Ain Shams University Credit Hours Engineering Program

Engineering Measurement MDP 141

Assignment 4

Measurement Errors

Q1: With the aid of neat sketch, explain the different types of errors:

Q2: a Discuss the correctness of the following statements

	1. Measurement uncertainty defines an interval around the measured value within which the true value lies with some probability
	2. If a measurement result has uncertainty then it means that the measurement was not performed correctly.
	3. A measured value can be regarded as an estimate of the true value.
	4. Measured value can be corrected by subtracting measurement uncertainty from it.
	5. Uncertainty has a sign but error does not
	6. Uncertainty and error have different units

Q2: b Give one word or few words:

	• Difference between the measured value and the true value
	• Error arise on account of pointer and scale not being on the same plane
	• The value of the measurand which is free from errors
	• The instrument does not read zero when the input is zero
	• If the observer's eye is not squarely aligned with the pointer and scale

Q3: An external micrometer was used to measure the length of a given work-piece and its reading was found to be 24.55 mm. The micrometer was designed and manufactured to have a pitch equals 0.5 mm. After the measurement was taken, the pitch of the micrometer threaded screw was checked and found that equal to 0.49 mm all over its measuring range. The micrometer was also found to have a zero error of 0.06 mm. Calculate the correct length of the measured work-piece.

Q4: Given expected voltage value across a resistor is 80V. The measurement is 79. Calculate,

The absolute error.

The %error

Q5: 0-150 V voltmeter has a guaranteed uncertainty of ±1% full scale deflection. The measured voltage by this voltmeter is 83 V. Calculate the percentage error in this measured value.

Q6: A circuit requirement for a resistance of 550 is satisfied by connecting together two resistors of nominal values 220 and 330 in series. If each resistor has a uncertainty of ±2%. Calculate the combined uncertainties.

Q7: A fluid flow rate is calculated from the difference in pressure measured on both sides of an orifice plate. If the pressure measurements are 10.0 bar and 9.5 bar and the uncertainty in the pressure measuring instruments is specified as ±0.01 , Calculate the flow rate.

Q8: if the voltage of a circuit is calculated by measuring resistance and current. The resistance is measured as 100 ±0.05 Ω, while the current is measaured as 2 ±0.01 A. Calculate the circuit voltage.

Q9: if the current of a circuit is calculated by measuring resistance and voltage. The resistance is measured as 100 ±0.05 Ω, while the voltage is measured as 200 ±0.02 A. Calculate the circuit current.

Q10: Two resistors 250±2.1 Ω, and 100±1.5 Ω are connected in series. Find the uncertainty of the resultant resistance.

Q11: The current passing through a resistor of 100±0.2 Ω is 2.00±0.01 A. Using the relationship, $P=I^2R$, calculate the dissipated power and its uncertainty.

Q12: A voltage drop of 120.4±0.1 v is measured across a resistor passing a current of 2.45±0.05 A. Calculate the power dissipated of the resistor as well as its uncertainty.

Q13: A measuring system consists of a transducer, signal conditioner, amplifier, and recorder. If the limiting error of the transducer, signal conditioner, amplifier, and recorder are 2%, 1%, 1 respectively. What is the accumulated limiting error of the whole system.

Q14: The inside diameter of 20 rings was measured at the same location by each of the four inspector using two types of bore gauges. The total tolerance on the dimension was 0.0007 or 7.0 in units of ten thousandth of an inch. Variability due to various causes was calculated in terms of 6 standard deviations and is summarized below:

Source	Variability
Product	4.6
Air gauge	1.1
Mechanical gauge	4.4
Inspector A	4.3
Inspector B	3.7
Inspector C	5.1
Inspector D	9.3

Calculate the observed variability with the best combination of product, gauge and inspector?

Calculate the observed variability with the worst combination of product, gauge and inspector?

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Notes: The rules for combined uncertainties

	Relation Between Z and A and B	Combined Uncertainty ΔZ
1	**Z = A + B**	$(\Delta Z)^2 = (\Delta A)^2 + (\Delta B)^2$
2	**Z = A - B**	$(\Delta Z)^2 = (\Delta A)^2 + (\Delta B)^2$
3	**Z = AB**	$\left(\frac{\Delta Z}{Z}\right)^2 = \left(\frac{\Delta A}{A}\right)^2 + \left(\frac{\Delta B}{B}\right)^2$
4	**Z = A/B**	$\left(\frac{\Delta Z}{Z}\right)^2 = \left(\frac{\Delta A}{A}\right)^2 + \left(\frac{\Delta B}{B}\right)^2$
5	**Z =** A^n	$\frac{\Delta Z}{Z} = n\frac{\Delta A}{A}$
6	**Z = ln A**	$\Delta Z = \frac{\Delta A}{A}$
7	**Z =** e^A	$\frac{\Delta Z}{Z} = \Delta A$