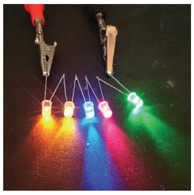
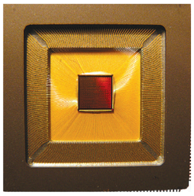
Monika Badecka-Kozikowska

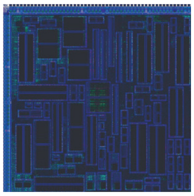
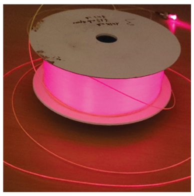
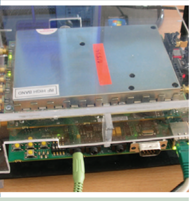
ENGLISH FOR STUDENTS OF ELECTRONICS AND TELECOMMUNICATIONS

Text based activities in developing English for Specific Purposes

Teacher's Book





Gdańsk 2015

PRZEWODNICZĄCY KOMITETU REDAKCYJNEGO
WYDAWNICTWA POLITECHNIKI GDAŃSKIEJ
Janusz T. Cieśliński

RECENZENCI
Zbigniew Czaja
Iwona Gajewska-Skrzypczak

PROJEKT OKŁADKI
Wioleta Lipska-Kamińska

Wydano za zgodą
Rektora Politechniki Gdańskiej

The **Teacher's Book** and audio recordings are available online –
http://cjo.pg.edu.pl/badecka

Oferta wydawnicza Politechniki Gdańskiej jest dostępna pod adresem
http://www.pg.edu.pl/wydawnictwo/katalog
zamówienia prosimy kierować na adres wydaw@pg.gda.pl

ISBN 978-83-7348-635-5

WYDAWNICTWO POLITECHNIKI GDAŃSKIEJ

Wydanie I. Ark. wyd. 4,2, ark. druku 4,5, 1112/895

Druk i oprawa: Totem.com.pl, sp. z o.o., sp. k.
ul. Jacewska 89, 88-100 Inowrocław, tel. 52 354 00 40

Table of Contents

Preface

In the era of English becoming the language of instruction of lectures, seminars and classes at the level of tertiary education in Poland the book *English f*or *Students of Electronics and Telecommunications* addresses the need for developing language and academic skills in technical English at level B2 and upwards.

The academics and researchers at the Gdańsk University of Technology, Department of Electronics, Telecommunications and Informatics (*see* the Acknowledgements) have devised a selection of English texts dealing with various disciplines of Electronics and Telecommunications which have become an inspiration for creating language activities, exercises and pronunciation drills intended for the practice of technical vocabulary, language structures that naturally emerge from the texts or are inspired by them, as well as academic skills such as presentation skills, note-taking, summary writing, presentation based on a visual, and other skills.

The experience of many years' observation of student performance on English courses at Polish universities reveals a picture of many students, who despite their fluency struggle with grammar, are unable to give a well-planned and clearly delivered presentation, or stumble over pronunciation of more sophisticated and specialist vocabulary. *English f*or *Students of Electronics and Telecommunications* offers a variety of pronunciation drills, including those on a light note which I encourage the teachers not to ignore since they are to eradicate pronunciation problems frequently neglected in the English class. Phonetic drills are usually a nice break from class routine and have a remedial value.

The book is devised for students of level B2 upwards, but ambitious students at high level B1 may undertake an adventure with the language and subject-matter content, as well. For lower level students *English for Students of Electronics and Telecommunications* is supplementary to all kinds of technical course-books like Technical English – 2 and 3 by David Bonamy, Cambridge University Press. It is a good idea to go over the language and subject-matter material content on page 6 to get some insight into what can be done with *English for Students of Electronics and Telecommunications*. The book, however, does not cover all the fields of Electronics and Telecommunications but is a selection of a few important topics.

Feel free to use the book in any order of the ten units. The book is independent of any strict syllabus guidelines but covers topics regarded as important ones. The glossaries in the Student's Book, devised specifically for each unit may come in handy for discovering what some notions look and sound like in Polish, and also for more formal English-Polish and Polish-English translation.

The exclusive use of the Teacher's Book as an online resource entitles its users to exploit electronic resources as provided in the links referred to in the instructions, footnotes and Bibliography.

Note that the keys to the exercises and activities in the Teacher's Book have been highlighted by means of this pictogram , whereas the scripts of the listening texts and pronunciation drills have been denoted with .

Acknowledgements

I want to express my appreciation of the contribution to this publication by the academics from the Department of Electronics, Telecommunications and Informatics of the Gdańsk University of Technology. They have delivered a selection of subject-matter texts in English as listed in the table of contents. The texts are the basis for the language activities in *English for Students of Electronics and Telecommunications*.

It is my pleasure to thank **Wojciech Toczek, Ph.D. D.Sc**. for being the very first one to respond to my e-mails and help with the materials for Electronic Measurement and Test Instruments (UNIT FOUR); to **Paweł Wierzba, Ph.D.** who delivered a huge amount of materials and additionally devised a comprehension exercise for Optoelectronics (UNIT THREE), as well as sent his own photographs of lasers, LED's and optical fibers; to **Michał Rewieński, Ph.D.** who despite becoming a "newly-born-father"managed eventually to explain the intricacies of the difficult topics of UNIT ONE (Computational Electromagnetics) and UNIT TWO (Automated Design and Optimization of Microwave Components for Wireless Communication Systems); to **Prof. Andrzej Czyżewski, Maciej Kulesza**, authors of the text on Audio Coding, and especially to **Andrzej Ciarkowski** who in no time corrected the unit in respect to the subject-matter of Audio Coding and devised the glossary for the unit; to **Jacek Marszal, Ph.D. D.Sc**. for contributing the text to the unit on Modern Navigation Systems, for the correction of the unit and devising the glossary; to **Marek Wójcikowski, Ph.D.** for authoring the text, glossary and executing the correction of Design of Advanced Integrated Circuits; to **Wojciech Siwicki** who is the author of the texts, photographs and glossaries on Software Defined Radio and Propagation of Radio Waves; to **Marcin Narloch, Ph.D.** and **Magdalena Młynarczuk,** the authors of the text, glossary and correction of UNIT TEN, From Telephony to Next Generation Network. I am also grateful to **Prof. Tomasz Ciszewski** whose wonderful voice has been recorded in the listening exercises and pronunciation drills available online.

Last but not least, many thanks to **Prof. Krzysztof Goczyła** and **Marek Moszyński, Ph.D. D.Sc.** who commissioned, supervised and facilitated the whole undertaking of the book writing.

Language and Subject-matter Content

UNIT ONE Computational Electromagnetics	**Basic notions of electromagnetism and computational electromagnetics:** *electromagnetic field, electromagnetic interaction, boundary, boundary layer, Maxwell's equations, integral and partial differential equations, initial value, numerical analysis and computational electromagnetics, dielectric, electric conductivity, dielectric permittivity, electric displacement, magnetic permeability, magnetic susceptibility, etc.* **Language**. **Adjectives describing greatness, importance, significance**, e.g. … *of great importance, significant, enormous*, etc. **Structures for giving a presentation** (plus optionally derivation of equations).
UNIT TWO Automated Design and Optimization of Microwave Components for Wireless Communication Systems	**Basic notions related to components for the Automated Design and Optimization of Microwave Components for Wireless Communication Systems** e.g. *multiplexers, diplexers, lossy filters, coupling circuits*, etc. **Language. Cause & Effect structures** e.g. *due to, since, therefore*, etc. **Verbs:** *influence, impact, determine, affect,* etc. **Nominalization**. *The fact that it is incapable of causing >>> Its incapability to …*
UNIT THREE Optoelectronics	**Basic notions of optoelectronics**, e.g. *optical fibers, optical cables, lasers, LED's, attenuation, etc.* **Language. Structures for expressing / describing how things, devices work, operate**, e.g. *How does the OTDR work*? **Structures to indicate simultaneous actions or actions being a result or consequence of other actions** – the use of the Present Participle (*enabling, implying*, etc.). **Applications of optoelectronics in medicine, safety,** etc**. Names of various therapeutic and diagnostic instruments and kinds of therapies** (e.g. *confocal microscopy*).
UNIT FOUR Electronic Measurement and Test Instruments	**Measurement and test instruments and how they work, how they are used**, e.g. *Hand-held multimeters, Bench multimetr, Oscilloscope, Flash Analog–to–Digital Converter, Prescalers in frequency counters,* etc. **Language. Describing how instruments work, ctd. Complex noun phrases**, e.g., *digital sampling oscilloscope,* etc. Diagram completion of a multimeter. **Vocabulary building – nouns made of adjective / adjectives made of verbs,** e.g. *sensitive – sensitivity, certain – certainty, resolve – resolution, measure – measurement, to programme – programmable, etc.* **Structures for functions of arguing, problem solving – decision making**, e.g. choosing an appropriate instrument for the company (speaking communication activities).
UNIT FIVE Audio Coding	**Basic vocabulary and notions of audio coding**: *audio signal, speech signal, codec, coding,(to) encode / decode, sound storage and transmission, Pulse Code Modulation (PCM) format, 8-bit code words/ 16 bit code words, novel methods, MP3, MPEG-4, AAC, PSN.* **Topics. 1.Reducing bit rate requirements for audio signal storage and transmission,** e.g. *lossy coding techniques, human auditory system, compression ratio, transform codec, lossy data compression.* **2. Towards Transparent Coding Quality** – *hearing threshold, masking phenomena, quantization noise*, etc. **Language. Structures with *not only*** – common syntax mistakes. ***Not only* at the beginning of a sentence**. Performing revision and summary of the unit content in diagram form – communication in pair / team work.

UNIT SIX Modern Navigation Systems	**Basic notions in the topic of the Hydroacoustic Ship Berthing Aid System at the Gdańsk North Harbour:** *jetty, berth / berthing, anchor, precision navigation, complicated manoeuvres, sound propagation, visibility, dock, sonar aircraft, hydroacoustic, luminescent, luminance, hydroacoustic, ultrasound transducers, echo pulses.* **Language. Describing how a berthing system operates. Collocations for noun verb associations. Producing a commentary to a video** from the Internet on berthing operations (communication activity – speaking, writing, recording).
UNIT SEVEN Design of Adavanced Integrated Circuits	**Basic vocabulary and notions:** *state, gate array, flip-flops, driver, clock, middleware microprocessor, peripheral, bus, netlist, core clock, Field Programmable Gate Array, clock gating, memory, semi-conductor structures of an Application Specific Integrated Circuit.* Basic acronyms used in the discipline: *IC, ASIC, SoC, CAD, IP, HDL, VHDL, FPGA, PCB, JTAG, CPU, GPU* and what they stand for. **Vocabulary and language. Compact hyphenated phrases.** *<u>Example</u>: an enterprise on a small scale – a small-scale enterprise.* **Nouns** like the word *"manufacturability"*, **with the ending – *ability.*** Communication activity – **Team presentation based on a visual.**
UNIT EIGHT Propagation of Radio Waves	**Basic notions. Phenomena concerning propagation of light waves / electromagnetic waves**. Absorption. Tropospheric scattering. Multipath propagation. Reflection and refraction. Diffraction. Frequency Bands. Power Budget. Fresnel zones. Fresnel clearance**.** **Language: Equation completion and reading. Problem solving –** calculating a mathematical / physics problem.
UNIT NINE Software Defined Radio	**Basic notions:** *mixer, demodulator, transmitter, filter, etc***. Difference between classic and Software Defined Radio. Components of SDR:** *DSP (Digital Signal Processing), IF (Intermediate Frequency amplifiers), A/D Convertor, Demodulation detection, hardware/ software***.** **Language**. **Writing an amplified definition in academic writing** – what is something, how it works, what properties it has, how it is used, future development of the thing / system. **Task**. Write an amplified definition of cognitive radio.
UNIT TEN From Telephony to Next Generation Network	**History of Telephony. Telephony Related Technology. The Next Generation Network and how it will differ from today's Internet. Sophisticated vocabulary:** *ubiquitous, unfettered, unrestricted, independent, convergence, intercept***. Technology of the NGN – vocabulary:** *comprise, packet, designate, carrier, synchronous, nodes, asynchronous, conversational voice teleservice Voice over Packet, Voice over Internet Protocol (VoIP),* real-time services, non-real time services, *data transfer and access to streaming and multimedia content, delivery of interactive Internet Protocol Television available via the Internet (over IP).* **Language. Functions of comparing, contrasting, arguing, holding a debate** on the global – political, economic and social impact of the NGN. **Essay writing /** Alternatively – **speech delivery**.

