Budapesti Műszaki és Gazdaságtudományi Egyetem
Gépészmérnöki Kar
Áramlástan Tanszék
Mechanical Engineering Modelling (MSc)
Fluid Mechanics major (MSc)

Budapest University of Technology and Economics (**BME**)
Faculty of Mechanical Engineering
Department of Fluid Mechanics (**DFM**)
Mechanical Engineering Modelling (MSc)
Fluid Mechanics major (MSc)

Flow Measurements
(Áramlástani méréstechnika)

1.	*Code (kód)*	*Semester (szemeszter)*	*Requirements (követelmények)*	*Credit (kredit)*	*Language (nyelv)*
	BMEGEÁTMW03	1.	lect./sem./lab. (exam / pract. / signat.) 2/1/1 (p)	5	English

2. Responsible person and Department (Tantárgyfelelős személy és Tanszék):

Name (Név):	*Status (Beosztás):*	*Department (Tanszék):*
Dr. János VAD	associate professor	DFM

BME, DFM, (Bdg. "Ae"), 1111 Budapest, Bertalan L. u. 4 - 6.
Tel.: (+36 1) 463-2464, 463-4072, Fax: +(36 1) 463-3464, Email: vad@ara.bme.hu, web: www.ara.bme.hu

3. Lecturer (Tantárgy előadó(k)):

Name (Név):	*Status (Beosztás):*	*Department (Tanszék):*
Dr. János VAD*, Jenő Miklós SUDA** Márton BALCZÓ***	*assoc. prof., **assist. prof., ***res. assist.	DFM

4. Thematic background of the subject (A tantárgy az alábbi témakörök ismeretére épít):
Fundamentals of Fluid Mechanics

5. Compulsory / suggested pre-requisites (Kötelező/ajánlott előtanulmányi rend):

	Subject name (tárgynév)	*Code (tárgykód)*
Compulsory:	-	-
Suggested:	Fluid Mechanics	BMEGEÁTAG01 or BMEGEÁTAE01 or BMEGEÁTAM01 or BMEGEÁTAT01 or BMEGEÁTMF03

6. Main objectives of the subject (A tantárgy célkitűzései):
Getting acquainted with the measurement principles, application areas, advantages and limitations of various flow measuring techniques applied in industrial practice as well as in R&D related laboratory activities. Getting skill in solution of measurement-related industrial problems via case studies. Acquiring basic skill in carrying out flow measurements.

7. Detailed thematic description of the subject (A tantárgy részletes tematikája) (tentative, to be agreed):

Interactive Presentations
Date: Mondays, 12.15 – 14.00, **Venue:** DFM (Bdg. Ae), First Floor, classroom at the end of the corridor (Mérlegterem)

Week 1: Introduction. The need for flow measurements. Practical / industrial necessity of flow measurements in general. Quantities to be measured. Aspects of „being advanced". Special notes on advanced flow measurements.
Week 2: Measurement of temporal mean pressures: static, total, dynamic. Probes and methods. Manometers. Pressure-based measurement of velocity magnitude and direction. Anemometers, thermal probes. Temperature measurements.
Week 3: Measurement of unsteady pressures. Sound and vibration measurements. **Laboratory display:** Devices for pressure, velocity and temperature measurements. Pneumatic measurements (pressure, temperature, flow rate). Electro-pneumatic systems.
Week 4: Hot wire anemometry. Flow visualization. Introduction to lasers applied to optical flow diagnostics.
Week 5: Laser optical flow measurements. Laser Doppler Velocimetry (LDV). Phase Doppler Anemometry (PDA). Particle Image Velocimetry (PIV).
Week 6: Laboratory display: Wind tunnel techniques. Hot wire anemometry. Laser operation. Laser Doppler Anemometry.
Week 7: Mid-term test 1 – Part A: closed book test (theory), Part B: open book test (solution of practical problems)
Week 8: Flow rate measurements with use of contraction elements and deduced from velocity data. Comparison.
Week 9: Specialised flowmeters: ultrasonic, MHD, capacitive cross-correlation technique, Coriolis.
Week 10: Easter holiday
Week 11: Specialised flowmeters: vortex, rotameter, turbine, volumetric.
Week 12: Laboratory display: Ultrasonic flowmetry, MHD flowmetry, rotameters, turbine flowmeters.
Week 13: Mid-term test 2 – Part A: closed book test (theory), Part B: open book test (solution of practical problems)
Week 14: The complementary characters of flow measurements and Computational Fluid Dynamics. Industrial case studies.

