Introduction to Uncertainty Analysis and Experimentation

Course outline

Now does on NPTEL online course work?

I will address fundamental issues on uncertainty analysis and their applications and give an overview of experimental methods, practical engineers, researchers, and engineering students at UG, PG and PhD. From here, more topics will be added over the course. The notes include experimentation process, error in measurements, uncertainty in a measurement, and in the real-world uncertainty propagation, pre-validation, and test uncertainty analysis, uncertainty analysis for design of systems, and rigorous and simulation. Teaching the methodology will follow ASME, "Performance Test Code", and ISO. "Guide to the expression of uncertainty in measurements "- an ISO IEC standard. The course covers various practical applications and use of national and international standards related to engineering and research and their relevance to education.

INTENDED AUDIENCE
- UG, PG, and PhD level engineering students; Engineering/technology professionals in industry and R&D organizations

PREREQUISITES
- This course is aimed at 3rd year undergraduates, masters, and PhD students with at least bachelor's degree in engineering or science.

INDUSTRIAL SUPPORT
- This course is open to many industries, especially MSMEs as it will enhance quality and adhere to standards.

Prof. S. R. Kale

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Professor Smt. S.R. Kale has been with the Department of Mechanical Engineering since 1989. He has developed and taught UG courses (thermostatic, transducers, measurement error, pressure transducers, electronic measurement, electrical measurement, communication, and test technology laboratory), and PG courses (experimental methods for thermal engineering, multivariate analysis). His research, academic, and industry-related, in the field of heat transfer, fluid mechanics, low power electronics, and energy conversion.

COURSE TYPE

Elective

COURSE LEVEL

Undergraduate/Postgraduate

Week 1: INTRODUCTION

Outline of the course: Course objectives, Learning outcomes. Course plan - Expressing a result as a mean (arithmetic) value and its uncertainty at a specified confidence level - Importance of uncertainty analysis in industry; exercise: energy measurement - Developments in uncertainty analysis; ASME PTC 19-1 and ISO/IEC 110 016 UIM - The approach to uncertainty analysis

Week 2: ERROR, UNCERTAINTY

The result relation; measured parameters - Error distribution, statistical basis, standard uncertainty, definition of uncertainty and its variants - Classification of errors; error in ASME PTC 19-1 and ISO/IEC 110 016 UIM - Combined and truncated errors

Week 3: EXPERIMENTATION

Processes from result for data: the decision-making in obtaining data - Options for conducting an experiment - Shaken / Thrown experiments, load application, pre-test and post-test activities - Relevance of uncertainty analysis in the experimentation processes

Week 4: UNCERTAINTY IN A MEASUREMENT - I (FUNDAMENTALS)

- Measured parameters (measurands) and raw data - Calculated parameters (result) - Source of errors in a measurement - elemental sources of error - Classification of error: random and systematic errors - Type A-Type B error - Calculating standard uncertainty of each measured parameter, expanded uncertainty in a measurement

Week 5: UNCERTAINTY IN A MEASUREMENT - II (SPECIFIC CASES)

- Systematic uncertainties in a measurement: Instrument specification, Data from Table, Measurement limits, Absolute error, Measurement uncertainty

- Physical basis of systematic errors: Displacement errors, Thermal errors, Domain errors - Error in electronics, Sensitivity and linearity - The result formula, Taylor Series Method (TSM), Type A and Type B errors - Confidence interval - The result formula, Taylor Series Method (TSM), Type A and Type B errors - Confidence interval

- Contribution from different measurements, dominance uncertainty, Uncertainty Percentage Contribution (UPC)

Week 7: UNCERTAINTY IN A MEASUREMENT - III (SPECIFIC CASES)

- Sensitivity coefficient, Relative uncertainty coefficient, Uncertainty Multiplication Factor, UMF - Error and the result - Contribution from different measurements, dominance uncertainty, Uncertainty Percentage Contribution (UPC)

- Techniques for evaluating sensitivity coefficient - Single variable property - Multiple variable property - Contribution by measurement uncertainties to result uncertainty - Pareto chart - Application to process uncertainty analysis

Week 8: DATA ANALYSIS AND REPORTING

- Reporting results in reporting mean (nominal) values and uncertainty - Reporting results in reporting mean (nominal) values and uncertainty in measurements and in report - Data comparison, Introduction to correlations - technique, goodness - Dealing with outliers, p-values, q-values, and significance - Quality control and examination for further study

BOOKS AND REFERENCES


CERTIFICATE

The certificate is free to enrol and learn from. But if you want to verify your certificate, you have to write and fill the online proctored exam conducted by an online test on the designated exam centre. The exam is optional for a fee of Rs. 1000/- (Re dissipate one thousand only). Exam and Time of Examin. 21 March 2023 Morning session from 10:00 am to 1:30 pm Registration by 15 March 2023. Exams are scheduled for 2023. Exams Schedule is final. The exam registration fees is Rs. 1000. If there are any changes, it will be informed then. Please fill for the fees from more details for the exam where the exams will be held, the conditions you agree to and fill the form etc.

CERTIFICATE TO GET A CERTIFICATE

Average assignment score = 25% of average of best 4 assignments out of the total 8 assignments given in the course. Exam score = 70% of the proctored certificate exam score out of 100.

First score = Average assignment score + Exam score

You will be eligible for a certificate only if the average assignment score >= 625 and exam score >= 3075. If one of the criteria is not met, you will not get the certificate even if the final score >= 850

Certificate will have your name, photograph, and the signature of the final exam with the bundle.p will have the logo of NPTEL and ST Web. It will be available at https://nptel.ac.in/

Only the certificate will be made available. Hard copies will not be dispatched.

Once again, thanks for your interest in our on-line courses and certification. Happy learning.

- NPTEL team