unit

1 COMPUTATIONAL ELECTROMAGNETICS

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in. Electromagnetism

Electromagnetism

One of the phenomena associated with the propagation of electromagnetic waves such as radio waves (especially radar) and light waves is **scattering** (e.g. **Rayleigh scattering** – by small particles compared to the wavelength of light; **Mie scattering** – by particles about the same size as the wavelength of light, valid only for spheres; **Geometric scattering** – by particles much larger than the wavelength of light, etc.). Other phenomena are the following ones: **absorption, reflection, multipath propagation, diffraction, attenuation, interference.**

1. **Diagram Completion.**

A. Reflection, **B.** Scattering, **C.** Diffraction, **D.** Refraction.

I Computational Electromagnetics.

1. **Speaking.** Computational Electromagnetics is concerned with modeling the interaction of electromagnetic fields with physical objects (and the environment) of very complex structures. It is important in the design, and modeling of antenna, radar, satellite and other communication systems, nanophotonic devices and high speed silicon electronics, medical imaging, cell-phone antenna design, etc.

Following from **1** in the Lead-in, revise again what has been illustrated in the picture propagation of light waves. One of the phenomena associated with the propagation of electromagnetic waves such as radio waves (especially radar) and light waves is **scattering** (e.g. **Rayleigh scattering** – by small particles compared to the wavelength of light; **Mie scattering** – by particles about the same size as the wavelength of light; **Geometric scattering** – by particles much larger than the wavelength of light, etc.). These phenomena need to be taken in consideration when complicated devices and instruments are designed in today's telecommunications.

Up to a certain point **Maxwell's equations** could cope with calculating the electromagnetic interaction with objects of simple and regular structure. However, challenged by the real-world electromagnetic problems caused by complex geometries of actual devices (e.g. waveguides) numerical methods of Computational Electromagnetics were used for modeling of electromagnetic scattering[1].

[1] Bohren, C.F.; Huffman, D.R. (1983). *Absorption and Scattering of Light by Small Particles*. Wiley. ISBN 0-471-29340-7

2. **Speaking to predict. Subject matter background for the teacher.**

An **electromagnetic field**, sometimes referred to as an **EM field**, is generated when charged particles, such as electrons, are accelerated. All electrically charged particles are surrounded by electric fields. Charged particles in motion produce magnetic fields. When the velocity of a charged particle changes, an EM field is produced. The electromagnetic field extends indefinitely throughout space and describes the **electromagnetic interaction**. It is one of the four fundamental forces of nature (the others are gravitation, weak interaction and strong interaction). The field can be viewed as the combination of an electric field and a magnetic field. The electric field is produced by stationary charges, and the magnetic field by moving charges (currents); these two are often described as **the sources of the field**. The way in which charges and currents interact with the electromagnetic field is described by **Maxwell's equations** and the **Lorentz force law**. Maxwell's equations are a set of **integral** and **partial differential equations** that, together with the Lorentz force law, form the foundation of classical electrodynamics, classical optics, and electric circuits. These fields in turn underlie modern electrical and communications technologies. Maxwell's equations describe how electric and magnetic fields are generated and altered by each other and charges and currents. They are named after the Scottish physicist and mathematician James Clerk Maxwell, who published an early form of those equations between 1861 and 1862. A **partial differential equation** contains unknown multivariable functions and their partial derivatives.

Boundary – the edge of the volume of an electromagnetic field, or more specifically **a boundary** is the edge of the computational domain – i.e. the edge of a spatial region of interest (which may be a resonator, a waveguide, a filter) where we attempt to find the electromagnetic field distribution. Typically, the boundary includes perfect or imperfect electric or magnetic conductors, as well as ports through which the electromagnetic field is excited inside the region of interest. At the boundary, mathematical '**boundary conditions**' are specified which model the conductors, port excitations, etc. Those boundary conditions complement the differential equation (derived from Maxwell's equations) and allow one to solve it. The differential equation with complementary boundary conditions is called in mathematics a '**boundary value problem**'.

A **boundary layer** is pretty much the same as a boundary.

EM excitation – a phenomenon where a force acting upon electrically charged particles such as electrons accelerates them, inducing an electromagnetic field.

Initial value is the distribution of electric or magnetic field at the initial moment of time**.** We specify this initial electromagnetic field distribution, and then try to find the evolution of the fields in the region of interest or the propagation of the electromagnetic wave in time, i.e. we find how the fields change at time moments following the initial time point. The initial value complements the differential equation (again, derived from Maxwell's equations) and allows one to solve it and find the time-evolution of EM fields. The differential equation with a complementary initial condition is called in mathematics an '**initial value problem**' (or **Cauchy problem**).

Numerical analysis is the study of algorithms that use numerical approximation (as opposed to general symbolic manipulations) for the problems of mathematical analysis (as distinguished from discrete mathematics).

Computational electromagnetics is the process of modeling the interaction of electromagnetic fields with physical objects and the environment. It typically involves using computationally efficient approximations to Maxwell's equations and is used to calculate antenna performance, electromagnetic compatibility, radar cross section and electromagnetic wave propagation when not in free space.[2]

3. **Reading.** The mistakes have been printed in *italics* whereas the corrected words have been underlined. If a word is missing, a sign of + and the correct missing word has been added.

   a. An **electromagnetic field**, is generated when charged particles, such as electrons, *are not in motion* / are in motion i.e. slowed down or accelerated. When the velocity of a charged particle changes, an EM field *disappears* / is produced. The electromagnetic field extends indefinitely throughout space.
   b. The **electromagnetic interaction** is one of the *three* / four fundamental forces of nature (the others are gravitation, + weak (nuclear) and strong (nuclear) interaction).
   c. **Boundary** is the *centre* / edge of the computational domain, i.e. the *centre* / edge of a spatial region of interest (which may be a resonator, a waveguide or a filter) where we attempt to find e.g. the electromagnetic *compatibility* / field distribution
   d. **Maxwell's equations** and the **Lorentz force law** describe the way in which charges and currents *cease to* [...] *any* / undergo a reaction with the electromagnetic field. (Remove: "cease to [...] any" and leave: "undergo a reaction" - as the correct answer.)
   e. A **partial differential equation** contains *an unknown single function* / unknown multivariable functions and *its* /their partial derivatives.
   f. **Initial value** is the distribution of electric or magnetic field at the *final* / initial moment of time**.** We specify this *final* / initial electromagnetic field distribution, and then try to find the evolution of the fields in the region of interest or the propagation of the electromagnetic wave in time.
   g. Numerical **analysis** is the study of algorithms that use *general symbolic manipulations* / numerical approximation (as opposed to *numerical approximations* / general symbolic manipulations) for the problems of mathematical analysis.
   h. **Computational electromagnetics** is the process of modeling the interaction of electromagnetic fields with physical objects and the environment. It typically involves using computationally efficient approximations to Maxwell's equations and is used to calculate antenna performance, electromagnetic compatibility, radar cross section and electromagnetic wave propagation *when in* / when + not in free space.

4. **Vocabulary presentation.**

   The four fundamental constitutive relationships to describe the response of a medium to a variety of electromagnetic input,

   J = σ**E** – the relationship between the electric field and the conductive current,
   D = ε**E** – the relationship between the electric field and the electric displacement,
   B = μ**H** – the relationship between the magnetic field H and the magnetic induction B,
   M = χ**H** – the relationship between the magnetic field H and the magnetic polarization M,

   where σ is the electric conductivity, ε is the dielectric permittivity, μ is the magnetic permeability, and χ is the magnetic susceptibility.

5. **Pronunciation. Listen and repeat (Rec. 1).**

   a. *electric – dielectric, conductivity – permittivity – permeability – susceptibility,*
   b. *electric conductivity, dielectric permittivity, magnetic permeability, magnetic susceptibility, magnetic polarization.*

---

[2] The term Computational Electromagnetics has been explained to the author by word of mouth by Michał Rewieński Ph.D., Faculty of Electronics, Telecommunications and Informatics, Gdańsk University of Technology. For more information go to **http://www.aticourses.com/sampler/computational_electromagnetics.pdf**

6. **Symbol reading.** The pronunciation of the Greek letters by speakers of English may differ from the original Greek pronunciation like that of the letter μ which in Greek is pronounced [mi:] but in American English it may be [mu:] or [mju:]. If unsure, stick to the original Greek pronunciation available on **http://www.foundalis.com/lan/grkalpha.htm** or go to a You Tube video entitled Greek alphabet the CORRECT Pronunciation on **https://www.youtube.com/watch?v=28yu1PFc438**.

σ [sɪgmə]	– stands for the electric conductivity;
ε [epsɪlən]	– stands for the dielectric permittivity;
μ [mi:] *BE*, [mu:] *AE*	– stands for the magnetic permeability;
χ [chi:] / [kai] *AE*	– stands for the magnetic susceptibility.

7. **Speaking to predict.** Students will find answers to this task in **8**.

8. **Listening (Rec. 2). Check … . Instructions.** Before playing the recording elicit from the class definitions of *radar cross section, antenna, antenna performance, electromagnetic compatibility (see **7** above).*

Speaker 1 Extract 1

*I found this definition of the **radar cross section** in a book entitled Radar Cross Section Measurement by Eugene F. Knott published in 2006[3]. The author defines the radar cross section of an object as "a fictitious area that describes the intensity of a wave reflected back to the radar. […] The **RCS** is the projected area of an electrically large, perfectly conducting sphere whose echo strength would match that of a target if we were to replace the target with the sphere. By electrically large is meant a sphere at least several wavelengths in diameter, and the projected area is simply* Πa^2 *([pi:] multiplied by squared radius).*

Speaker 2, Extract 2

*Everybody knows what antenna is but do they actually know? So I looked it up in Wikipaedia[4] and this is what I found. An **antenna** (or **aerial**) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency (i.e. a high frequency alternating current (AC)) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals, that is applied to a receiver to be amplified.*

Antennas are essential components of all equipment that uses radio. They are used in systems such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, wireless microphones, Bluetooth-enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise.

And what are the components of an antenna? And how does it work? Typically an antenna consists of an arrangement of metallic conductors (elements), electrically connected (often through a transmission line) to the receiver or transmitter. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. These time-varying fields radiate away from the antenna into space as a moving transverse electromagnetic field wave. Conversely, during reception, the oscillating electric and magnetic fields of an incoming radio wave exert force on the electrons in the antenna elements, causing them to move back and forth, creating oscillating currents in the antenna.

