

PLACE ANSWERS IN BOXES AND SHOW WORK ON ADDITIONAL PAGES

①

An accelerometer has an electrical output voltage and is approximately linear. The sensitivity of this transducer is 10 mV/g. Note: $1\text{ g} = 32.2\text{ ft/s}^2$. Determine the measured acceleration in units of ft/s^2 and in units of m/s^2 when the output is 1.6 volts.

②

A digital voltmeter has an input range of 0 to 30 V and displays three significant figures XX.X. The manufacturer claims an accuracy of +2% of full scale. A voltage reading is taken as 12.5 V. Determine the percent uncertainty due to accuracy and the percent uncertainty due to resolution.

③

A strip of unknown metal is "L" in. long and has cross section of "w" in. by "t" in. It is subjected to an axial load of "P" lbf. Two strain gages are attached to the surface, one in the axial direction and one in the transverse direction. The axial gage indicates a strain of " ϵ_a " μstrain and the transverse gage indicates a strain of " ϵ_t " μstrain (compression). Determine the modulus of elasticity and Poisson's ratio.

P (lbf)	L (in)	w (in)	t (in)	ϵ_a (μstrain)	ϵ_t (μstrain)
4200	12	1	0.1200	1150	-335

④

Calibration of a strain gage load cell has produced the following set of data as output voltage from the bridge circuit for known applied loads. The supply voltage for the bridge circuit during calibration is 12 V. Determine the calibration constant for the load cell in units of (mV/V) / lb. The load cell is used to measure an unknown load. The output from the cell is 0.85 mV. Determine the unknown load.

Load (lb)	0.00	2.00	5.00	10.00	20.00
V_{out} (mV)	0.00	0.11	0.25	0.49	1.02

⑤

An internal combustion engine is driving an electric dynamometer. The torque arm length is 0.45m (from the axis) and the measured force is 225 N. A tachometer indicates the shaft speed is 3500 rpm. Determine the engine torque and engine power.

⑥

A 3500 Hz sine wave with 4.25 V_{peak} amplitude is to be sampled with a digital oscilloscope. The scope is a 16-bit device and the user can select either a +/- 10V range or a +/- 5 V range. Determine the uncertainty (or bit-error) of the measured amplitude for both ranges.

①

A filter circuit is constructed of a resistor, 1500×10^3 ohms, and capacitor, 25 μ farads. Determine the time constant for the circuit and the filter cut-off frequency.

⑧

A sensor is modeled as a mass-spring system with mass, $m = 0.25$ lbm, and spring, $k = 20$ lbf/in, and negligible damping, $c = 0$ lbf-s/ft. Determine the circular natural frequency, ω_n (rad/s), and the natural frequency, f_n (Hz).

⑨

Power transmitted through the drive shaft of a car results in a rotational speed of 2400 rpm with a power transmission of 200 horsepower. Determine the torque transmitted through the drive shaft.

⑩

An analog signal containing frequencies of 300 Hz, 450 Hz, and 700 Hz is to be sampled with a DAQ card in a computer. Determine the suggested frequency sampling rate, Hz, needed to capture the frequency components without aliasing.

⑪

A large sampling ($N > 5000$) from a population of bearings is taken to measure the bearing diameter. An automated measuring system indicates diameter mean of 0.5 inches and variance of 0.0001 inches². Determine the lower and upper range values containing 99.73% of the population.

⑫

A first order measuring system is subjected to a step input during calibration. The step input at time = 0 seconds is 10 units and at 1.5 seconds the system output is 8 units. Determine the time constant for the measuring system. Determine the time at which the system output reaches a value of 10 units.