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TEACHING OF MEDICAL PHYSICS TO MEDICAL, DENTAL, HEALTHCARE AND BIOMEDICAL ENGINEERING STUDENTS IN THE CZECH REPUBLIC

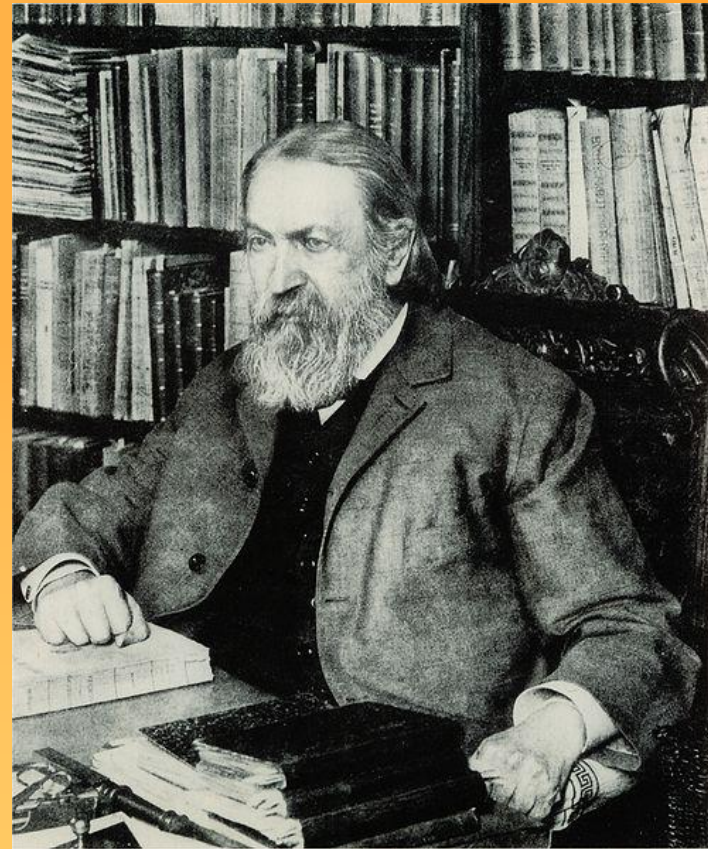
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Regional history of Medical Physics

- In the Austro-Hungarian Empire, the teaching of medical physics started in the 50' of 19th century.
- The teachers were physicists, and, at the beginning, the same syllabus was delivered to both students of medicine and physics.
- In the Czech region, the situation changed after the arrival of **Ernst Mach** to Prague. Special lectures on physics were introduced for students of medicine and pharmacy. They were of relatively small extent – 2 semesters, each with 5 hours of lectures for both parts of Charles University (Czech and German).



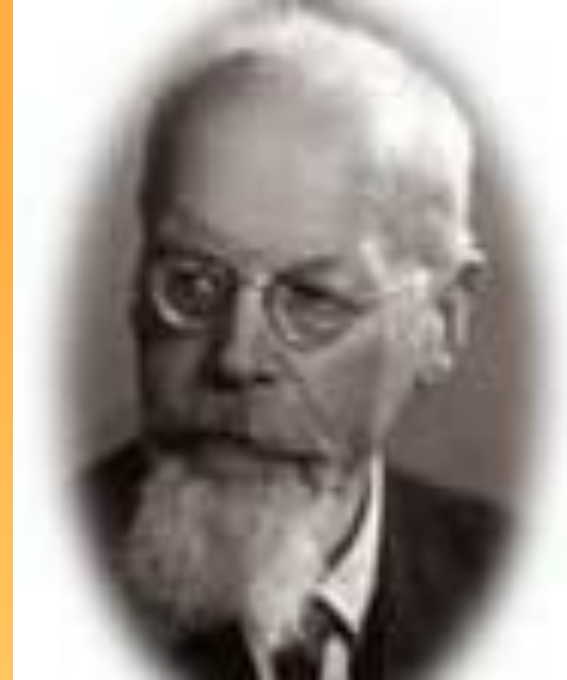
Ernst Mach (1838-1916), born near Brno

History in Masaryk Univ., Brno

Masaryk University (MU) – today 2nd big University in CR - was founded in 1919, its Medical Faculty (MF) in 1920.