---

[3] Knott, Eugene, F. (2006). Radar Cross Section Measurement. Van Nostrand Reinhold, New York.

[4] Access: **https://en.wikipedia.org/wiki/Antenna_(radio)**. Retrieved 2014.05.05

Speaker 1, Extract 3

*As far as the **electromagnetic compatibility** is concerned I found this. It is the branch of electrical sciences which studies the unintentional generation, propagation and reception of electromagnetic energy with reference to the unwanted effects (e.g. electromagnetic interference) that such energy may induce. The goal of EMC is the correct operation, in the same electromagnetic environment, of different equipment which use electromagnetic phenomena, and the avoidance of any interference effects*[5].

9. Reading.

a. NM,
b. AM,
c. NM,
d. AM,
e. NM.

10. Pronunciation (Rec. 3).

radar – radar cross section, satellite, antenna, approximate (verb) – approximate (adjective) – approximation (noun), discrete – discretization, sample – sampling, iterative – iteratively – iteration, compatible – compatibility – electromagnetic compatibility.

II The Origins and Concerns of Computational Electromagnetics

1. Reading and vocabulary presentation.

a. enormous progress,
b. electromagnetic (EM) analysis,
c. initial value,
d. integral or partial differential equations,
e. frequency or time domains,
f. complicated geometries,
g. extremely complex,
h. numerical analysis,
i. computing resources,
j. staggering technological advances,
k. numerical analysis,
l. numerical algorithms,
m. numerical modeling,
n. microwave engineering,
o. novel numerical technologies,
p. numerical algorithms.

2. Reading and speaking. Refer … .

a. Ability to characterize interaction of electromagnetic field with very complex structures.
b. It involves solving boundary or initial value problems for Maxwell's equations, i.e. for a system of either integral or partial differential equations (PDEs), formulated in frequency or time domains.
c. Complicated geometries and advanced materials used in structures of practical significance make initial value problems extremely complex.
d. The application of numerical analysis and powerful computing resources are required.
e. Aspects of speed, architecture and memory capacity.
f. The gap between the researchers' demand for computing power and what the manufacturers could supply. "This permanent gap between what is achievable and what is deemed necessary".
g. On rigorous numerical modeling of EM fields.
h. It originated from the demand for efficient computing of EM fields in various structures and systems has become so important that many research papers in electromagnetics are currently dedicated to novel numerical technologies, which has lead to the emergence of a new research field called computational electromagnetics.

[5] Adapted from: https://en.wikipedia.org/wiki/Electromagnetic_compatibility. Retrieved 2014.05.05.

3. **Vocabulary presentation.**

"very big" = **enormous, colossal**;
"full of energy/power" = **powerful**;
"amazing / extraordinary, surprising, shocking" = **staggering**;
"very important / vital" = **crucial**;
"so far unknown, not encountered before" = **unprecedented**

Collocations: colossal progress, enormous progress, powerful computing resources, the problem [of …. is so] **crucial**.

4. **Vocabulary practice.**

They express and emphasize greatness, large size / large scale (*enormous, colossal, unprecedented*); speed (*staggering*); force, impact, efficiency (*powerful*) and importance (*crucial*).

a. colossal / unprecedented,
b. enormous / colossal,
c. powerful,
d. unprecedented,
e. staggering,
f. crucial.

5. **Speaking and vocabulary use.**

Possible answers: Einstein's theory of relativity occurred to be an **enormous** step forward in physics and cosmology. The Internet has caused a **colossal progress** in global communications. The personal computer has been **crucial** in increasing the efficiency of human activity and in connecting people socially. Semiconductor electronics has speeded up technological progress in an **unprecedented** way. Abraham Lincoln's **powerful** rhetoric became **crucial** in the process of abolishing slavery and establishing democracy in the early period of the American history. The free trade Union Solidarity had an **enormous/colossal** contribution in / to creating a new democratic system in Poland. Marina Sand Bays in Singapore reached **staggering** construction costs of 6 billion $.

6. **Pronunciation (Rec. 4). Listen and repeat. Then mark … .**

The primary stress falls onto the underlined syllables: *confrontational* – ***computational;*** *logarithm* – ***algorithm;*** *spherical – clerical* – ***numerical; colossal*** – *glossal; amorphous* – ***enormous; rigorous*** – *vigorous; dented – scented* – ***unprecedented;*** *angering* – ***staggering;*** *essential* – ***crucial*** – ***initial; analysis*** – *paralysis – dialysis; contain* – ***domain*** / dəˋmein/; *credential – essential* – ***differential;*** *martial* – ***partial;*** *spectrometry* – ***geometry.***

III Improving efficiency for numerical prototyping tools

1. **Dialogue completion. Sample answers.**

01. What does Computational Electromagnetics focus on / is concerned with?
02. Where are numerical prototyping tools used?
03. What are they? What can you tell us about the first usage model?
04. Can you give an example of what exactly is solved or analyzed or what kind of problem is solved?
05. What do you mean / is meant by "suitable, efficient and rigorous solution algorithms"?
06. (… which is) *robustness.* Can you explain what it means in computer science?
07. And what is meant / do you mean by "qualitatively and quantitatively different or similar phenomena"?

08. What does the other / second usage model involve?
09. When is it (this kind of scenario) encountered? / When is it used? (Can you give an example?)
10. What does *synthesis* here / in this context mean? What is *optimization*? What do you mean by *synthesis* / *optimization* in this context?
11. Is the term *trade-off* related to system optimization?
12. If it is, then what does it mean?

2. Reading and vocabulary scanning.

numerical **prototyping** tools; design-**development** cycle; **novel** structures; EM – **excitation**; to calculate radar **cross** section; currents **induced** in the human body; rigorous **solution** algorithms; **appropriate** problem formulations; to provide **robustness** and accuracy; to model **qualitatively** different phenomena.

3. Reading and matching.

a. repetitive analysis,
b. trade off accuracy of a single simulation for its computational complexity in order to achieve overall reduced design cycle time,
c. optimization loop,
d. subsequent analysis runs,
e. predefined way,
f. optimization method,
g. iterations,
h. simulation runs,
i. convergence.

OPTIONAL ACTIVITY. Study skills. Presentation

Instructions for the teacher. This may be a difficult task (paradoxically especially for the teacher of English) which will require the knowledge of mathematics and physics. Symbol and equation reading in English can be quite a challenge. You may then decide to assign the task to volunteers who wish to demonstrate, their above average language skills in the context of electromagnetism. Direct students to a resource on the Internet (e.g. **https://www.youtube.com/watch?v=AWI70HXrbG0**) or other resources of their choice. Start the next class with the derivation of Maxwell's equations by a volunteering student, involve the class in comment-making after the demonstration by the student. Get the students to teach you things they know which you only have a vague idea of. It may greatly contribute to their sense of self-esteem and a sense that the class belongs to them, rather than to the teacher.

AUTOMATED DESIGN AND OPTIMIZATION OF MICROWAVE COMPONENTS FOR WIRELESS COMMUNICATION SYSTEMS

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in

1. Discuss … .

The broadening of the range of applications for wireless communication systems and the growing costs of bandwidth associated with the rapidly increasing number of simultaneously operating wireless communication systems, competing in a band with limited capacity have caused higher transmission rates.

2. Match … .

1 k – radio transmission rates;
2 j – frequency bands;
3 n – communication medium;
4 m – high frequency transmitter and receiver circuits;
5 l – frequency splitting circuits;
6 e/g/o/p – microwave circuits;
7 f – neighbouring frequencies;
8 i – simultaneously operating wireless communication systems;
9 h – more demanding performance parameters;
10 e/g/o/p – high rejection filters;
11 e/g/o/p – lossy filters;
12 e/g/o/p – lossless filters;
13 d – coupling circuits;
14 c – cpu resources;
15 b – optimization gradients;
16 a – wall time.

I Vocabulary Presentation and Practice

1. / 2. Explain / Discover and check … .

a. **dielectric** – insulating material or a very poor conductor of electric current. When **dielectrics** are placed in an electric field, practically no current flows in them because, unlike metals, they have no loosely bound, or free, electrons that may drift through the material;
b. **attenuate** – to gradually lose intensity in any kind of flux through a medium. For instance, sunlight is **attenuated** by dark glasses, X-rays are **attenuated** by lead; light and sound are **attenuated** by water;
c. **denominator** – in a fraction (part of a whole) integer (number) displayed below the line;
d. **numerator** – in a fraction (part of a whole) integer (number) displayed above the line;
e. **passband** – is the range of frequencies or wavelengths that can pass through a filter without being attenuated;
f. **design constraints** – restrictions, limits, requirements imposed on a design of a system;
g. **rational function** – any function which can be defined by a rational fraction, *i.e.* an algebraic fraction such that both the numerator and the denominator are polynomials. The coefficients of the polynomials need not be rational numbers;
h. **conductance** – a measure of the ability of a body to conduct electricity; the reciprocal (opposite) of its resistance;

i. **poles and zeroes** – of a transfer function are the frequencies for which the value of the denominator and numerator of transfer function becomes zero respectively. The values of the **poles and the zeros** of a system determine whether the system is stable, and how well the system performs. Control systems, in the most simple sense, can be designed simply by assigning specific values to the **poles and zeros** of the system. Physically realizable control systems must have a number of **poles** greater than or equal to the number of zeros. Systems that satisfy this relationship are called proper.[1]

3. **Listen … . (Rec. 5)** (the answers have been underlined).

High rejection filters
A microwave filter is a network which transmits signals with frequencies within its passband, and attenuates signals with frequencies in its stopband. High rejection filters strongly attenuate or reject signals in the stopband, as compared to signals from the passband, which is typically a desired feature.

Lossy & Lossless filters
Microwave filters are lossy if power losses associated with the dielectric materials and finite conductance of the conductors applied are significant and need to be considered when designing or analyzing the device. For lossless microwave filters one may neglect the effects of power losses associated with e.g. the applied dielectrics or the finite conductance.

Frequency splitting circuits
The purpose of frequency splitting circuits is to separate the incoming signal, consisting of components with various frequencies, into a number of different signals with spectra limited to some pre-specified frequency bands. The frequency splitting circuits typically include microwave filters, diplexers, and multiplexers.

Coupling circuits
Coupling circuits (couplers) are microwave components which are usually three- to four-port networks used to inject a new signal into a network, or as a means to sample a signal within a network.

Gradient optimization (or gradient optimizer)
Gradient optimization is an algorithm which finds a local minimum for a specified cost function by computing its gradients (i.e. derivatives). The cost function typically implements design constraints and objectives to be satisfied by the optimized system (e.g. a microwave circuit).

Multiplexer
A multiplexer is a network that separates signals from a common port to other ports, sorted according to their frequency.

Diplexer
A diplexer is a three-port network which splits the incoming signals from a common port into two paths (sometimes called "channels"), dependent on frequency. Diplexer is the simplest form of a multiplexer.

