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

1.	*Code (kód)*	*Semester (szemeszter)*	*Requirements (követelmények)*	*Credit (kredit)*	*Language (nyelv)*
	BMEGEÁTMW03	1.	lect./sem./lab. (**e**xam / **p**ract. / **s**ignat.) 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

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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*, Dr. Jenő Miklós SUDA**, Márton BALCZÓ***, Csaba HORVÁTH****	*assoc. prof., **assist. prof., ***res. assist., ****univ. 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) (SEE NEXT PAGE):

Interactive Presentations (Lecture+seminar): Date: Mondays, 12.15-15.00, Venue: KF87 (Bdg. K)
Laboratory Excercises: Date: Selected occasions on Mondays, 15.15-17.00, Venue: DFM Departmental Laboratory

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 × 30 = 60 scores.
- Scores for real-time contribution to interactive problem solving. Maximum achievable scores: 15 scores.
- Laboratory report - maximum achievable scores: 15 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):
To be agreed, 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, 11th of February 2013

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

Interactive Presentations, with Industrial Case Studies (ICS): Date: Mondays, 12.15-15.00, Venue: KF87 (Bdg. K)

Week 1 (11 Feb): 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. **ICS – examples:** Development of a dynamic fire extinguishment method. Survey on the air technical system of a pet food production plant. Water coning in the model of an oil production well.
Week 2 (18 Feb): 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. Thermal flowmetry. **Movie. ICS – examples:** Improvement of a mineral wool production process. Fault diagnostics of the air supply system of a gas motor power generator.
Week 3 (25 Feb): Measurement of unsteady pressures. Sound and vibration measurements. **ICS – examples:** Investigation on a wood chip drying tower. Noise reduction of an airfoil by means of acoustically soft coating. Proposal for noise reduction of an aerobic waste water treatment system. Vibration diagnostics on a boiler combustion air supply fan.
Week 4 (4 Mar): Flow rate measurements with use of contraction elements and deduced from velocity data. Comparison. **Movie. ICS – examples:** Fluid mechanical survey of a gas turbine power plant. Measurements on a silencer built in a cement industry flue gas duct. Investigation of the cooling process applied in sheet metal industry. Extension of a food industry cooler system.
Week 5 (11 Mar): Hot wire anemometry. CTA. (**Horváth Cs.**) Optical flow visualization. Introduction to lasers applied to optical flow diagnostics. (**Suda J./Balczó M.**)
Week 6 (18 Mar): Mid-term exam 1 – Part A: closed book test (theory), Part B: open book test (solution of practical problems).
Week 7 (25 Mar): Introduction to the theory, application, and measurement of fluid machinery (turbomachinery). **ICS – examples:** Development of an axial fan of long throw. Development of a standardised axial fan test facility for testing industrial fans. Testing a wind tunnel via ad hoc measurements. Fluid mechanical survey of a combustion air supply fan of a thermal power plant.
Week 8 (1 Apr): Easter holiday
Week 9 (8 Apr): Presentation by Dr. Ben Thornber (Cranfield University): Utilization of flow measurement data in CFD evaluation. Consultation on the Cranfield Socrates/Erasmus study programme (Final project).
Week 10 (15 Apr): Laser optical flow measurements. Laser Doppler Velocimetry (LDV). Phase Doppler Anemometry (PDA). Particle Image Velocimetry (PIV). Stereo PIV. (**Suda J./Balczó M.**)
Week 11 (22 Apr): Specialised flowmeters: ultrasonic, MHD, capacitive cross-correlation technique, vortex. **Movies. ICS – examples:** Survey on a heat power measurement method in a remote heating system. Study on the effect of flow rate measurement noise in a natural gas supply line.
Week 12 (29 Apr): Specialised flowmeters: Coriolis, rotameter, turbine, volumetric. **Movies. ICS – examples:** Reconstruction of the pump system of a chemical industrial reservoir park. Testing compressors used in air conditioners.
Week 13 (6 May): Mid-term exam 2 – Part A: closed book test (theory), Part B: open book test (solution of practical problems).
Week 14 (13 May): ICS – examples. Consultation on the possibilities of continuing collaboration.

Laboratory-related activities:
Date: Selected occasions on Mondays, 15.15-17.00, Venue: DFM Departmental Laboratory

1. **Week 4 (4 Mar): Laboratory display:** Devices for pressure, velocity and temperature measurements. Pneumatic measurements (pressure, temperature, flow rate). Electro-pneumatic systems. Clamp meter. Stroboscopy. (**Vad J.**)
2. **Week 5 (11 Mar): Laboratory display:** Measurements of unsteady pressures. Wind tunnel techniques. Hot wire anemometry. CTA. (**Suda J./Balczó M., Horváth Cs.**)
3. **Week 6 (18 Mar): Facultative consultation (Laboratory exercise leaders): Preparation of laboratory measurements**
4. **Week 7 (25 Mar): Laboratory measurements 1.**
5. **Week 10 (15 Apr): Laboratory display:** Laser operation. Laser sheet techniques (**e.g. Várhegyi Zs. – to be involved by Suda J.**). Laser Doppler Anemometry. (**Suda J./Balczó M.**)
6. **Week 12 (29 Apr): Laboratory measurements 2.**
7. **Week 14 (13 May): Presentation of laboratory measurement results.**