Physics became a regular part of curriculum, it was taught by Czech professors of physics from the Faculty of Sciences of MU or from Brno Technical University.

The first author of a Czech textbook on Medical Physics was professor Viktor Teissler (published in 1937). He worked in Bratislava and later also in Brno (namely after World War II).



prof. PhDr. Viktor Teissler (1883-1962), author of the 1st Czech textbook on Medical Physics

History in other Czech Universities

- The other Czech MF were founded after the WW II. Practical laboratory classes were introduced (firstly measurements of basic quantities, from about 70' gradually oriented to clinical problems, inc. demonstrations of medical devices, later the students could perform simple physical examinations as laboratory tasks - e.g., measurement of BP, determination of visual acuity or skin impedance).
- The Depts. of Medical Physics were growing, and started with research. Today numbers of employees exceed ten in most departments. Due to Soviet influence, and also due to major progress in molecular sciences, Medical Physics was renamed as Medical Biophysics. It became directed on general, molecular and physiological biophysics. This trend was broken in the last 10-15 years, and the subject (denoted still as biophysics) is gradually reorienting on the safe, efficient and effective use of medical devices.

Situation today

Eight medical faculties (MF) exist in the Czechia today and all include a medical biophysics department. They are listed in Table 1. (teaching General Medicine) and Table 2. (teaching also Dental Medicine).



Table 1.

Medical Faculty (MF)	additional content	semester	lectures – labs ¹
<i>Charles Univ. Prague</i>	XXX	XXX	XXX
1st MF in Prague	-	1st	2-4
2nd MF in Prague	-	1st	2-3
3rd MF in Prague	informatics	1st	0-53 (total)
MF in Pilsen	-	2nd	3-4
MF in Hradec Králové	biostatistics	1st	41-69 (total)
MF of <i>Masaryk Univ. in Brno</i>	informatics	1st	3-4
MF of <i>Palacký Univ. in Olomouc</i>	informatics, biostatistics	1st and 2nd	60-60 (total)
MF of <i>Univ. Ostrava</i> ²	informatics	1st and 2nd	2-2

¹hours per week or total number of hours

²starting this year (new faculty)

Table 2. Medical Biophysics for Dental Medicine in Czech medical faculties

Medical Faculty (MF)	additional content	semester	lectures – labs¹
<i>Charles Univ. Prague</i>			
1st MF in Prague	-	1st	2-2
MF in Pilsen	-	1st	2-2
MF in Hradec Králové	biostatistics	1st	23-60 (total)
MF of <i>Masaryk Univ. in Brno</i>	informatics	1st	2-0-4
MF of <i>Palacký Univ. in Olomouc</i>	informatics, biostatistics	1st	15-45 (total)

¹hours per week or total number of hours

- Notice the situation in Charles University – 5 (!) medical faculties, three of them in Prague. Historically, the 1st MF, the oldest, has been oriented on General Medicine. The 2nd has been oriented on Paediatrics and the 3rd on Hygiene and Prevention.
- English study programmes are taught everywhere, except at the MF in Ostrava, where courses started this year.
- Besides the students of medicine, most of the faculties have big numbers of bachelor students of health care professions (e.g. nursing, optometrists, radiological assistants, nutrition specialists, midwives, physiotherapists). Except for physiotherapists, radiological assistants and optometrists, these study programmes involve less (bio)physics compared to medicine.
- Health informatics is often taught in our departments (from PC hardware and software to data mining, sharing and processing).
- Faculties in Hradec Králové and Olomouc teach also basic biostatistics so that they have more lectures and laboratory hours. Otherwise, biostatistics and health informatics is taught in separated courses.

What we teach – a typical syllabus

- We try to provide students with basic knowledge of physical principles encountered in medicine both as a background of physiological processes and as working principles of biomedical devices. To assess the risks connected with operation of diagnostic or therapeutic systems it is necessary to understand interaction of many physical agents with human body.
- Our programme also includes fundamentals of health informatics (from PC hardware and software to data mining, sharing and processing).
- We will concentrate on the content of lectures now. Despite of small differences between faculties given by research interests, the following syllabus of lectures at Brno MF is typical to what is found at other Czech universities.