Low and high order circuits
High order circuits (or systems) are characterized by a complicated frequency response, associated with a large number of poles and zeros. The rational function representation of such systems involves high-order polynomials in the numerator and the denominator of the rational function. For a low order circuit, the number of poles and zeros in its frequency response is limited. [2]

[1] Encyclopaedia Britannica, 2013. Consulted 2014-12-12.
[2] Pozar, D. (1998), *Microwave Engineering*, 2nd Ed., J. Wiley & Sons

4. **Read the description … (Fig. 1 Television diplexer).**

1. High-pass filter, 2. Screw terminals (to which the antenna is connected), 3. Low-pass filter

5. / 6. **Vocabulary building. Instructions.** Do not provide answers to **5** before doing **6 / 6**. Now check ... the answers.

a. loss, lossy, lossless;
b. frequency
c. transmitter, transmission;
d. interference;
e. optimization, optimizer;
f. receiver;
g. resonator;
h. coupling (cross-coupling);
i. additional;
j. manageable;
k. simulator, simulation;
l. performance;
m. computational;
n. efficiency;
o. brand-new;
p. inadequate
q. significance;
r. resistor;
s. amplifier (*24 words altogether*)

II Reading Comprehension. Speaking and Pronunciation

1. **Read again the text in 6 (section I) … . Answers to questions.**

a. The broadening of the range of applications of wireless communication systems.
b. High frequency transmitter and receiver circuits.
c. Frequency splitting circuits in both transmitting and receiving paths, including microwave filters, diplexers, and multiplexers.
d. They limit interference from other systems operating at neighbouring frequencies and allow to separate transmitting and receiving paths which use a common antenna.
e. The growing costs of bandwidth (as confirmed by usage license prices), associated with the rapidly increasing number of simultaneously operating wireless communication systems, competing in a band with limited capacity.
f. High rejection filters and multiplexers.
g. By using high order circuits with additional zeros in its transmission characteristics.
h. On the number of resonators.
i. Lossy filters. They work by introducing signal loss in the path, compensated by an appropriate power amplifier.
j. Resonators and coupling circuits and lossy elements such as resistors. Their structure is very complex.
k. On the cost of their design to be kept at a manageable level.
l. The availability of appropriate computer aided design prototyping tools.
m. To demonstrate better performance, functionality and the automation necessary to efficiently analyze and optimize advanced microwave components and systems, such as high-rejection lossy filters.
n. To be able to perform a detailed full-wave electromagnetic simulation during the circuit analysis phase.
o. The analysis phase performed by electromagnetic simulators is extremely time-consuming due to their inadequate efficiency additionally exacerbated by a very large number of separate simulations which need to be completed.

p. Inadequate technologies applied during the optimization phase i.e. the available electromagnetic simulation lacks advanced analysis features or dedicated final optimization engines tailored to filter circuits.
q. Traditional gradient optimizers, using simple cost functions based on the allowed and forbidden regions specified for the system's scattering parameters.
r. Optimization requires repeated analysis of the system in a given frequency band. Consequently, the number of analyses may reach many thousands, and the number of simultaneously optimized parameters reaches a few dozen. Therefore, if traditional techniques based on specifying the allowed and forbidden regions are used to optimize such complex circuits as multiplexers, the optimization process may take many weeks, and produce no satisfactory results.
s. Performance, functionality and automation.
t. It'll shorten time-to-market for novel and more advanced designs.

2. **Pronunciation (Rec. 6). Word stress**. **Instructions.** I strongly recommend to arrange for class pronunciation competitions after every session of pronunciation practice. Students do enjoy it.

The highlighted syllables in the multi-syllable words are primarily (more strongly) stressed. a. obviously "loss" and "moss" are not multi-syllable words b. ***wi****reless,* ***loss****less c. auto****ma****tion, autho****ri****zation, optimi****za****tion; d.* ***mul****tiplexer,* ***di****plexer; e. ki****lo****meters, pa****ra****meters; f. tra****di****tional, compu****ta****tional; h.* ***a****dequate, in****a****dequate; i.* ***re****sonator,* ***si****mulator; j. functio****na****lity, punctu****a****lity; k.* ***cir****cuit;* ***se****parate; l. inter****fe****rence, perse****ve****rance; m.* ***cross****-coupling;* ***du****ckling; n. trans****mi****ssion, tran****si****tion; o. sc****a****ttering, p.* ***o****ptimize, q.* ***a****nalyze; r. a****na****lysis, pa****ra****lysis; s.* ***ma****nageable;* ***le****gible; t.* ***mo****ments, com****po****nents.*

3. **Pronunciation (Rec. 7). Listen to these somewhat absurd … .**

a. *Multiplexers and diplexers analyze and optimize.*
b. *Lossy filters are not necessarily flossy or glossy.*
c. *Costs may be legible and manageable but not quite edible.*
d. *Going in circles on the Circle Line in London I tried to figure out what low order circuits and high order circuits are.*
e. *Can signal loss occur in wet green moss?*
f. *Are we adequate or inadequate as academics?*
g. *Cross-coupling is a bit like two loving ducklings on a cross-country outing.*
h. *Resistors, resonators and simulators are a humanist's intimidators.*
i. *Don't you need perseverance when you come across interference?*
j. *Gradient optimizers are no good fertilizers for a wireless system's functionality modernizers.*
k. *Automation and optimization prevent modulation and save wireless communication.*
l. *Isn't scattering the opposite of gathering?*
m. *Her parameters shorten kilometers in men's race to her magnetometers.*
n. *I hope that the choice of components may deter our opponents.*
o. *Aren't these brand-new computational tools just sensational?*
p. *Filters act as splitters but I don't think they glitter.*
q. *These brave microwaves pave the way to the new realm of technology and the smart engineers' fame.*

III Language

1. **Read excerpts A, B and C … .**

They function as verbs expressing change, implication, origin, cause and result, etc.

Excerpt A – has created, has implied, have become, determin(e) ing – mainly the Present Perfect Tense;
Excerpt B – is associated with – the Present Simple Tense;
Excerpt C – stems from – the Simple Present Tense.

2. **Complete these sentences … .**

a. has …. affected;
b. has created;
c. is associated;
d. determine;
e. result;
f. result;
g. imply;
h. stems;
i. caused / resulted in;
j. impact.

3. **Now study Excerpts D and E … . Instructions.**

Elicit from the class what they think conjunctions are. Put them up on the board as the students come up with examples. Optionally, you may ask them for sentence examples including conjunctions. Then go on to Language Box II where conjunctions "trigger" cause, change and effect. Devote some time to the use of commas in sentences with conjunctions as students tend to ignore the importance of punctuation in written English.

4. **In five different ways change … . Instructions.** Some students may not cope with sentence **e**. where they need to use "Due to". Treat it as an experiment and check in the feedback session how the class have handled that sentence. They will find helpful tips in Language Box III.

a. Lossless filters are not capable of ensuring efficient performance and functionality of wireless communication systems, **therefore, … . / Therefore,** research is focused nowadays on the development of high rejection lossy filters.
b. Lossless filters are not capable of ensuring efficient performance and functionality of wireless communication systems, **hence, … . / Hence,** research is focused nowadays on the development of high rejection lossy filters.
c. Lossless filters are not capable of ensuring efficient performance and functionality of wireless communication systems, **thus, … . / Thus** research is focused nowadays on the d development of high rejection lossy filters.
d. Lossless filters are not capable of ensuring efficient performance and functionality of wireless communication systems, **consequently, … . / Consequently,** research is focused nowadays on the development of high rejection lossy filters.
e. **Due to the incapability of ensuring** efficient performance and functionality of wireless communication systems, research is focused nowadays on the development of high rejection lossy filters (nominalization is required after due to; *incabale of* > *the incapability of* ……).

Note. All the above conjunctions in **4** can be used interchangeably, either at the beginning or end of the sentences.

Language Box III. Explain the notion of "nominalization". Make sure students know how important the use of nominalization is in more sophisticated writing where verbs are replaced by more concise nouns, noun phrases or gerunds (forms with *–ing* which function as nouns).

5. **Link pairs of sentences …** (the correct answers have been underlined).

a. Due to the development of high frequency transmitter and receiver circuits, communication systems have become modernized. / Communication systems have been modernized due to the development of ……………… . / The modernization of communication systems has occurred / taken place due to the development of high frequency transmitter and receiver circuits. Due to the … etc.
b. Due to the employment of significantly more complex filtering systems such as ones based on lossy filters, higher rejection rates will be obtained. / Higher rejection rates will be obtained due to the employment of significantly more complex systems …. .
c. Due to the use of traditional techniques to optimize such complex circuits as multiplexers ……, the optimization process may take many weeks, ………. .

Note. The underlined phrases are nominalizations, i.e. clauses with verbs changed into nouns or noun phrases).

6. **Now rewrite the sentences … .**

a. The development of high frequency transmitter and receiver circuits has resulted in the modernization of communication systems / The modernization of communication systems has resulted from the development of high frequency transmitter and receiver circuits. / High frequency transmitter and receiver circuits have been developed, the (main/direct) result of which is the modernization of communication systems.
b. The employment of significantly more complex filtering systems such as ... , will result in obtaining higher rejection rates.
(Obtaining) higher rejection rates will result from / will be a direct result of the employment of significantly more complex filtering systems such as ones based on lossy filters.
c. Traditional techniques are used to optimize such complex circuits as multiplexers, the direct result of which may be many weeks' optimization process that will produce no satisfactory results.

7. **Here are some … .** The key provides sample answers, many other options are possible; correct answers have been highlighted.

a. When the transistor was invented in 1947 it was considered a revolution. **Since** it was small, fast, reliable and effective, it quickly replaced the vacuum tube. **As a result of being freed** from the limitations of the vacuum tube, engineers finally could begin to realize the electrical constructions of their dreams.
Due to its small size, **speed and effectiveness,** it quickly replaced the vacuum tube. / **Its small size, speed and effectiveness** quickly replaced the vacuum tube**. The fact that engineers were freed from** the limitations of the vacuum tube **created opportunities for them to realize** the electrical constructions of their dreams.
b. The transistor acts like a switch **since** it can turn electricity on or off, or it can amplify current. / The transistor acts like a switch **due to / as a result of its ability** to turn electricity on or off, or to amplify current. / **The ability to turn** electricity on or off or to amplify current, **makes / determines / causes** the transistor to act as a switch. / **The ability to** […………..] **implies the fact that it** can act as a switch.

c. The diode stops electricity **as a result of / as a consequence of / due to** some conditions and allows it to pass only when these conditions change. This is used in, for example, photocells where **as a result of a light beam being broken,** the diode stops the electricity from flowing through it.

d. **The control** of the amount of current that is allowed to pass **is possible due to / is a result of / results from** the fact that the resistor limits its flow. / **Since** the resistor limits the flow of electricity, it gives the possibility to control the amount of current that is allowed to pass. / **The fact that** the resistor limits the flow of current **implies / creates** a possibility to control the amount of current that is allowed to flow.

e. The capacitor collects electricity **as a result of which it may release / it releases** it all in one quick burst; like for instance in cameras where a tiny battery can provide enough energy to fire the flashbulb.

f. These components are like the building blocks in an electrical construction kit **since** depending on how the components are put together when building the circuit, everything from a burglar alarm to a computer microprocessor can be constructed. / **Due to the fact that these components are like** building blocks [………] / **Due to these components being** like building blocks in an electrical construction kit (and) depending on how they are put together when building the circuit, everything from a burglar alarm to a computer microprocessor can be constructed. / **As a result of these components being** like building blocks ……………. .

g. The small size (smallness) and effectiveness of the transistor (at their hands) **created** possibilities for the electric engineers to construct far more advanced circuits than before. / Possibilities for the electric engineers to construct far more advanced circuits than before **stemmed from / resulted from / were a result of** the small size and effectiveness of the transistor (at their hands).

h. However, **since** the complexity of the circuits grew, problems started arising. / However, **the growing complexity of** the circuits **caused** problems to arise. / Arising problems **were caused by / due to / a result of** the growing complexity of the circuits.

