**1.** Uncertainty analysis at the design-of-experiment stage is necessary to determine a) The type of equipment needed b) The experimental procedures to be followed c) The minimum level of uncertainty that is acceptable d) None of a. – c **e) All of a. – c**

**2.** Assumptions that are implicit in an uncertainty analysis include **a) Knowing the objectives and obtaining the data under controlled conditions** b) Knowing a relationship between the dependent variable *y* and the c) Knowing that there is no bias in the data d) Having the ability to transform the data into a Gaussian distribution e) Being able to estimate the 95% confidence interval

3. Only one of the following is most appropriate concerning uncertainty analysis a) It is used to determine the major independent parameters that govern an experiment **b) It is a statistical evaluation of the error of a measurement** c) It is used to determine if the methodology can be justified on theoretical grounds d) It is used to compare the results against those obtained elsewhere or against handbook data e) It is used to calibrate instruments that is affected by multiple inputs

**4.** Bias in an experiment can be accounted for by a) Changing one independent parameter at a time
b) Allow the test conditions to vary in a systematic way c) Comparing the data with theory
d) Performing experiments in controlled conditions **e) Calibration and inter-facility comparison**

**5.** Suppose you are interested in the daily traffic on a highway. The traffic data is best described as a) Gaussian b) Transient c) Steady d) Random **e) Non-stationary**

**6.** For a Gaussian distribution, ±3σ (3 times the standard deviation) corresponds to a probability of approximately a) 25% b) 50% c) 68% d) 95% **e) 99%**

7. Implicit in the use of the Gaussian (or normal) distribution is that a) There is a finite data set with a well-defined mean and standard deviation **b) There is an infinite data set with a well-defined mean and standard deviation** c) One can ignore the mean and standard deviation d) The data can be fitted by any mathematical function with an arbitrary confidence level e) It allows bad data to be rejected with objective criteria

**8.** If a measurement is expected to follow the Gaussian distribution, one of the following **CANNOT** be done a) The mean and standard deviation can be computed b) The probability that a certain range of occurrences can be computed c.)An upper bound can be computed given the probability for its occurrence
d) A level of significance can be assigned to the mean, from which the minimum number of measurements
that is needed to estimate the mean can be computed **e) The bias of the data can be estimated**

**9.** A measurement is given as 50 ± 0.1 cm (95% confidence). A confidence level of 95% means that statistically,the probability of the measurement being within the range 49.9 – 50.1 cm is a) 1 out of 20
b) 1 out of 19 **c) 19 out of 20** d) dependent on 3 times the estimated standard deviation e) None of the above
**10.** A certain measurement was found to follow a probability distribution function $p(x)$. The probability that a measured value will lie within an interval defined by any two values 1 $x$ and 2 $x$ ( 1 2 $x$ $x$ > ) is given by

**11.** Strictly speaking, the observed mean value from a series of observations a) Is dependent on the confidence level assigned to the observation b) Must undergo the Student T test to be valid c) Can only be made if the observations are expected to follow a Gaussian distribution d) Can only be valid if the large dataset is broken up into a number of smaller sets, with their individual means obtained and then averaged
**e) Is only an estimated value that approaches the (theoretical) true value as the number of observations approach infinity**

**12.** The observed mean can vary due to finite sample sizes and random variations in the measurement. The relationship between the observed mean and the expected mean is obtained from a) Performing a least-squares regression analysis **b) Performing a Student T test** c) Performing a hypothesis test d) Performing a test using Chauvenet's criterion e) Performing a convergence test

**13.** Most experiments gather only a small dataset. In view of this, it may be appropriate to quote the uncertainty by a) Stating the level of significance, which is 2.5% for a two-tailed distribution b) Stating that the data are obtained under controlled conditions c) Stating the number of measurements taken for the dataset d) Stating that the uncertainty is assumed to be Gaussian **e) Including a statement that the uncertainty is to a probability of *P*%, typically 95%**