Interactive seminars (Industrial case studies, ICS, with optional lab displays) + laboratory excercises
Date: Tuesdays, 14.15 – 16.00, **Venue:** as for Interactive Presentations + DFM Departmental Laboratory

Week 1: ICS: Fault diagnostics of the air supply system of a gas motor power generator. Development of a dynamic fire extinguishment method. Testing a wind tunnel via ad hoc measurements.
Week 2: ICS: Optimization of a mineral wool production process. Development of an axial fan of long throw. Visualisation of water coning in the model of an oil production well.
Week 3: ICS: Proposal for noise reduction of an aerobic waste water treatment system. Investigation on a wood chip drying tower.
Week 4: ICS: Optimization of a pharmaceutical fermentation process. Measurement and simulation of an electro-pneumatic brake modulator. Vibration diagnostics on a boiler combustion air supply fan.
Week 5: ICS: Experimental investigation on a scaled-up model fuel pump. Extension of a food industry cooler system.
Week 6: Laboratory display: Visit to the laboratory of Institute of Physics, Eötvös Loránt University of Science. PIV measurements.
Week 7: Preparation for the laboratory measurements. Laboratory measurements 1.
Week 8: Laboratory measurements 2.
Week 9: Laboratory measurements 3.
Week 10: ICS: Development of a standardised axial fan test facility for testing industrial fans. Fluid mechanical survey of a gas turbine power plant.
Week 11: ICS: Measurements on a silencer built in a cement industry flue gas duct. Fluid mechanical survey of a combustion air supply fan of a thermal power plant.
Week 12: ICS: Survey on a heat power measurement method in a remote heating system. Reconstruction of the pump system of a chemical industrial reservoir park.
Week 13: ICS: Investigation of the cooling process applied in sheet metal industry. Study on the effect of flow rate measurement noise in a natural gas supply line. Testing compressors used in air conditioners.
Week 14: Presentation of laboratory measurement results

8. Mode of education of the subject (A tantárgy oktatásának módja):
Interactive presentations; interactive seminars; laboratory displays and excercises.

9. Requirements (Követelmények):
- 2 written mid-term tests. Maximum achievable scores: 2 × 20 = 40 scores.
- Scores for real-time contribution to interactive problem solving. Maximum achievable scores: 40 scores.
- Laboratory report - maximum achievable scores: 10 scores. Submission of report: within 2 calendar weeks of measurement.

No repeated laboratory measurement is offered. Absence from the labs is acceptable only with written medical document.
- Presentation of laboratory results: - maximum achievable scores: 10 scores. No repeated presentation is offered. Absence from the presentation is acceptable only with written medical document.

Pre-requisite for achievement of the subject: min. 40 % obtained out of the part-scores, for each item.
Total: 100 scores.

10. Consulting opportunities (Konzultációs lehetőségek):
Thursdays, 12.15 – 13.15, Dr. János VAD

11. Reference literature (Jegyzet, tankönyv, felhasználható irodalom):
- Website of the subject: http://www.ara.bme.hu/oktatas/tantargy/NEPTUN/BMEGEATMW03
- Compulsory literature: Vad, J. (2008), *Advanced flow measurements.* Műegyetemi Kiadó, 45085. ISBN 978 963 420 951 5.

12. Home study required to pass the subject (A tantárgy elvégzéséhez szükséges tanulmányi munka):
3 hours / week.

13. The data sheet and the requirements are prepared by (A tantárgy tematikáját kidolgozta):
Budapest, 9th of February 2009

Name (Név):	*Status (Beosztás):*	*Department (Tanszék):*
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