- **a) Medical Biophysics in General Medicine programmes**
- *Device-oriented lectures:* Medical devices - X-ray imaging, Biosignals and their processing. Thermometry, Protection from ionizing radiation and image quality in X-ray imaging, Biomolecular and cellular research devices, Magnetic resonance imaging (MRI), Infrared imaging, Devices for electrochemical analysis, Microscopy, Nuclear medicine and radiotherapy, Sensory perception examination and aids, Physical therapy, Endoscopes, tissue ablation devices and lithotripters, Nanomedical devices, Occupational safety when using medical devices, Devices for substitution and support for body organs, Ultrasound diagnostics.
- *Lectures on general and physiological biophysics:* Structure of matter, Thermodynamic principles, Thermodynamics and life, Structure of living matter, Resting and action membrane potential, Biophysics of cardiovascular system and breathing, Hearing and vestibular sense, Visual perception, Safety aspects of air pressure, gravity changes and ultrasound, Biocybernetics, Healthcare informatics.

- **b) Medical biophysics in Dental medicine programmes**
- *Device-oriented lectures:* Medical devices - introduction, X-ray imaging, Protection of the patient from ionizing radiation and image quality in X-ray imaging, Magnetic resonance imaging (MRI), Infrared imaging, Biosignals and their processing, Thermometry, Microscopy, Nuclear medicine and radiotherapy, Physical therapy, Sensory perception examination and aids, Ultrasound diagnostics.
- *Lectures on general and physiological biophysics:* same as in general medicine.
- The syllabus used for dental medicine is rather reduced (the whole study programme is shorter) and not so strongly device-oriented, because fewer medical devices are used in dentistry. However, in some cases, diagnostic or therapeutic instrumental methods are explained for better understanding of themes taught in other courses.

Testing and examining

- Rigorous quality assurance, i.e. examining and testing of students, become is a time consuming activity which is sometimes considered as an obstacle for scientific research by many our colleagues. It results in abundant use of written tests for final exams, and, generally, in the degradation of the teacher's role.
- We are convinced that student assessment by written tests or essays on their own is not sufficient for accurate appraisal. Our tradition includes an oral exam, which gives good feedback to the teacher, and the written test is used to act as an impetus for the students to prepare seriously for the oral part. After the first experiences obtained in the English study programme, we have introduced such tests generally.

Medical physics for biomedical engineering programmes

- The second large group of students taught in some medical faculties (1st MF in Prague, MF in Brno) are **biomedical technicians** (bachelor level). These will soon be joined by **biomedical engineers** (master level).
- In the past, these study programmes were fully managed by Technical Universities in Prague and Brno. To improve the understanding of biomedical problems, medical terminology and the organisation of health care services, these study programmes now include units taught at MF.
- About ten biomedical science subjects are taught and examined at MF. Since biomedical technicians (engineers) receive tuition regarding medical devices at their own faculty we emphasize different topics such as Microscopy, Sensory perception and its examination, Physical therapy, Endoscopes, tissue ablation devices and lithotripters, Devices for substitution and support of body organs, Structure of matter, Thermodynamic principles, Thermodynamics and life, Structure of living matter, Resting and action membrane potential, Biophysics of cardiovascular system and breathing, Safety aspects of air pressure, gravity changes, and ultrasound. It is evident that **teaching these students is more general biophysics-oriented.**

Perspectives

- The SWOT audit methodology proposed by Carmel Caruana et al. has been applied by ourselves at the faculty level. The main danger for us is to ignore overlapping of subject matter taught in other departments (like physiology) or to concentrate too much on medical informatics and biostatistics. The departments of medical biophysics can maintain a strong position only when teaching subjects which are difficult for other departments.
- It is difficult for faculty management to ignore that without (bio)physical (and technical) knowledge the use of biomedical devices by medical staff is dangerous for patients as well as for the staff itself. Many clinicians are aware that their own ability to use physics for the improvement of patients' treatment is not sufficient for good practice. This can lead naturally to occasional or even regular cooperation with biophysical departments.

- To maintain academic acceptance of medical biophysics within MF we need to base our curricula on device oriented teaching and internationally accepted research. Weak biophysics department can easily be absorbed by new departments arising from the boom in biomolecular sciences.
- It is already evident that many medical students from different European countries study the medicine without understanding physical concepts like energy, power, electric voltage or radioactivity. These students come from high schools without classes in physics and when the lack of physics is not made up in medical curricula life-threatening situations can arise for patients when a communication is needed between the doctor and a medical physicist or technician.

Acknowledgment

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