**14.** A certain length was measured with a precision of 5 . 0 ± mm when a **large number** of measurements is taken. How many measurements are necessary to establish the mean length to a 5 % level of significance such that x=+- 0.2mm? (It is unnecessary to know $x$ in this problem.). a) 10 b) 20 **c) 25** d) 50 e) ∞

**15.** One of the following statements is true regarding the Student T-distribution a) How well a set of measurements follows an assumed distribution b) How well a set of measurements follows the Gaussian distribution **c)How well the mean approaches the true value** d)How random is a data set e) Whether a curve-fit makes sense

**16.** It is sometimes useful to determine how precise the standard deviation is from batch to batch. To do this, one would use the a) Gaussian distribution b) Student T-distribution **c) Chi-squared distribution**
d) Chauvenet's criterion e) Poisson distribution

**17.** The chi (or chi-squared) test results in a probability of occurrence $P$. The rule of thumb for accepting a hypothesis is if a) $P = 0$ b) $P < 0.1$ **c) $0.1 < P < 0.9$** d) $P > 0.9$ e) $P = 1$

**18.** One of the following statements is **NOT TRUE** regarding the T-distribution a) It can be used to determine the confidence level on the mean b) It can be used to estimate the sample size required for a given confidence level c) It can be used to determine the limits to an estimated mean value given the estimated standard deviation and an imposed confidence level d) It can be used to compare the means of two samples of different sizes to a certain level of confidence **e) It can be used to determine the true mean**

**19.** In both the T and chi distributions, the term "degree of freedom" is used. The "degree of freedom" is
**a. The sample size less one** b. The sample size c. The sample size plus one
d. The sample size plus the mean e. Half of the sample size (sample size of at least two)

**20.** The T-distribution requires two arguments, which are typically: a) The number of samples and the mean b) The mean and the variance c) The mean and the confidence (or probability level), the latter sometimes being substituted by the level of significance α **d) The degree of freedom and the confidence (or probability level), the latter sometimes being substituted by the level of significance α** e) The square root of the number of samples and the confidence (or probability level), the latter sometimes being substituted by the level of significance α

**21.** Fifteen measurements are taken of a certain length to obtain a sample mean and sample standard deviation of10 cm and ±0.1 cm respectively. The 90% confidence interval is
**a. ±0.045 cm** b. ±0.055 cm c. ±0.1 cm d. ±0.2 cm e. ±1 cm

**22.** Suppose a measurement is quoted as x=x+_ $u_x$ (P%) We understand ux to be a) The estimated mean at some probability level ($P$%) b) The estimated standard deviation at some probability level ($P$%) c) The estimated skewness at some probability level ($P$%) d) The estimated kurtosis at some probability level ($P$%) **e) The uncertainty at some probability level (*P*%)**

**23.** Engineering measurements are taken of measurands that are either continuous in time and space, or discrete. Such data are known as **a. Random** b) Probabilistic c) Discrete d)Digital e) Analog

**24.** Consider discrete data. There is a difference in the definition of the **variance** depending on whether one is considering infinite or finite statistics. Which one below is the correct expression for the variance of a finite sample set, where $N$ is the number of samples, $x$ is the estimated mean and $N$ *i xi* , , 1 , … = is the number of data points?

**25.** A cubic container with sides of length 1 . 0 100 ± = *l* mm contains dry air at uniform conditions. The pressure and temperature of the dry air in the container are 200 = $p$ kPa % 1 ± and 10 400 ± = $T$ K respectively. The mass of air in the container is given by the expression m=$RT/pV$ where $V$ is the volume and 286.9 = $R$ J/(kg·K) is the gas constant of air, which can be regarded as an exact value. What is the uncertainty in the mass measurement? **Information you may need:** 1 kPa = 1000 Pa, 1 Pa = 1 N/m2, 1 N = kg·m/s2; 1 J = 1 N·m. a. 0.1 % b. 0.5 % **c. 2.5 %** d. 3 % e. 3.1 %