UNIVERSITÀ DI PISA

ELECTRONIC AND COMMUNICATION TECHNOLOGIES

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CdS	AUDIOPROTHESIC TECHNIQUES
Codice	634II
CFU	6

Moduli	Settore/i	Tipo	Ore	Docente/i
SISTEMI E DISPOSITIVI DI SUPPORTO AUDIOPROTESICO	ING-INF/06	LEZIONI	24	MARCO PATERNI
TECNOLOGIE ELETTRONICHE	ING-INF/07	LEZIONI	24	MARCO PATERNI

Learning outcomes

Knowledge
At the end of the course:

- the student will have acquired knowledge about electronic technologies that concern hearing aids systems
- the student will be able to discriminate and understand audioprotectic systems according to the reference technology
- the student will have acquired knowledge to follow the technological evolution of hearing aids.

Assessment criteria of knowledge
For the assessment of knowledge, tests are carried out during the course and meetings are available between the teacher and the students

Skills
At the end of the course:

- the student will be able to evaluate electrical / electronic data relating to hearing aids
- the student will be able to evaluate electronic schemes related to the hearing care world
- the student will be able to intercept problems to be addressed to specialized assistance centers
- the student will be able to manage terminology relating to the electronic technologies used in the hearing care sector

Assessment criteria of skills
The course includes exercises and simulations that represent an opportunity to deepen and verify the skills acquired

Teaching methods
The course consists of lectures presented with the aid of slides and videos.
The lessons include group exercises carried out on the blackboard and simulations also carried out with IT tools.
Indications are provided for any further information (textbooks, WEB resources, software, etc.).
All teaching materials and simulations are available on the e-learning portal of the University of Pisa.
In support of the students, the teacher is available for direct interviews to be booked by phone or e-mail.

Syllabus
Electronic Technologies Module

Semiconductors
Conductors, insulators and semiconductors. Doping of a semiconductor. PN junction: characteristics and electrical behavior.

The Diode
The diode. Characteristic curves of diodes. The operation of the diode as a rectifier. Varactor diode. Zener diode. The led diode Primary and secondary optics. The led diode as infrared emitter. Photodiode. Elements of hearing aid applications.

The transistor
NPN and PNP junctions at rest and under polarization conditions. The transistor and its characteristics. Transistor polarization. Loading line.

Work point instability. Use of an input signal to the transistor. Transistor as a diode. Transistor as switch. Field effect transistor (JFET). Characteristic curves of a JFET. Use of the FET as an amplifier. Examples.

Transistor amplifiers
Transistor amplifiers. Models for small signals. Coupling amplifiers to loads and input signals. Consideration for the optimization of the amplifiers (polarization, stabilization, amplification). Darlington configuration. Class A, B, AB, D amplifiers. Hearing aid applications.

Simulators
Electronic circuit simulation. Illustration of the functional characteristics of the 5SPICE program. Use of the 5SPICE program to simulate topics covered during the lessons: capacitor and inductance behavior, diode circuits, transistor amplifiers

Integrated circuits
Integrated circuits. General characteristics. Construction typologies. Hearing aid applications.

Operational Amplifiers
Operational amplifiers and functional characteristics. Use of operational amplifiers and various circuit types: inverting and non-inverting amplifier, adder, tracker, integrator, derivator, high pass filter, low pass filter, oscillator, voltage controlled amplifier, instrument amplifier. Drift and noise management. Hearing aid applications.

Elements of digital electronics
General principles. Logic gates. Combinatorial and sequential circuits. Memories and registers. Analog/digital and digital/analog conversion. Microprocessors. DSP. Hearing aid applications.

<u>Hearing aid systems and devices module</u>

Microphones
General principles. Functional characteristics. Pressure and pressure gradient microphones. Construction technologies. Particular constructive adaptations. Microphones and hearing aids. Directional microphone systems. Microphone arrays. MEMS technology.

Receivers
General principles. Balanced armature magnetic receivers: single and dual receivers, output level, armature, response curve, membrane. Piezoelectric receivers. MEMS receivers.

Telecommunication principles
General telecommunication concepts. Transmission through analog and digital signals. Modulation and demodulation concept. Analog modulation of an analog carrier (AM, FM. PM). Analog modulation of an impulsive carrier (PAM, PWM, PPM). Digital modulation of an analog carrier (ASK, FSK, PSK)

Magnetic induction communication devices
Audioprosthetic applications of telecoil systems. The characteristics of the system and compliance. Infrastructure geometries: perimeter loops, elimination loops, comb loops, multiple loops. Covering large surfaces. Implants for special applications: the bearer of a self-prosthetic system in the hospital. Advantages and disadvantages of telecoil technology. Comparison of telecoil technology with standard microphone technology. Application solutions in the hearing care world.

Radio frequency telecommunication systems.
Electromagnetic wave: characteristics, polarization, propagation, reflection, refraction, diffraction. Antennas.

Radio frequency telecommunication systems.
Electromagnetic wave: characteristics, polarization, propagation, reflection, refraction, diffraction. Antennas: operating principle and operating characteristics. Scheme of a radio frequency transmitter. Scheme of a radio frequency receiver. Radio frequency communication systems used in the hearing care sector.

Infrared-based telecommunication systems.
Infrared characteristics in telecommunication systems. Transmitters and receivers. IRDA and digital protocols (SIR, MIR; FIR). Transmission of analog signals. Hearing aid applications.

Bluetooth technology.
Introduction to the standard and historical background. Personal Area Network (PAN). Power classes, bands used and modulation. Network types. Piconet and scatternet. Functional roles: master and slave. Evolution of the standard. Hearing aid applications. Physical communication channel. Addressing. Types of connection. Functional states of bluetooth stations and operating modes. The various versions of the standard. Bluetooth 4.0 and new usage scenarios. Hearing aid applications.

WIFI technology.
Introduction to the standard and historical background. WLAN concept. Band of WIFI technology. Network types (IBSS, BSS, ESS). Access point and distribution system. Station services. The evolution of the standard.

Sound generators
Sound generators in reduction of tinnitus disorder. White, pink and brown noise generators: analog and digital construction technologies.

Examples of stand alone generators and combined with hearing aid systems.

Electromagnetic compatibility.
Electromagnetic phenomena and interference. Electromagnetic compatibility. Interference reduction. Electromagnetic compatibility and hearing aids. Some examples of problems related to electromagnetic compatibility in the hearing care world.

Bibliography

All teaching materials and simulations are available on the e-learning portal of the University of Pisa. Here are available references for bibliography and textbooks to deepen knowledge.

Non-attending students info

There are no variations for non-attending students regarding: program, exam modalities and bibliography. However, it is advisable to contact the teacher for a clarification interview on the various aspects of the course.

Assessment methods

The exam consists of an oral test in which knowledge of the various topics covered during the course will be assessed.
The exam will be passed if a score greater than or equal to 18/30 is achieved on both modules.
If this score is not achieved even on one of the two modules, the entire exam will have to be taken again.

Notes

For any information please contact marco.paterni@med.unipi.it

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