ACTIVITY – Study Skills

Presentation. Giving a talk.

Present to the class …. . Guidelines. This activity requires research. Draw students' attention to the linguistic side of the task, i.e. structures suitable for presenting causes and effects which have been practised in the unit. This link, which is also provided in the Student's Book may help to complete the task **http://en.wikipedia.org/wiki/Integrated_circuit#Advances_**

unit

3 OPTOELECTRONICS

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in

Lead-in. 1. Optoelectronics is a branch of science that combines optics with electronics by creating devices and systems that use both electrons and photons in their operation. It is a young discipline. Laser is one of the phenomena discovered and at the same time an instrument which is made use of by optoelectronics. The acronym stands for Light Amplification by Stimulated Emission of Radiation. Other inventions of optoelectronics are optical fibers for transmitting information, high power LED's used in all kinds of displays, etc.

Lead-in. 2. A. Light Emitting diodes. B. Optical cable. C. Optical fiber. D. Lasers

I Laser, a Little Bit of History

1. Reading and vocabulary (table completion).

a. emission, b. Albert Einstein, c. optical, d. first, e. Theodore, f. synthetic ruby, g. flashlights, h. pulses, i. red, j. blades, k. solid-state, l. emitted, m. monochromatic, n. coherent, o. unprecedented, p. lasing, q. vapors, r. (to) power, s. developed, t. Bell, u. beam, v. wavelength, w. barcode scanners, x. pumped, y. arsenide, z. phosphide.

2. Pronunciation (Rec. 8). Instructions for the teacher.

Go over all the words with the class. Allow time for the students to focus on specific sounds as represented with the phonetic symbols. The point is to raise the students' awareness of the importance of pronunciation as even advanced students mispronounce technical terms, especially.

razor, laser; charismatic, monochromatic; hear, fear, inherent, coherent; length, strength, wavelength; team, beam; impulse, repulse, pulse; paper, scraper, vapor; gallium, helium; neon, freon; formulated, modulated; rigid, digit, fidget; oxide, chloride, bromide, arsenide, phosphide; exacerbated, collimated.

3. Vocabulary Practice.

Down

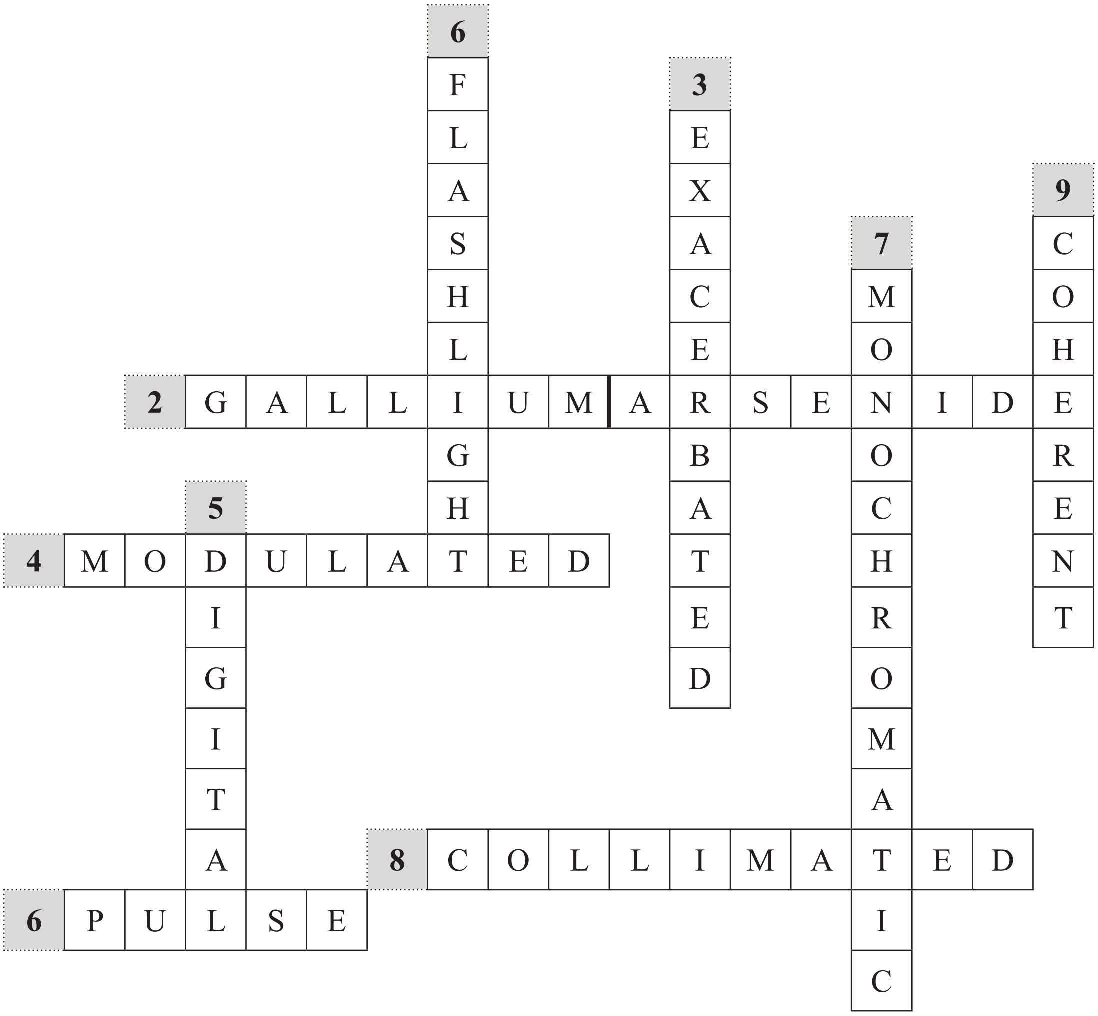
1. Light appearing for a tiny fraction of a moment, may come from a lamp in a camera – **flashlight**
3. Made stronger – **exacerbated**
5. If a signal is not analog, it must be … – **digital**
7. Of one colour – **monochromatic**
9. Consistent or being of homogenous nature – **coherent**

Across

2. GaAs in full words – **Gallium Arsenide**[1]
4. Altered in volume, pitch or tone; modified or adjusted – **modulated**
6. A sharp transient (of short duration) wave in the normal electrical state, or a series of such transients – **pulse**
8. Made parallel – **collimated**

[1] in Polish – arsenek galowy

Optoelectronic Crossword Puzzle



4. **Reading. True false.**

a. F (false because it was bulky, required power supply of high voltage, gasses were contained in fragile glass);
b. T;
c. F (false because it was bulky);
d. F (the intensity of the laser could not be modulated);
e. T;
f. F (false because the former could be modulated by a digital signal while the latter could not).

5a. Pronunciation (Rec. 9).

Bulky, fragile, voltage.

5b. **Relating … .**

The three pronunciation categories are:
/ʌ/ **b<u>u</u>lky** sulky, sultry, multi, pulpy, hulky;
/ɪdʒ/ – (like the Polish "dż") **volt<u>age</u>,** vintage, postage, carnage, dosage, blockage, signage;
/aɪl / fragi<u>le</u>, agile, file, tactile, missile, pile

5c. **Listen …. . (Rec. 10).**

a. *I am a bit agile. Who's stolen my fragile file? Or has it been hit by a missile?*
b. *Low voltage or high voltage? Make up your mind as to the dosage. Otherwise there will be a blockage.*
c. *What laser would you like? Bulky, sulky or hulky? Sultry, please.*

II Optical Fibers

1. **Vocabulary presentation.**

Instructions. Do not provide the answers unless the students have read the text in **2. Collocations**: information transmission / transmitting, reduce (the) attenuation of glass, (the) level of (the) purity of glass, limited transmission range, (to) develop (a) manufacturing process, optical/glass fibers, (to) reduce (the) power of (a) beam of light, glass waveguides / fibers.

2. **Reading (answer to the question)**. What initially made the transmission of information impossible at distances longer than 50–300 meters was caused by the attenuation of a signal due to the properties of glass which demonstrated high levels of impurity.

3. **Speaking / sentence writing.**

Attenuation in optical fibers is a measure of the loss of signal or light power as light pulses propagate, expressed in decibels per kilometer.

4. **Timeline.**

Before 1968 – Attenuation of glass was 1000dB/km;
1968 – Charles Kao calculated the level of purity required of glass to reduce attenuation to 20 dB/km;
1970 – Corning Glass was the first company to develop a manufacturing process of optical waveguides whose attenuation was below 20 dB/km. Their diameter was 125 μm;
After 1970 – Corning Glass reduced the attenuation of glass waveguides to 0.2 dB/km at the wavelength 1550 nm.

4a. **Answer to the Question.** The diameter which allowed the glass waveguides to be called optical fibers was 125 μm.

5. **Measurement unit reading. Instructions.** Do NOT play the recording before students have tried to read the units **(Rec. 11).**

One / A thousand decibels per kilometer, one Watt; one microwatt; one hundred and twenty five micrometers; one / a thousand five hundred and fifty nanometers (a microwatt – one millionth of a watt; a nanometer – one billionth of a meter).

6. **Listening and writing (Rec. 12).**

20 dB/km (twenty decibels per kilometer); *1550 nm* (one / a thousand five hundred and fifty nanometers); *780 nm* (seven hundred and eighty nanometers); *5 W (five watts); 10 mW* (ten milliwatts);
50 μm (fifty micrometers); *1310 nm* (one / a thousand there hundred and ten nanometers); *850 nm* (eight hundred and fifty nanometers); *62,5 μm* (sixty two point five micrometers).

7. **Sentence reading.**

a. true; b. false – because mW stands for microwatts, NOT megawatts; c. true; d. false – because the name of the famous scientist and inventor was Alexander Graham Bell (not Adam Bell) who invented the telephone; e. false, 150 km (not 250 km) is needed to attenuate 1 W beam down to 1 mW.

III Further Development of Optical Fibers

1. **Vocabulary and speaking.**

   It is a prediction exercise. Students may just speculate and not feel guilty that they do not know some of the terms. Encourage them to be free to say anything they think makes sense. They will find answers later in the text in **2,** but do not allow for reading since it is a speaking exercise. EDFA – erbium-doped fiber amplifier; WDM – wavelength-division multiplexing; DWDM – dense wavelength-division multiplexing.

2. **Reading (for gist).** Allow time for students to quietly read the text. Help with the vocabulary if they signal it, approach to help individually. Hold a feedback session and find out how close they were to the content of the text in their predictions from **1**. Also, the answers to the questions in **3** will help you figure out the core content of the text. (See the **key** in **3** below).

3. **Reading. Find answers in the text to the following questions.**

   a. It resulted in a revolution in telecommunications. Optical cables containing several fibers were laid between large cities in the US and Europe, across the Atlantic and the Pacific, enabling new services and applications.

   b. Initially, optical cables operated at the wavelength of 1310 nm, transmitting information at the line rate of 1 Gbps in a single fiber.

   c. Later, the line rate was increased to 2.5 Gbps, and systems operated at 1550 nm. Because then the attenuation of a fiber is the lowest.

   d. The disadvantage of those systems was that after 50–150 km the signal had to be amplified.

   e. Repeaters were used. They converted the optical signal to the electrical one, amplified it, often re-shaping it, and subsequently converted it back to the optical signal.

   f. It consists of a length of an optical fiber doped by erbium[1] ions, pumped by semiconductor lasers, amplifies any incoming optical signal by several decibels, using the phenomenon of stimulated emission, the same as in the laser. It can amplify virtually every modulated signal because no optical-to-electrical conversions are required and the amplification bandwidth is very large (60 nm).

   g. Because EDFA (*erbium-doped fiber amplifier*) amplifies any signal whose wavelength is from 1510 nm to 1560 nm, it is possible to obtain simultaneous amplification of several signals with different wavelengths.

   h. In *wavelength-division multiplexing* (WDM) optical beams with different wavelengths propagate without affecting one another, thereby transmitting several channels of information simultaneously over a single fiber.

   i. It is *dense wavelength-division multiplexing* (DWDM) in which the number of channels in a single optical fiber ranges from 60 to 180. When combined with a line rate increased to 10 Gbps it allows each fiber to transmit from 0.6 to 1.8 terabit per second.

   j. When several signals are sent, their combined power induces non-linear effects such as *four-wave-mixing*. This results in spurious signals, transfers power from one signal to another signal; it may increase scattering in a fiber.

   k. *Dispersion* is the dependence of the velocity of the propagation of light on the wavelength of light Dispersion causes spreading of light pulses that carry information in a fiber, which may lead to partial overlapping of these pulses. This overlapping, often called *intersymbol interference* makes it difficult or even impossible to detect transmitted information.

   l. *Narrow linewidth* lasers have to be used, along with *dispersion management* solutions that minimize the influence of dispersion on the performance of an optical fiber link.

[1] Erbium, name of a chemical element (Er) which is a soft, malleable, lustrous white-silvery metal, and reacts very slowly with oxygen.

4. Pronunciation (Rec. 13).

Instructions – marking stressed syllables. You may write up on the board a multi syllable word dividing it into syllables e.g. importance > *im por tance*, and elicit from the class where the primary stress falls. Highlight the stressed syllable (*–por-*) and go on to the pronunciation drill. Make sure students know what primary stress is. Here is an explanation. There are three types of word stress (primary, secondary and tertiary), they may all occur in one word. The category depends on how strong the stress is, i.e. which syllable is stressed the strongest. Primary stress is the strongest and is marked with an inverted comma **over** a primarily stressed syllable, e.g. in the word *international* the primary stress is on the third syllable represented with letters *–**na**-* ; and the secondary stress is on the first syllable, marked with an ordinary comma >*,**in** ter **'na** tio nal.*

*re **pea** ters **mul** ti ple xing di **vi** sion pro pa **ga** tion **wave** length **line** width dis **per** sion am pli fi **ca** tion mo du **la** tion **in** ter sym bol inter **fe** rence **ma** nage ment **spu** rious **fu** rious **sig** nal **vul** ne rable a **do** rable **te** ra bit **me** ga bit trans **mis** sion trans **mitt** ing ve **lo** ci ty pro pa **ga** tion si mul **tane** ous si mul **tane** ous ly **er** bium **gi** ga hertz **do** ped **de** ci bel phe **no** me non e **ffect** **non-li** near*

5. Pronunciation (Rec. 14) – marking word stress. **Note.** So far only syllable stress has been marked in the pronunciation exercises. In this exercise, however, it is the word stress that needs to be marked. This activity is about the distribution of stress in noun phrases. In two noun phrases it usually falls on the first noun or adjective (but not always!) which defines the second noun. It may differ in multi word noun phrases. If your students happen to have a recording application with a visual graph of the sound waves on their smartphones, you could allow them (after they have heard and practised them in the drill) to record the noun phrases and then to play and observe the stress distribution in the recorded phrases.

<u>optical</u> fiber; <u>fiber</u> cable; <u>erbium</u>-doped; <u>signal</u> modulation; <u>spurious</u> signal; <u>partial</u> overlapping; <u>line</u>-rate; <u>line</u>-width; <u>intersymbol</u> <u>intereference</u>; <u>wavelength</u>-division-<u>multiplexing</u>; <u>dense</u>-wavelength-<u>division</u>-multiplexing; <u>dispersion</u> management; <u>optical</u> signal; <u>electrical</u> signal; <u>optical</u>-to-<u>electrical</u> conversion; <u>erbium</u>-doped <u>fiber</u> amplifier; <u>non-linear</u> effects; The <u>White</u> House.

6. Language.

a. <u>enabling</u> is the Present Participle form of the verb *enable*;
b. <u>transmitting</u> – is the Present Participle of the verb *transmit.* The Present Participle may replace the structure of a subordinate clause with the relative pronoun *which.* See Language Box I for explanation. Make sure that in writing students use a comma preceding the Past Participle in the compound sentences.

7. Language practice.

a. Scientists and engineers were able to send gigahertz signals over long distances, spawning a revolution in telecommunications.
b. The combined power of optical signals in one optical fiber induces nonlinear effects such as *four-wave mixing,* producing spurious signals.
c. Spurious signals transfer power from one signal to another, increasing scattering in an optical fiber.
d. An increased line rate makes the system more vulnerable to the phenomenon of *dispersion,* causing spreading of the light pulses that carry information in the fiber.
e. The spreading of the light pulses may lead to the partial overlapping of these pulses, often called *intersymbol interference,* making it difficult to detect transmitted information.
f. The EDFA amplifies any signal whose wavelength is from 1510 nm to 1560 nm, making it possible to obtain simultaneous amplification of several signals having different wavelengths.

8. **Language.**

It expresses *purpose.*

Note. In fact exercises 8 and 9 should be more of language revision than new language presentation and practice.

9. **Language practice.**

a. … enable new services and applications.
b. … in order to / so as to transmit several channels of information simultaneously over a single fiber.
c. … in order to amplify any incoming optical signal by several decibels.
d. I study electronics / telecommunications in order to qualify for … / become a professional … / to get a title of … / a job in …, etc. (optional).

IV How Does the Erbium Doped Fiber Amplifier Operate?

1. **Reading and diagram completion.** A**.** Optical Isolator. B. Wavelength Selective Coupler (WSC). C. Port of WSC. D. Port of WSC. E Port of WCS. F. Pump laser diode (PLD).

2. **Vocabulary (collocations).** The signal is amplified, the signal propagates, the optical isolator transmits …, the arrow indicates …, the optical isolator absorbs …, the signal enters the port, the power of the signals is coupled.

3. **Speaking and vocabulary use. Instructions.** Make sure students do NOT refer to the text in **1**. Reading is not the point of the activity. You may allow students to study the text for a couple of minutes and rehearse a description of how the EDFA works before the activity starts but make it clear to them that reading during the activity is not allowed since it is a speaking activity. For this activity, an illustration of the EDFA could be displayed on a poster or screen in the classroom for students to relate to the diagram as they talk about how the EDFA works. Students might use the language of presentations, e.g. *The diagram illustrates the EDFA which consists of the following components, …………….. as marked by A in the diagram, …………… as indicated with the letter B in the diagram, …………… etc. The EDFA operates by …………….. etc. The signal is amplified … . The signal enters … etc.*

4. **Reading.**

4.1 – c, 4.2 – b, 4.3 – b, 4.4 – d.

V Tools for Testing Optical Communication Systems and their Components

1. **Vocabulary** and **2. Reading.**

Do not allow for reading the text in **2** before the students have attempted to do **1** on their own.

OPM – optical power meter; OTDR – optical time domain reflectometer; OSA – optical spectrum analyser.

3a. **Pronunciation (Rec. 15).**

optical *– critical;* ***analyser*** *– paralyser; meter – speedometer –* ***reflectometer****; centrum –* ***spectrum****; rain – grain –* ***domain****.*

Instructions for the teacher. The words from **3a** highlighted in the script above are the target pronunciation words (from the text in **2**). They have been grouped with the words which have similar pronunciation.

3b. **Pronunciation (Rec. 16).** The stressed words have been underlined words – *<u>optical power</u> meter; <u>optical time</u> domain reflectometer; <u>optical spectrum</u> analyser.*

4. Erbium doped fiber amplifiers are tested in order to ensure that signals from adjacent channels do not interfere and each channel is correctly amplified.

5. **Language practice. Testing optical communication systems.**

a. Laser radiation is generated by delivering energy to an active medium.
b. Non-linear effects are induced by sending several signals in a single fiber.
c. Transmitting information in several channels simultaneously is made possible by using the technique of *wavelength-division multiplexing* (WDM).
d. Solar thermal energy panels operate by storing the energy produced by the sun and allowing it to be used as needed through an inverter.
e. Car engines work by burning gasoline inside the engine (in an internal combustion engine) and turning the obtained energy to motion.
f. Air conditioners operate by modifying the temperature (cooling/heating) and humidity of the air inside a building (car, etc. in such a way as to allow for comfort of its users), and by means of chemicals which convert gas to a liquid and back again.
g. … by making use of the optical spectrum analyser (OSA).

6. **Speaking. Instructions.** Allow students to speculate.

temperature, strain, pressure, etc. However, do NOT provide these answers unless students shave read the text in **7**.

7. **Reading. Read … .** The answer is: temperature, strain, pressure, etc.

8. **Reading and speaking.**

a. 1st advantage – they can operate in the presence of high voltages or intense microwave radiation due to the fact that they are made of glass and other non-conductive materials. 2nd advantage – they can perform *distributed sensing,* i.e. measure a quantity continuously along a length of a sensing fiber, rather than in selected points.
b. Gyroscopes (rotation sensors)– in passenger airplanes, they indicate top and bottom position, directions like north, south, etc.; hydrophone arrays (underwater acoustic emission sensors) used for military purposes like detection of submarines, surface ships and mines.
c. Optical fiber temperature and strain sensors are used mostly in monitoring large industrial and civil-engineering structures, such as pressure vessels, chemical reactors, dams and bridges.

9. **Pronunciation (Rec. 17).**

periscope – microscope – horoscope – ***<u>gy</u>roscope;*** *cellphone – telephone – methadone –* ***<u>hy</u>drophone;*** *bay – spray – stray –* ***ar<u>ray</u>.*** The stresses fall onto the underlined syllables.

Note the pronunciation of *gyroscope* [ˈdʒairəskəup], especially the first consonant which is pronounced a bit like the Polish *dż*.

VI How Does the Optical Time Domain Reflectometer Operate?

1. In its operation the OTDR takes advantage of two phenomena always present in optical fiber links, ***Rayleigh scattering*** (optionally see & show **https://www.youtube.com/watch?v=twSg2zbjjnA** and ***Fresnel reflection*** (optionally see & show **https://www.youtube.com/watch?v=F-2cUWUe0fY** . *Rayleigh scattering* is scattering from individual particles of silica glass from which a fiber is made. Another result of this process is the blue color of the sky. *Fresnel reflection* appears when optical radiation travels across the border between two media that have different refractive indices, for example when sunlight is reflected from a pane of glass).

   The OTDR measures the attenuation of optical fiber telecommunication links or determine where a link has been severed.

2. A. Laser diode controller, B. Photodetector, C. Coupler, D. Output Connector, E. Optical fiber, F. Analog-to-digital converter, G. Controller.

3. **Speaking. Instructions for the teacher**. Allow time for students to prepare the talk by referring to the texts in **V.2**. and **VI.2**, and the completed diagram in Figure 2. This activity may be preparatory practice of the language of presentations (like the talk about the EDFA in **IV. 3**, see also **Communication Activity** at the end of this Unit).

VII Light Emitting Diodes

1. **Speaking. Instructions for the teacher.** Treat this activity as a warmer for the reading in **2**. Briefly discuss with the class what students think the answers are, however, do NOT confirm any of their answers or provide those given in the key below until after the class have checked them by reading the text in **2**.

