BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS
FACULTY OF MECHANICAL ENGINEERING

SUBJECT DATASHEET

I. SUBJECT DESCRIPTION

1. GENERAL DATA

1.1. Subject name (in Hungarian, in English)

Measurement technology • Measurement techniques

1.2. Neptun code

BMEGEMIBXMT

1.3. Type

study unit with contact hours

1.4. Course types and number of hours (weekly / semester)

course type	number of hours (weekly)	nature (connected / stand-alone)
lecture (theory)	2	-
exercise	-	-
laboratory exercise	1	coupled

1.5. Type of assessments (quality evaluation)

mid-term grade

1.6. ECTS

4

1.7. Subject coordinator

name:	Dr. Samu Krisztián
post:	associate professor
contact:	samuk@mogi.bme.hu

1.8. Host organization

Department of Mechatronics, Optics and Mechanical Engineering Informatics (https://www.mogi.bme.hu)

1.9. Course homepage

https://www.mogi.bme.hu/tantargyak/BMEGEMIBXMT

1.10. Course language

hungarian, english, german

1.11. Primary curriculum type

mandatory

1.12. Direct prerequisites

Strong prerequisite:	BMETE94BG01
Weak prerequisite:	-
Parallel prerequisite:	-
Milestone prerequisite:	-
Excluding condition:	BMEGEMIAMG1

(the subject cannot be taken if you have previously completed any of the following subjects or groups of subjects)

2. AIMS AND ACHIEVEMENTS

2.1. Aim

The purpose of the course is to measure the geometric quantities typically encountered in mechanical and mechatronic systems and to process the measured data. Systematization of errors, their nature, origin, and ways to reduce their impact. Electrical measurement of non-electric quantities that changes over time. The structure of the measuring chain, the systemization of sensors and signal converters, the role of intermediate quantities, measuring procedures. Dynamic and frequency transmission errors. Basics of signal frequency analysis. Introduction to digital measurement technologies and rules for sampling.

2.2. Learning outcomes

Competences that can be acquired by completing the course:

A. Knowledge

- Be familiar with the definition of measurement and the role of measurement technology in mechanical engineering and mechatronics.
- Identify the elements of the measuring chain and the relationship between the physical principle of the sensors and the measurable quantity.
- Summarize the most important passive and active signal converter as well as their organization and operation.
- Be familiar with the form of the measurement result (type A and B), the methods of processing the measurement data: grouping the measurement data, defining rounding rules, choosing the level of confidence.
- Know how to calculate empirical standard deviation and error propagation (also through examples).
- Be familiar with the historical background of the measurement activity, the development of modern measurement, its organizations and the SI system.
- Be familiar with the concepts of official calibration and calibration (linear regression), rules of traceability and deduction, and principles of analysis and classification of measurement errors: by origin, character and form.
- Understand the concept of the license number of the error and the basic instrument characteristics defined when measured: sensitivity, reconstitution, resolution.
- Distinguish between measurement errors (also through examples), their cause, their properties and how to eliminate them.
- Understand the problems of measuring time-varying physical quantities over time and frequency range.
- Describe dynamic calibration on first and second order system modeled measuring chains.
- Identify technical signals, the spectrum of basic signal types, and their sampling problems.

B. Ability

- Identify areas of mechanical and mechatronic measurements.
- Examine the elements of a simple mechatronic measuring chain.
- Examine measurement errors and errors in measurement results.
- Apply the mathematical statistics methods in measurement technology.

- Apply the Type A and B rules for specifying the measurement result and the error propagation calculation methods.
- Able to identify measurement tasks and assign measuring sensors for measuring quantities that are constant and variable over time.
- Describe basic signal types and task for calibrating first and second order measurement systems.
- Manage calibration and official calibration processes for mechatronic measuring chains.
- Use Excel and other data processing softwares to select how the measurement results are processed.
- Produce a measuring report in a precise and professionally correct form, express their thoughts in an orderly form both orally and in writing.
- Design the measurement chain and report making methodology for length measurement tasks.
- Designs an experimental design for each element of the measurement process.

C. Attitude

- In the course of increasing their knowledge, strive to cooperate with the lecturer, the lab supervisor and their student companions.
- Constantly gaining knowledge in measurement technology.
- Open to the use of software statistical data processing systems.
- Open for the use of automated measuring systems.
- Open to discover new sensors and measuring systems in measurement technology.
- Student continuously expands the ability to integrate electrical sciences in measurement technology through continuous acquisition of knowledge.
- Seek to follow the changes in the legal regulations of measurement technology.
- Strive for accurate, flawless, easy to understand and formally appropriate measurement reports.

D. Independence and responsibility

- Accept guidelines for laboratory measurements and reports.
- Feel responsible for their colleagues' work during the measurement team's measurement activities.
- Assume responsibility for the prudent implementation of measurement activities.
- Evaluate the measurement tasks with maximal care and on time.
- When solving professional problems, checks the compliance of measurements with legal requirements.

2.3. Teaching methodology

Lectures, demonstrations of measuring instruments, laboratory measurements, basic measurements and application of mechanical measurements and instruments, preparation of measurement reports. In lectures, with a mathematical, statistical and information theory foundation, solving practical measurement tasks that are of general technical applicability. Carrying out and recording basic measurements of length measurement during laboratory exercises, which can be transformed into other technical fields as well.

2.4. Support materials

a) Textbooks

E. O. Doebelin: Measuring Systems, Application and Design (McGraw Hill Book Comp. N.Y.)

b) Lecture notes

Richard Figliola and Donald E. Beasley: Theory and design for mechanical measurements, Wiley, 2006

c) Online materials

http://www.tankonyvtar.hu/hu/tartalom/tamop425/0029_2A_Merestechnika - Czifra, Drégelyi-Kiss, Galla, Huba, Kis, Petróczky: Technical measurements, 2012.

http://www.mogi.bme.hu "lecture_slides" library and Teams group folders

http://www.mogi.bme.hu "measurement_guidelines" library and Teams group folders

2.5. Validity of the course description

Start of validity:	2022. May 15.
End of validity:	2026. July 15.

II. SUBJECT REQUIREMENT

3. ACHIEVEMENT CONTROL AND EVALUATION

3.1 General rules

Assessment of the learning results is based on mid-term written performance measurement (two summative assessment) and active participation in laboratory exercises (formative assessment). At least 40% of part and total study performance can be attributed to a sufficiently minimal student achievement. Attendance is not required for the lecture. Participation in laboratory is compulsory, of which one may be omitted.

3.2 Assessment methods

A. Detailed description of mid-term assessments

1. Mid-term assessment

type: diagnostic assessment

count: 1

purpose, description: Diagnostic assessment (test) is a written test of the knowledge and practice-type competencies that are essential for the successful completion of laboratory measurement tasks in the subject, which will be conducted in 2 laboratory practice of the subject; the syllabus on which the diagnostic assessment is based shall be determined by the practice leader; the content of the test is covered by the topics of the laboratory practice; preparation material is included in the laboratory manual; the available working time is 10 minutes at the beginning of the laboratory practice; in case of unsuccessful result (less than 40%) the measurement practice cannot be continued;

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3. Mid-term assessment

type: formative assessment, point-in-time personal act

count: 1

purpose, description: Formative assessment (active participation) is a simplified way of evaluating the knowledge, ability, attitude, independence and responsibility type competencies of the subject, which takes the form of prepared appearance, active participation in a laboratory measurement task, and finished on-site measurement report; the evaluation is based on the results of 6 measurements; 1 piece of lab task can be omitted; In case of the formal assessment evaluation below 40%, the subject fails;

4. Mid-term assessment

type: summative assessment

count: 1

purpose, description: Summative assessment is a complex written assessment of subject and knowledge type skills in the form of a midterm exam; the midterm exam focuses mainly on theoretical knowledge, thus focuses on the background knowledge required for practicing measurement technology, the part of the study material that is the basis of the assessment is the lecture and downloadable presentations, the available working time is 30 minutes; in case of the summative assessment evaluate below 40% the subject is failed; the opportunity to fulfill the midterm test is at the time specified in the learning outcomes assessment plan, and is foreseen at 14th week's lecture.

B. Detailed description of assessments performed during the examination period (if relevant)

Elements of the exam:

1. written partial exam
   -
2. oral partial exam
   -
3. practical partial exam
   -
4. inclusion of mid-term results
   -

3.3 The weight of mid-term assessments in signing or in final grading

identifier	**weight**
1 . Mid-term assessment	8 %
2 . Mid-term assessment	8 %
3 . Mid-term assessment	34 %
4 . Mid-term assessment	50 %

3.4 The weight of partial exams in grade (if relevant)

type	**weight**
written partial exam	0 %
oral partial exam	0 %
practical partial exam	0 %
inclusion of mid-term results	0 %

3.5 Determination of the grade

grade ● [ECTS]	**the grade expressed in percents**
very good(5) ● Excellent [A]	above 90%
very good(5) ● Very Good [B]	85% .. 90%
good(4) ● Good [C]	70% .. 85%
satisfactory(3) ● Satisfactory [D]	55% .. 70%
sufficient(2) ● Pass [E]	40% .. 55%
insufficient(1) ● Fail [F]	below 40%

The lower limit specified for each grade already belongs to that grade.

3.6 Attendance and participation requirements

Must be present at at least **0%** (rounded down) of lectures.

At least **85% of** laboratory practices (rounded down) must be actively attended.

3.7 Special rules for improving, retaken and replacement

The special rules for improving, retaken and replacement shall be interpreted and applied in conjunction with the general rules of the CoS (TVSZ).

Need mid-term assessment to individually complete?

yes

The way of retaking or improving a summary assessment for the first time:

each summative assessment can be retaken or improved

Is the retaking-improving of a summary assessment allowed, and if so, than which form:

retake or grade-improving exam possible for each assesment separately

Taking into account the previous result in case of improvement, retaken-improvement:

new result overrides previous result

The way of retaking or improving a partial assessment for the first time:

partial assesment(s) in this group can be improved or repeated once up to the end of the repeat period

Completion of unfinished laboratory exercises:

missed laboratory practices must be performed in the repeat period

Repetition of laboratory exercises that performed incorrectly (eg.: mistake in documentation):

incorrectly performed laboratory practice (e.g. Incomplete/incorrect report) can be corrected by repeating the practice

3.8 Study work required to complete the course

Activity	**hours / semester**
participation in contact classes	42
preparation for laboratory practices	14
preparation for summary assessments	16
additional time required to complete the subject	48
summary	**120**

3.9. Validity of subject requirements

Start of validity:	2022. May 15.
End of validity:	2026. July 15.

4. ADDITIONAL INFORMATION

4.1 Primary course

The primary (main) course of the subject in which it is advertised and to which the competencies are related:

Mechanical engineering

4.2 Link to the purpose and (special) compensations of the Regulation KKK

This course aims to improve the following competencies defined in the Regulation KKK>

a) knowledge

- Student has the knowledge of the theories and contexts of fundamental importance in the field of engineering and of the terminology which underpins them.
- Student has the knowledge and understanding of the terminology, main specifications and aspects of other fields related to the technical field and of particular importance for the practice of the profession (in particular logistics, management, environmental protection, quality assurance, information technology, legal, economic, health and safety, fire protection, security).
- Student has the detailed knowledge and understanding of the methods of knowledge acquisition, data collection, ethical constraints and problem-solving techniques in the technical field.

b) ability

- Student has the ability to apply the general and specific mathematical, scientific and social principles, rules, relationships and procedures acquired in solving problems in the field of engineering.
- Student has the ability to apply the theories and related terminology in an innovative way when solving problems in a given field of engineering.
- Student has the ability to apply innovative methods of knowledge acquisition and data collection to solve specific technical problems in student's field of specialisation.

c) attitude

- Student is open and receptive to learning, embracing and authentically communicating professional, technological development and innovation in engineering.
- Student strives to meet and enforce quality standards.
- Student embraces the professional and ethical values associated with the technical discipline.

d) independence and responsibility

- Student has the ability to work independently on engineering tasks.
- Student encourages student's colleagues and subordinates to act in a responsible and ethical manner.

4.3 Prerequisites for completing the course

Knowledge type competencies

(a set of prior knowledge, the existence of which is not obligatory, but greatly facilitates the successful completion of the subject)	Student knows the basic mathematical procedures of statistics. Student knows the basic principles of measuring physical quantities.

Ability type competencies

(a set of prior abilities and skills, the existence of which is not obligatory, but greatly contributes to the successful completion of the subject)	Student is capable of performing and documenting correctly an independent measurement task.