TEHNIKA I INFORMATIKA U OBRAZOVANJU
3. Internacionalna Konferencija, Tehnički fakultet Čačak, 7–9. maj 2010.
TECHNICS AND INFORMATICS IN EDUCATION
3rd International Conference, Technical Faculty Čačak, 7–9th May 2010.

UDK: 621.8:61.75-089.28 Stručni rad

ACOUSTICS AND HEARING PROSTHESES

Cosmina Vigaru [1]

***Summary**: The paper presents the main problems concerning Acoustic and hearing prostheses. The aim of discipline is to acquire knowledge about acoustic waves propagation and attenuation, noise effects on human organism in generally and on hearing organ in special, required for elaborate and realize hearing prostheses. These prostheses must replace the hearing organ functions and be as efficient as possible.*

***Key words:** ear, hearing aid, prosthesis*

AKUSTIČNE I SLUŠNE PROTEZE

***Rezime:** U radu su predstavljeni glavni problemi koji se javljaju kod akustičnih i slušnih proteza. Cilj ove discipline je sticanje znanja o širenju i slabljenju akustičnih talasa, o uticaju buke na ljudski organizam uopšte, a posebno na slušni organ, znanja koje je potrebno za razvijenje i izradu slušnih proteza. Ove proteze moraju zameniti funkcije slušnog organa i biti što je moguće efikasnije.*

***Ključne reči**: uho, slušno pomagalo, proteza*

1. INTRODUCTION

Developing this complex scientific field was done in close connection with the diversification measurement and control equipments for sound and noise characteristics. Acoustics is the science of sound, considered as part of physics that deals with the study on the production, propagation, reception and sound effects.

The auditory analyzer is a complex structure with an amazing sensibility. The auditory analyzer has three important parts: external ear, middle ear and inner ear.

2. COURSE INFORMATION

The presented discipline has 2 hours per week for lectures and other 2 hours per week, one for laboratory, and one for project. At the end of the teaching period is provided an distributed evaluation, having assigned 4 ECTS Credits. The student's evaluation is made upon a written paper work, the final mark being calculated in relation with the laboratory and project activity, in percentage of 50 %. The mark for application activities is calculated as a weighted average between 25% laboratory work and 75% project.

[1] Lecturer Ph.D. Cosmina Vigaru, Politehnica University of Timisoara, Faculty of Mechanical Engineering, Timisoara, Bd. Mihai Viteazu No 1, E-mail: cosmina@cmpicsu.upt.ro

In order to assure an international compatibility, the discipline syllabus was established taking into account syllabi of some similar courses taught in other universities, such as: University of Salford [4], Frankfurt University of Applied Sciences [5], University of Portsmouth [6].

- The modern prostheses are complex consist from mechanical and electronical component, so a medical engineering graduate should have the following knowledge and skills:
- knowledge of design and element calculation in order to realize an ear model;
- knowledge of the basic principles signal analysis;
- knowledge of the basic principles of electronics in order adjust and repair a prosthesis.

This course is useful to the medical engineering graduates and gives them the opportunity to work in these areas:

- design and production of hearing prostheses;
- maintenance adjustment and repairment of hearing protheses;
- upgrading of existing automated systems;
- service activities.

The lectures are taught using modern techniques such as oral communication and conversation, video projector and internet. The students receive the course support both in electronic format and print material. In addition, they can study the recommended bibliography available in university library.

3. COURSE DESCRIPTION AND OBJECTIVES

The aim of discipline is to acquire knowledge about acoustic waves propagation and attenuation, noise effects on human organism in generally and on hearing organ in special, required for elaborate and realize hearing prostheses.

The course consists of 9 chapters of the main areas of acoustics, disorder of human ear, rehabilitation methods in close correlation with the implications there are in practice.

The main topics of the lectures are:

- Acoustic wave - Acoustic field. Sound pressure. Plane wave. Spherical wave. Sound intensity level. Sound pressure level;
- Acoustic wave propagation - Reflection. Refraction. Interference. Doppler Effect;
- Physiological acoustics. Sound characteristics. - Anatomy of the auditory organ. Listening mechanism. Area of audibility. Weber-Fecher law. Sound strength. Height sound. Sound timbre;
- Pathophysiology of auditory disorders - Factors that cause hearing loss. Types of hearing loss;
- Methods for investigating the auditory apparatus - Audiometry. Timpanometry;
- Sound measurement - Devices for noise measurement. Measurement methods. Frequency Analysis;
- Principles and solutions for the noise control - Effects of noise on the human body. Noise reduction methods. Individual protection means. Standards for noise measuring;
- Hearing prostheses - Types of hearing prostheses. Constructive elements;
- Cochlear implant - Types of cochlear implants. Constructive elements.

The topics of the laboratory sessions are focused on:

- Presentation of the equipments used in noise measuring;

- Noise measurement of traffic road;
- Audiometry. Investigation of the human ear conducted both by air and bones;
- Performing and interpretating an audiogram;
- Masking effect;
- Performing and interpretating the tympanogram;
- Hearing prostheses and cochlear implants.

The first part of the applications is reserved to examplify the measurement of acoustic quantities in order to characterize the noise environment. Acoustic measurements are made using a sonometer.

The second part of applications is reserved to investigation of the human ear. Audiometry is the testing of hearing ability. Typically, audiometric tests determine a subject's hearing levels with the help of an audiometer (*fig. 1*), but may also measure the ability to discriminate between different sound intensities, recognize pitch, or distinguished speech from background noise. Acoustic reflex and oto-acoustic emissions may also be measured using a middle ear analyzer (*fig. 2*). Students can perform tests on: tympanometry; reflexes using four different tones or three types of noise; ipsi and contralateral reflex decay tests; Eustachian Tube Function tests for intact and perforated eardrums.

Results of the audiometric tests are used to diagnose hearing loss or diseases of the ear, and often make use of an audiogram. Students learn how to interpret an audiogram.

In particular, the conditions for teaching are ideal for practical evaluation of the ear disorder.

Figure 1: *Audiometer MA 33*

Figure 2: *Middle ear analyzer MI 44*

The project is in accordance with laboratory work and course content. The goal of the project is to produce a computer model that can be used to simulate the ear function. The project subjects are established taking into account the following issues:

- middle ear function is important for sound transmission to the cochlea;
- modeling of the middle ear is important in order to build middle ear prostheses;
- aim of any prosthesis is to rehabilitate the damaged organ in order to improve its natural function;
- based on a better understanding of the middle ear's sound transmission, prostheses' design could be optimized to produce transmission characteristics that are seen in the normal human ear;
- partial ossicular reconstruction prostheses (PORP) are frequently used in practice to restore ossicular continuity when the incus is eroded or missing;
- total ossicular reconstruction prostheses (TORP) are used when the arch of stapes are absent or the malleus is missing or eroded.

4. CONCLUSIONS

The course *Acoustics and hearing prostheses* offers to the students basic knowledge on the fundamental concepts of acoustics, methods for investigating the auditory apparatus, equipment use, hearing aids and cochlear implants. All the achived skills are important for specialists in Biomedical Engineering.

5. REFERENCES

[1] http://maico-diagnostics.com
[2] N. Enescu et. al., *Acustică tehnică*, EdituraTehnică, Bucureşti, 1998.
[3] M. Poenaru, *Agresiunea sonoră şi surditatea de percepţie*. Editura Mirton, Timişoara, 1999.
[4] http://www.salford.ac.uk/
[5] http://www.fh-frankfurt.de/en/the_university.html
[6] http://www.port.ac.uk/