2. **Reading. Applications and advantages of LEDs**. LEDs allowed to replace incandescent bulbs in automation systems, *white goods* (e.g. refrigerators, washing machines), signage and transportation, while obviating the need for color filters required by the incandescent bulbs. The lifetime of LEDs was several times longer than that of incadescent bulbs, reducing maintenance costs and improving reliability. Subsequently LEDs were used in numerical displays called *seven-segment displays*, almost entirely replacing other types of numerical displays. Later used in full-color signage in public venues or enhanced car dashboards. When LEDs emitting in ultraviolet were produced, they found also industrial applications – in water purification or in the production of polymer materials. **Drawbacks.** The price of LEDs remains high, because they are made from expensive inorganic semiconductors in an expensive process**. Material**. LED's were initially made of Silicon Carbide (SiC)[2]; now they're made of <u>Gallium Nitride (GaN)</u>[3]. **OLED** stands for <u>Organic Light Emitting Diodes</u>.

[2] In Polish – węglik krzemu, *karborund*
[3] In Polish – azotek galowy

3. **Vocabulary.** made more visible, clearer, “pimped” – **enhanced**; showed, presented – **demonstrated;** [value that] exceeded [an original value] by an [another much higher category of values, e.g. ten times bigger] – **surpassed** by an **order** of **magnitude;** a cleaning process **– purification;** production process – **manufacturing process;** making (something) unnecessary or being able to do without something – **obviating**; producing bright light when heated – **incandescent;** fittings – **fixtures;** a measure of the perceived power of light – **output flux;** turns, changes to – **converts to;** places where events take place **– venues;** a form of electronic display for displaying decimal numbers – **seven-segment display;** mostly **– predominantly;** easily noticed – **notably;** included, made part of something – **incorporated;** being not organic – **inorganic;** made possible, allowed for – **enabled;** a system of signs, visual ways of informing, warning or prohibiting (e.g. in road traffic) – **signage;** like points of light but not quite them – **quasi-points of light.**

4. **Pronunciation (Rec. 18).** The stressed syllables have been highlighted –*‘**di**ode; ‘**light** e’**mit**ting ‘**di**odes; an ‘**or**der of ‘**mag** nitude, manu’**fac**ture, manu’**fa**cturing, incan’**de**scent, in’**or**ganic, ‘**no**tably, pre’**do**minantly, ‘**fix**tures, ‘**si**gnage.*

5. **Vocabulary practice.**

a. manufacturing;
b. Incandescent;
c. predominantly;
d. inorganic;
e. enhanced;
f. Output flux, demonstrated;
g. venue;
h. Notably, surpasses;
i. enables;
j. Numerical displays;
k. an order of magnitude;
l. signage.

VIII Applications of Optoelectronics

Vocabulary work. 1 **and** 2**.** It is not only a linguistic exercise but a way to focus on disciplines in which optoelectronics has major applications**. See the categories below.** Words in italics stand for additional names to complete the categories. **Category I** (ending in *–gy*) **–** archeology, information technology, zoology, metrology**,** *physiology, cosmology.* **Category II** (ending in *–ry*) **–** military, veterinary**. Category III** (ending in *–s* or *–cs*) communications, forensics**,** *physics, mathematics, electronics***,** *optics, optoelectronics, pharmaceutics,* **Category IV** (ending in *–cine* or- *sine*) medicine, *cuisine***. Category V (**ending in *–y*) – study, safety, security. **Category VI.** engineering **–** the only one on its own; **Category VII**. entertainment – on its own.

3. **Reading and table completion.** The answers in the table have been highlighted in bold-type.

DISCIPLINE	TECHNIQUE / TOOL	PURPOSE
Safety and security	*Raman spectroscopy*	to remotely detect the presence of dangerous substances
Medicine	***Pulse Oximetry, Laser Doppler Velocimetry***	to measure the oxygenation of a patient's hemoglobin and velocity of blood flow
Metrology	*Interferometry*	**to measure the distance from the Earth to the Moon with sub-millimeter resolution, or the roughness of a hard disk platter surface**
Safety and security	*Laser-Induced Breakdown Spectroscopy* (LIBS)	**to remotely detect the presence of dangerous substances**
Medicine	***Optical Coherence Tomography***	to detect ocular diseases at an early stage
Medicine	*confocal microscopy*	(as a diagnostic tool) to … provide ... **optical sections of specimens such as bacteria, blood cells, or neurons.**
Medicine	***fluorescence imaging***	(as a diagnostic tool) to detect … **cancerous tissues basing on the evaluation of fluorescence spectra of tissues illuminated by a suitable ultra-violet (UV) source.**
Safety and security	***Light Detection and Ranging* (LIDAR)**	to remotely detect the presence of dangerous substances
Medicine	lasers	to perform **specialized surgical procedures like laser eye surgery, soft tissue laser surgery, etc.**
Medicine	**photodynamic therapy**	to activate a drug only in the area of tissue illuminated by LEDs or lasers so as not to affect healthy tissue
Safety and security	**infrared cameras** burglar alarms	to provide security in military installations and airports, to inspect fruit and vegetables for traces of rot; **to detect the presence of a person (burglar alarms)**

4. & 4a. **Pronunciation (Rec. 19).**

*o**xi**metry, velo**ci**metry, to**mo**graphy, mi**cro**scopy, interfe**ro**metry, spec**tro**scopy, ho**lo**graphy.* The primarily stressed syllables have been highlighted.

5. **Pronunciation (Rec. 20).**

Pulse Oximetry, Laser Doppler Velocimetry, confocal microscopy, fluorescence imaging, laser eye and soft tissue surgery, photodynamic therapy, interferometry, Light Detection and Ranging, Laser-Induced Breakdown Spectroscopy, Raman Spectroscopy.

6. Reading.

a. What needs to be done and developed or devised are the following: noninvasive measurement of the level of glucose in blood, high-quality LED lighting, an instrument that detects gravitational waves, and many other things.
b. It measures the oxygenation of a patient's hemoglobin and the velocity of the blood flow.
c. *Optical Coherence Tomography* can detect ocular diseases at an early stage, when vision loss can be prevented with appropriate treatment.
d. It provides better cutting, reduces bleeding and accelerates healing of tissues.
e. The distance from the Earth to the Moon can be measured with sub-millimeter resolution and the roughness of a disc surface with accuracy in the picometer range.
f. In diverse areas – ranging from art restoration to building construction.

COMMUNICATION ACTIVITY

Instructions for the teacher

In the class prior to the presentations give students a homework assignment to research and prepare a presentation of 10 to maximum 15 minutes on a model of an instrument, device or apparatus used in medicine or in the other areas mentioned in the texts in this unit. In their presentations students will talk about how the instrument / device is built, its purpose and how it works. You may prepare a list of concrete models of instruments and then allow students to choose from the list so that the presentations do not overlap. But this will require your preparation by browsing company websites for the models they offer.

To ensure the use of appropriate language by the students during the actual activity in class (the language of presentations as indicated in the description of the task and the target language of the unit, i.e. *Present Participles*: *–by + ing; in order to*, *so as to*, etc. as shown in the language boxes), you may revise it shortly before the activity starts.

Also briefly remind the class of the importance of note-taking when the students have been paired off to listen to each other's presentations. You may check how attentive the students were during the presentations given by their classmates by assigning a brief written report of a chosen presentation by another student and then by checking it in the class to follow.

unit 4

ELECTRONIC MEASUREMENT AND TEST INSTRUMENTS

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in

1.

Measurement is the act of determining the value of some quantity**.**

2.

A. Time counter,
B. Bench multimeter,
C. Hand-held multimeter,
D. Analog meter/s,
E. Clamp meter.

3.

LIMITED-A **ACCURATE-D** INNACCURATE-A **IMPOSSIBLE TO SEND DATA OVER LONG DISTANCES–A** AUTOMATED-D **MECHANICAL-A** STORABLE DATA-D **VULNARABLE-A** MANUAL -A **AUTOMATIC-D** VERSATILE-D.

I Electronic Measurement and Test Instruments

1. **Vocabulary work.**

a) sensitivity; b) productivity; c) certainty; d) uncertainty; e) flexibility; f) continuity.

2. **Vocabulary work.**

a) specification/s; b) resolution.

3. **Vocabulary work**.

Sensitivity, resolution and ***uncertainty***. They are all part of the ***specifications*** of an instrument. Definition of ***sensitivity*** – the relation between the change in reading and the change in the measured quantity that produces it; ***resolution*** – the smallest change in the quantity being measured that will produce an observable change in the reading; ***uncertainty*** – the extent to which the reading it gives might be wrong, i.e., the extent to which it differs from the true value.

4. **Pronunciation (Rec. 21).**

measure – measurement; resolve – resolution; uncertain – uncertainty; specify – specification; sensitive – sensitivity; observe – observable; accurate – accurately.

II Multimeters

1. **Before you read … .**

a) F; b) T; c) F; d) F; e) T.

Note. Do NOT provide the answers before the students have read the text and discussed the answers between themselves.

2. **Reading and speaking.**

a. analog-to-digital converter, voltage reference and a digital display system;
b. dual-slope converter;
c. measures DC and AC voltage, current, resistance,
d. they provide for an audible continuity test and diode test;
e. by means of an electronic technique;
f. by measuring a voltage drop across a suitable shunt resistor;
g. some multimeters additionally measure capacitance, frequency, temperature;
h. by means of microprocessors which are extensively used in modern multimeters to provide automatic calibration features and eliminate the need for a large number of mechanical adjustments;
i. USB interface.

3. **Vocabulary work.**

programmable

4. **Vocabulary work.**

a. **adjustable** features;
b. **doable** (or: **feasible**) tests;
c. a **suitable** shunt resistor;
d. **measurable** voltage drop;
e. **steerable** horizontal well-drills;
f. a **preferable** dual-slope converter;
g. **storable** data;
h. **transportable** goods

5. **Pronunciation (Rec. 22).**

programmable, adjustable, doable, suitable, measureable, steerable, preferable, transportable, storable, vulnerable

6. **Vocabulary practice.**

a. doable;
b. measureable;
c. preferable;
d. steerable;
e. programmable;
f. vulnerable;
g. adjustable;
h. adjustable.

7. **Vocabulary work. Completion.** The Polish labels in Figure 1 should not make it difficult for non-Polish students to label Figure 2 with the English equivalents. **Key. 6 – Figure 2**

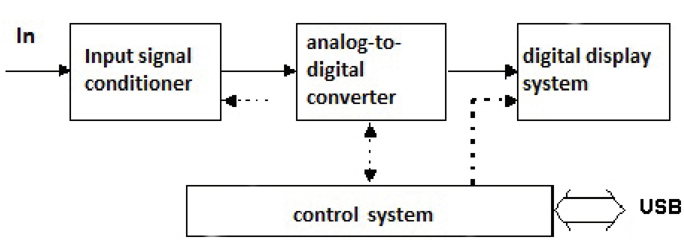


Figure 2. Block structure of the multimeter

III Oscilloscope

1. **Listening –Viewing for gist (Rec. 23). Instructions.** Both, the edited audio and video recordings[1] are part of this publication (for exercises 1, 2, 4 and 5 go to the links and recordings online labeled in the same way as in the exercises in the Student's Book and Teacher's Book). The whole unedited video is also available on You Tube on **http://www.youtube.com/watch?v=CzY2abWCVTY**

   Unlike the multimeter which shows discrete values of signals at an instant, the oscilloscope shows signals over a period of time.

