{n,meas}}$			

Observations: