SYLLABUS OF A MODULE

Polish name of a module	**Metrologia techniczna**
English name of a module	**Engineering Metrology**
ISCED classification - Code	*0710*
ISCED classification - Field of study	*Engineering & engineering trades*
Languages of instruction	*English*
Level of qualification:	*1 – BSc (EQF 6)*
Number of ECTS credit points	*4*
Examination:	*A - assignment*

Number of hours per semester:

Lecture	Exercises	Laboratory	Seminar	E-learning	Project
15	0	30	0	0	0

MODULE DESCRIPTION

MODULE OBJECTIVES

O1. To provide knowledge of measuring techniques and methods of engineering quantities

O2. Ability to conduct experiment

PRELIMINARY REQUIREMENTS FOR KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Fundamentals of mathematics, physics, mechanics, statistics, thermodynamics and fluid mechanics
2. Ability of individual work and collaboration in a group
3. Knowledge of the principles of work safety when using machinery and technological equipment.

LEARNING OUTCOMES

LO 1 – The student knows measuring techniques and methods, their applicability and limitations

LO 2 – The student is able to prepare experiment and to carry out the measurements

LO 3 – The student knows the rules of functioning of different types of probes and sensors, machines for roughness and waviness measurements.

MODULE CONTENT

Type of classes – lecture	**Number of hours**
Lec 1 – History of measurements. ISO standards defining the systems of tolerances and fits shafts and holes. Measurement errors.	**1**
Lec 2 - Length and angle standards. Callipers, micrometres and sensors. Measuring machines. Interferometers. Selection of measuring instruments.	**1**
Lec 3 - Measurements of shafts, holes and mixed dimensions. Angle and cone measurements.	**1**
Lec 4 - Measurements of threads and gears.	**1**
Lec 5 - The parameters of roughness and waviness. Methods of contact and optical measuring surface roughness. Stereometric method of measuring surface roughness.	**1**
Lec 6 – Optical measuring - theory, technique and methods of measuring.	**1**
Lec 7-8 – Coordinate Measuring Machines. Theory, technique and methods of coordinate measurement.	**2**
Lec 9 - Flow rate measurements.	**1**
Lec 10-11 - Hot wire anemometry. Constant Current (CCA) and Constant Temperature (CTA) Anemometers.	**2**
Lec 12-13 - Laser Doppler Anemometry (LDA)	**2**
Lec 14 - Particle Image Velocimetry (PIV)	**1**
Lec 15 - Shear stress measurements. Flow visualisation techniques.	**1**
Sum	**15**
Type of classes– laboratory	**Number of hours**
Lab 1-4 - Measurements of shafts, holes and mixed dimensions with micrometre, calliper and workshop microscope	**4**
Lab 5-6 - Measurements using gauge plates (Johansson blocks) and sensors	**2**
Lab 7-8 - Measurements of threads on a microscope using rollers and gauges.	**2**
Lab 9-13 - Geometry measurements on a 3D CMM ZEISS ECLIPSE coordinate measuring machine. Zeiss Calypso software.	**5**
Lab 14-15 - Surface roughness measurements on 3D Taylor Hobson NTFS 60 profilometer. Circularity measurements on 3D Talyrond 365.	**2**
Lab 16-19 - Determination of a discharge coefficient of an orifice	**4**
Lab 20-21 - Application of hot-wire anemometer (CCA) to measure temperature field in nonisothermal flow.	**2**
Lab 22-25 - Measurement of velocity distribution in turbulent flow by means of CTA system.	**4**
Lab 26-28 - Flow velocity measurements using LDA	**3**
Lab 29-30 - Flow visualization with the use of PIV	**2**
Sum	**30**

TEACHING TOOLS

1. - Lecture with the use of multimedia presentations
2. - Experimental stands equipped with measuring instrumentation
3. - Instructions to laboratory exercises
4. – Coordinate Measuring Machine, universal form testers for the analysis of roughness, cylindricity.

WAYS OF ASSESSMENT (F – FORMATIVE, S – SUMMATIVE)

F1. - assessment of preparation for laboratory exercises
F2. - assessment of the ability to apply the acquired knowledge while doing the exercises
F3. - evaluation of reports on the implementation of exercises covered by the curriculum
F4. - assessment of activity during classes
S1. - assessment of the ability to solve the problems posed and the manner of presentation obtained results - pass mark *
S2. - assessment of mastery of the teaching material being the subject of the lecture - exam

*) in order to receive a credit for the module, the student is obliged to attain a passing grade in all laboratory classes as well as in achievement tests.

STUDENT'S WORKLOAD

L.p.	Forms of activity	Average number of hours required for realization of activity
1. Contact hours with teacher		
1.1	Lectures	15
1.2	Tutorials	0
1.3	Laboratory	30
1.4	Seminar	0
1.5	Project	0
1.6	Consulting teachers during their duty hours	5
1.7	Examination	0
	Total number of contact hours with teacher:	50
2. Student's individual work		
2.1	Preparation for tutorials and tests	0
2.2	Preparation for laboratory exercises, writing reports on laboratories	25
2.3	Preparation of project	0
2.4	Preparation for final lecture assessment	15
2.5	Preparation for examination	0
2.6	Individual study of literature	10
	Total number of hours of student's individual work:	50
	Overall student's workload:	100
Overall number of ECTS credits for the module		4 ECTS
Number of ECTS points that student receives in classes requiring teacher's supervision:		2.0 ECTS
Number of **ECTS** credits acquired during practical classes including laboratory exercises and projects:		2.2 ECTS

BASIC AND SUPPLEMENTARY RESOURCE MATERIALS

1.	Bosch J.A.: Coordinate Measuring Machines and Systems. Marcel Dekker, Inc. New York, Basel, Hong Kong 1995
2.	Drake P..: Dimensioning and Tolerancing Handbook. McGraw-Hill, New York, 1999.
3.	Drake Paul Jr.: Dimesioning and Tolerancing Handbook. McGraw-Hill, New York, 1999
4.	Durst F.: Fluid Mechanics. An introduction to the theory of fluid flows. Springer-Verlag, Berlin, 2008
5.	Elsner J.W., Drobniak S.: Metrologia turbulencji przepływów. Ossolineum, Wrocław, 1995
6.	Goldstein R.J.: Fluid mechanics measurements. Taylor & Francis, 1996
7.	Henzold G.: Handbook of Geometrical Tolerancing. Design, Manufacturing and Inspection. John Willey & Sons, Chichester 1995
8.	Humienny Z.: Specyfikacje geometrii wyrobów (GPS). Wykład dla uczelni technicznych. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, Bielsko Biała, Erlangen, Huddersfield, Tallin, Wiedeń 2001.
9.	Jakubiec W., Malinowski J.: Metrologia wielkości geometrycznych. WNT, Warszawa 2004.
10.	Malinowski J., Jakubiec W., Płowucha W.: Pomiary gwintów w budowie maszyn. WNT, Warszawa 2008.
11.	Meadows J.D.: Geometric Dimensioning and Tolerancing: Applications and Techniques for Use In Design, Manufacturing and Inspection. Marcel Dekker, Inc. New York 1995.
12.	Ratajczyk J.: Współrzędnościowa technika pomiarowa. Politechnika Warszawska, Warszawa 2005.
13.	Whitehouse D.J.: Handbook of surface metrology. Institute of Physics. Bristol 1994
14.	Wieczorowski M., Cellary A., Chajda J.: Charakterystyka chropowatości powierzchni. Przewodnik. Zakład Graficzny Politechniki Poznańskiej, Poznań 1996.

MODULE COORDINATOR (NAME, SURNAME, E-MAIL ADDRESS)

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