

Study plan for Measurement Technology

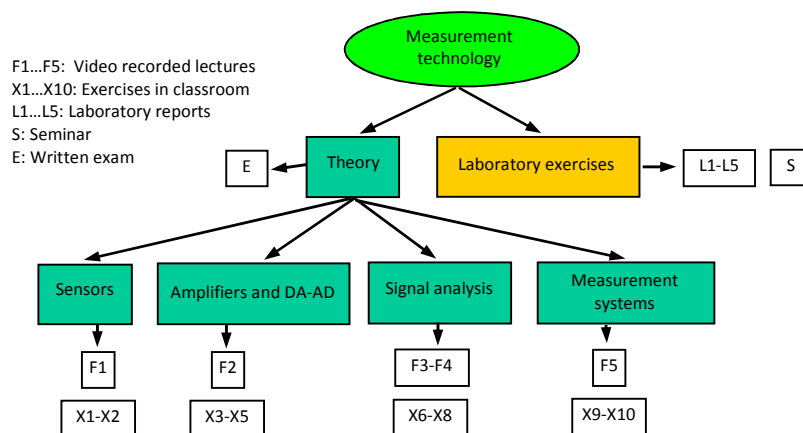
This course will be given as a standalone course, *Measurement technology 6 credits hp (ET044G)*. *Measurement technology* is further separated into four sub-parts, *Sensors*, *Amplifiers and AD-DA-conversion*, *Signal analysis* and *Measurement systems*. Both lectures and laboratory experiments are assigned to the four course modules.

Link to course homepage: <http://apachepersonal.miun.se/~benth/mt/index.htm>

Lecturer: Benny Thörnberg

Lab teacher: Benny Thörnberg.

1. Organization



2. Learning goals

After the course the student should be able to:

- develop a basic measurement system after specified signal to noise ratio, sensors, accuracy and dynamic behavior,
- apply different methods to improve signal to noise ratio in a measurement system,
- explain the phenomenon of channel leakage in DFT-analysis and of windowing,
- explain different factors affecting measurement uncertainty,
- explain principles for how noise is transferred and suppressed in measurement systems,
- explain basic principles for measurement of non-electrical measurands,
- explain principles and limits when time continuous signals are sampled,
- explain principles and limits when time continuous signals are reconstructed,
- explain principles for time continuous and time discrete filters.

3. Theory part

A series of five lectures will be made available to students as video presentations. In addition you must carefully study the assigned material in the text book. This material is extensive but at the same time it is assumed that you have certain pre-knowledge in electronics. This course links your pre-knowledge about electronics into the context of electrical metrology. Ten exercises in classroom will be focused on solving related problems and to give feedback on progress of your learning. Reading instructions for the corresponding lectures is given in Table 1.

Table 1. Reading instructions

Lecture	Subject	Chapters to read in Swedish textbook, <i>Elektriska mätsystem och mätmetoder</i>	Chapters to read in the English text book, <i>Principles of Measurement Systems</i>
F1	Introduction to measurement technology, motivation, different types of sensors	1, 2	1, 8, 9.1
F2	Amplifiers and AD-DA-converters	3.1-3.4, 4.1-4.3.2, 4.3.5, 4.3.7	9.2, 10.1
F3	Frequency analysis, mean value and correlation	5, 6, 7, 9.1-9.2	6.1-6.2, 10.1.1, 10.4.2 Fourier theory in an arbitrary math book
F4	Power spectrum, curve fitting and measurement precision	7.6, 9.1-9.2, 10.1.1	2.2-2.3, 3.1-3.2, 6.2.4-6.2.5
F5	Disturbance propagation and suppression, filters, dynamic performance of measurement system	11.1-11.6, 12, 13.1-13.2, 14	6.4-6.5, 4.1-4.3

4. Laboratory experiments

Five laboratory experiments are assigned to this course aimed to help you to get deeper knowledge in the following topics:

- Temperature measurement
- Measurement of volume by capacitive sensor
- Signal processing and data analysis using LabView
- Measurements of weights by using strain gauges
- Interference and noise reduction

5. Examination

A written exam is planned for the theory of the course. From this exam, a grade (A to F or Fx) will be given for the theory part corresponding to 2 credits hp. Five reports must be written for the laboratory exercises in the format of PowerPoint slides for oral presentation. You are expected to present one of these reports at a lab seminar at the end of the course. The oral presentation in combination with reports (slides) are graded (A to F or Fx) corresponding to 4 credits hp.

6. Course literature

This is the recommended minimum amount of literature needed to follow the course. You can choose either a Swedish or an English text book:

- Lars Bengtsson, *Elektriska mätsystem och mätmetoder*, Andra upplagan, Studentlitteratur, ISBN 91-44-02903-9
- John P. Bentley, *Principles of Measurement Systems*, Pearson Education Limited, ISBN 0-13-043028-5

These are additional reference books where you can find more detailed information about stochastic and deterministic signal analysis and processing:

- G.R. Cooper and C.D. McGillem, *Probabilistic Methods of Signal and System Analysis*, New York, Oxford University Press, Third edition, 0-19-512354-9
- M.L. Meade and C.R. Dillon, *Signals and Systems*, Chapman&Hall, Second Edition, 0-412-40110-X

But in general any literature from your previous courses in stochastic signal analysis, Fourier- and Laplace analysis and/or deterministic signal processing will help you to understand the underlying mathematical tools necessary for this course.