Course name	**Engineering metrology**	*Code*	**IV.4**	*Credit points*	**2**

Language of instruction English

Programme Computer Modelling and Simulation (CMS), Intelligent Energy (IE), Biotechnology for Environmental Protection (BI), Business and Technology (BT)

Type of studies BSc studies

Unit running the programme Institute of Machines Technology and Production Automation
Institute of Thermal Machinery

Course coordinator and academic teachers Tadeusz Nieszporek, Assoc. Prof., Dariusz Asendrych, Dr.

Form of classes and number of hours

Semester	Lec.	Tut.	Lab.	Proj.	Sem.	Credit points
IV	15		15			2

Learning outcomes Knowledge on selection of measuring equipment, analysis of results, their postprocessing and presentation, measurement errors estimation. Basic knowledge on digital signals processing. Knowledge on rules of functioning of different types of probes and sensors, equipment determining dimensions, machines for roughness and waveness measurements.

Basic knowledge on measuring methods and techniques of electrical (voltage, resistance), mechanical (speed, acceleration, force) and hydraulic (pressure, flow velocity) quantities.

Prerequisites (courses)

Prerequisites (mathematical tools) Fundamentals of physics, mathematics, fluid mechanics

Course description LECTURE

The basic theory of measurement.
Metrology of geometrical quantities. Mathematics in the metrology of geometrical quantities (probability and mathematical statistics, regression analysis and approximation theory, digital signal processing). Layout ISO limits and fits. Measurement errors.
Primary elements.
The principle of operation, construction and classification of transducers. Static and dynamic characteristics of transducers and other components of the measuring circuit. Processing and recording analogue and digital signals.
Instruments and measuring machines.
Patterns of length and angle. Instruments like slide gauges, micrometers srew and gauges. Measuring Machines. Interferometers. Selection of measuring instruments.

Metrology of geometrical quantities.
Measurements of shafts and cylindrical holes and dimensions of mixed. Measurements of angles and cones. Measurements of threads and gears.
Measurements of roughness and waviness.
The parameters of roughness and waviness. Methods of contact and optical measuring surface roughness. Stereometric method of measuring surface roughness.
Coordinate measuring technique.
The construction of coordinate measuring machines. Software and measurement technology.
Measurements of electrical and mechanical quantities.
Measurements of voltage and resistance. Measuring techniques of speed, acceleration and force.
Measurements of hydraulic quantities.
Measurements of static pressure, Pitot tube, manometers, pressure transducers. Flow rate meters, orifice, Venturi tube, rotameters. Measurements of flow velocity, Prandtl probe, hot-wire anemometry, optical techniques (LDA, PDA, PIV).

TUTORIALS: not applicable

LABORATORY: not applicable

Measurements of shafts and cylindrical holes and dimensions of mixed with instruments like sidle gauge, micrometer screw and microscope.
Measurements of internal and external threading on the microscope, rollers, and gauges.
Measurements of the geometry of 3D coordinate measuring machine CMM ZEISS ECLIPSE.
Measurements of surface roughness on the 3D profilemeter TaylorHobson NTFS 60.
Circularity measurements using instrument 3D Talyrond 365th
Measurements of static pressure. Measurements of flow velocity with the use of pressure probes, hot-wire anemometry, laser-Doppler anemometry.

PROJECT: not applicable

SEMINAR: not applicable

Form of assessment	Credit
Basic reference materials	1. Meadows J.D.: Geometric Dimensioning and Tolerancing: Applications and Techniques for Use In Design, Manufacturing and Inspection. Marcel Dekker, Inc. New York 1995 2. Drake Paul Jr.: Dimesioning and Tolerancing Handbook. McGraw-Hill, New York, 1999 3. Whitehouse D.J.: Handbook of surface metrology. Institute of Physics. Bristol 1994 4. Henzold G.: Handbook of Geometrical Tolerancing. Design, Manufacturing and Inspection. John Willey & Sons, Chichester 1995 5. Bosch J.A.: Coordinate Measuring Machines and Systems. Marcel Dekker, Inc. New York, Basel, Hong Kong 1995 6. Mitra S.K., Kaiser J.F.: Handbook for Digital Signal Processing. New York, Wiley 1993 7. R.J. Goldstein: Fluid mechanics measurements. Taylor & Francis, 1996 8. Durst F.: Fluid Mechanics. An introduction to the theory of fluid flows. Springer-Verlag, Berlin, 2008
Other reference materials	For Polish-speaking students: 1. Jakubiec W., Malinowski J.: Metrologia wielkości geometrycznych. WNT, Warszawa 2004 2. Wieczorowski M., Cellary A., Chajda J.: Charakterystyka chropowatości powierzchni. Przewodnik. Zakład Graficzny Politechniki Poznańskiej, Poznań 1996 3. Pr. zb. pod red. Humiennego Z.: Specyfikacje geometrii wyrobów (GPS). Wykład dla uczelni technicznych. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, Bielsko Biała, Erlangen, Huddersfield, Tallin, Wiedeń 2001 4. Ratajczyk J.: Współrzędnościowa technika pomiarowa. Politechnika Warszawska, Warszawa 2005 5. Malinowski J., Jakubiec W., Płowucha W.: Pomiary gwintów w budowie maszyn. WNT, Warszawa 2008 6. Izydorczyk J., Płonka G., Tyma G.: Teoria sygnałów. Kompendium wiedzy na temat sygnałów i metod ich przetwarzania. Helion, Gliwice 2006 7. Zieliński T.P.: Cyfrowe przetwarzanie sygnałów. WKŁ, Warszawa 2007 8. Zakrzewski J.: Czujniki i przetworniki pomiarowe. Podręcznik problemowy. Wydawnictwo Politechniki Śląskiej, Gliwice 2004 9. Nawrocki W.: Sensory i systemy pomiarowe. Wydawnictwo Politechniki Poznańskiej, Poznań 2001 10. Nawrocki W.: Komputerowe systemy pomiarowe. WKŁ, Warszawa 2002 11. J.W. Elsner, S. Drobniak: Metrologia turbulencji przepływów. Ossolineum, Wrocław, 1995

e-mail of the course coordinator and academic teachers	tadek@itm.pcz.czest.pl darek@imc.pcz.czest.pl
Average student workload (teaching hours + individ.)	2 hours of teaching (lecture + laboratory) + 2 hours of individual work per week
Remarks:	
Updated on:	10/02/2011