2. **Listening – Viewing for detail. (Rec. 24).**

   1. time
   2. machine
   3. allows
   4. over
   5. period
   6. multimeter
   7. essence
   8. slit
   9. window
   10. particular
   11. measurement
   12. changing
   13. instantaneous
   14. value
   15. constant
   16. instantaneously
   17. electronic
   18. signal
   19. broaden
   20. electronics

3. **Pronunciation (Rec. 25).**

   multimeter – multiplication – multifunctional - multi-faceted – multiplexer; instant – instantaneously; essential – essentially – in essence; constant – constantly; oscillate- oscilloscope; scene – scenic; perpendicular – particular – cellular.

   Comment: Draw students' attention to the fact that that the letter *-u-* in words like *multimeter* or *multiplexer is pronounced as a* short [ʌ]**.** Also note that *-c-* is dropped in the pronunciation of the words *oscilloscope, oscillate, scene and scenic,* e.g. [si:nɪk], not [sci:nɪk]; [osɪloskouəp], not [oscɪloskouəp].

4. **Viewing. (Rec. 26, video).** Figure 3

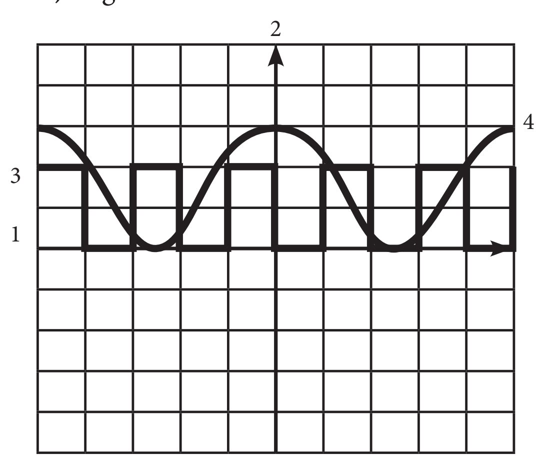


Figure 3. Oscilloscope screen

1. Time axis
2. "Volts axis" – Voltage axis / Middle line at zero volts
3. Square modulated signal from a solar charge controller.
4. Signal as a sinusoidal waveform of AC mains electricity

[1] Published by permission of Martin Lorton.

5. **Listening/viewing. (Rec. 27, video extract 1, video extract 2)**

a. probe
b. vertical position knob
c. trigger knob
d. horizontal position knob
e. ground lead
f. Reference signal.

6. **Reading and speaking.**

a. information such as shape, size, stability;
b. peak-to-peak voltage, the root mean square value of a voltage, frequency, phase difference between two signals, pulse width, rise time, fall time, delay time, and amplitude modulation;
c. multiplication, division, integration, Fast Fourier Transform, and more;
d. One division is into *analog* and *digital*; the other one refers to digital ones: DSO- *digital storage oscilloscopes, DPO – digital phosphor oscilloscope, digital sampling oscilloscope*;
e. The waveform information exists in digital form **as a series of stored binary values**, which allows it to be analyzed, archived, printed, and otherwise processed, within the oscilloscope itself or by an external computer;
f. While a DSO uses a serial-processing architecture to capture, display and analyze signals, a DPO employs a parallel-processing architecture which enables it to deliver unique acquisition and display capabilities of accurately reconstructing a signal;
g. The *digital sampling oscilloscope* is capable of measuring signals of up to an order of magnitude **faster than any other oscilloscope**. It can achieve **bandwidth and high-speed timing ten times higher** than other oscilloscopes for repetitive signals;
h. The sampling oscilloscope's dynamic range is limited to about 1 V peak-to-peak. Digital storage and digital phosphor oscilloscopes, on the other hand, can handle 50 to 100 volts. In addition the safe input voltage for sampling oscilloscope is reduced to about 3 V, as compared to 500 V available on other oscilloscopes.

7a. **Vocabulary work.**

modern digital <u>oscilloscopes</u>; safe input <u>voltage</u>; **digital sampling <u>oscilloscope</u>**; varying frequency-of-occurrence <u>information</u>; **permanent waveforms <u>storage</u>**, continuously updated <u>database</u>; **a three-dimensional real-time <u>display</u>**; fully automated <u>measurements</u>; **advanced mathematical <u>operations</u>**; extensive signal <u>processing</u>; **continuously variable <u>voltages</u>**; purely electronic digital <u>phosphor</u>; **intensified waveform <u>areas</u>**; unique acquisition and display <u>capabilities</u>

7b. **Vocabulary work.** Do NOT provide the answers unless students have listened to the noun phrases in **8.**

highly dangerous radiation; a manually operated analog oscilloscope; a poorly equipped mountain climber; a permanently operating high technology system; a strongly intensified input signal; periodically variable frequencies; an intermittently flashing light tube; a two dimensional drawing; a highly complex printed circuit board; highly technologically advanced instruments; an easily operated system; an easy-to-use multifunctional steering wheel; flash analog-to-digital converter

8. **Listening and pronunciation (Rec. 28).**

highly dangerous radiation; a manually operated analog oscilloscope; a poorly equipped mountain climber; a permanently operating high-technology system; a strongly intensified input signal; periodically variable frequencies; an intermittently flashing light tube; a two-dimensional drawing; a highly complex printed circuit board; highly technologically advanced instruments; an easily operated system; an easy-to-use multifunctional steering wheel; flash analog-to-digital converter

IV Flash Analog–to–Digital Converter

1. **Reading and writing.**

Diagram 4 Block structure of Flash AD Converter. Labels 1–6.

1. Analog input
2. Dividive resistors
3. Comparators
4. Digital Thermometer Code
5. Decoder
6. LSB (Least Significant Bit)

V Other Electronic Measurement and Test Instruments

1. **Speaking.** Allow time for students to discuss possible answers but do not provide the correct ones. They will find the answers by making sentences from sets of words in the table in **2** that follows.

2. **Reading. Speaking and writing.** Allow time for students to put the sets of words from the columns in full sentences. Tell them to work in pairs and say the sentences before they decide to write them down. In this way the activity is a combination of reading comprehension, speaking and writing.

   a. Signal generators deliver a sinusoidal signal with accurately calibrated frequency and amplitude.
   b. Basic frequency counters provide measurement of frequency only.
   c. Universal frequency counters perform various functions like totalizing (counting) input events, measuring frequency or period, phase, the ratio of two frequencies, frequency difference, time interval, pulse width, rise and fall time.
   d. Prescalers in frequency counters can extend the range of frequency to 5 GHz.
   e. Direct frequency counters have a typical upper range of 200MHz.
   f. Waveform generators generate voltage waves as replicas of the desired mathematical waveforms.

3. **Reading and graph completion.**

A. Sine – sinusoidal,
B. Square,
C. Triangle – triangular,
D. Sawtooth.

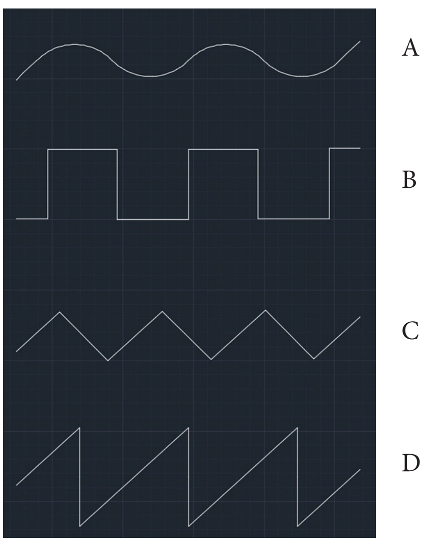


Figure 5. Waveform shapes on a waveform generator's screen

4. **Pronunciation (Rec. 29).**

sine – sinusoidal; triangle – triangular; sawtooth; square; rectangle – rectangular; circle – circular

Communication Activity

Communication Activity. Instructions for the teacher. Put students in groups of three or maximum four (if the number in class does not allow for threes, then in one group of four, two students may act as one student). Make sure that when the exchange of ideas starts they face each other in their little teams. For this it may be necessary to rearrange the seats so that the communication is easier. Explain the activity and get the students to read the introductory explanation, then direct A's to the text for Student A, B's to the text for Student B, and C's to the text for Student C. Allow enough time for reading and understanding the texts. On request, help with the vocabulary. Signal the beginning of the activity and set a time limit of about 15 minutes for group members to reach an agreement as to what instrument they would recommend to the superior. Hold a feedback session where you act as a superior and each group reports back to you what apparatus they have decided is the best one.

Communication Activity. The only generator which can meet the requirements is Agilent Function/ Arbitrary Waveform Generator Model A because it has a differential output, covers the required frequency and amplitude range, generates a differential signal shaped in the same way as a typical EKG.

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in

1. **What sound storage media …** (looking clockwise)? Gramophone record, Compact Disc, cassette tape.
2. **What developments in digital transmission …? Instructions.** Hold a brief debate. Students will probably come up with correct answers. If not, they may refer to the text in the next section (section **I**).

   The Personal Computer (PC) and the Internet stimulated broadcasting companies to switch from analog to digital sound storage and transmission. Violence of copyright for audio materials emerged since the Internet users started to commonly download music with no legal permission.

I Digital Revolution and Audio Material Storage

1. **Reading. Read the text … .**

   a. Limited capacity of storage discs and low efficiency of bandwidth of transmission canals.
   b. The Pulse Code Modulation (PCM) format was used.
   c. Yes, it was.
   d. The band was limited to 3.4 kHz and represented using 8-bit PCM code words.
   e. It requires more than the 700 kbps bandwidth (768 kbps to be precise).
   f. No, it was not feasible. It was a challenge.
   g. Novel audio coding methods needed to ensure lower transmission bandwidth.

2. **Pronunciation (Rec. 30). Listen and repeat.**

   audio – audio signal; code – audio coding – codec; wide – width; store – storage; novel.

3. **Pronunciation. How do you pronounce …? Instructions.** The target letter cluster is *–au* pronounced as the vowel [ɔː]. This is a commonly mispronounced vowel by Polish learners who tend to pronounce it [au], the same way it is pronounced in Polish. Highlight it in order to get rid of this common mistake amongst the Polish learners. Note that activities **3**, **4**, **5** and **6** do not provide recordings of the words in the boxes. They rely solely on the teacher's expertise. So make sure to instruct and drill the students' pronunciation of the target sounds and words without the support of the recordings. However, before giving feedback allow the class to come up with the correct pronunciation models.
4. **Pronunciation. How do you …? Instructions.** Diphthong [ou] is the focus of the drill. The rule is that in most one-syllable words where in spelling the middle letter *-o-* is followed by a consonant and the letter *-e* is located at the end of the word, the middle *-o-* is pronounced as the diphthong [ou]. More examples of this category: *grove, note, vote*, etc.

5. **Pronunciation. How do you …? Instructions.** The target syllable in respect to its pronunciation is – *age* [ɪdʒ]. Other sample words are percentage, lockage, etc.

6. **Pronunciation. Provide the pronunciation model … . Instructions.**

   Each set of the words was made up after a word from 2 (or the text in 1).

   3 – audio. 4 – code. 5 – storage.

7. **Pronunciation. How do these words differ …?**

   The difference lies in the pronunciation of long i [i:] like in feet, and short i [ɪ] like in fit, bit, etc.

   Category 1 – fit, bit, gig, live, grip, click.

   Category 2 – feet, beat, meet, beep, leave, grieve.

   The word from the text in **1** is *bit*.

8. **Vocabulary work. Complete … .**

   The highlighted words are the answers.

   a. Pulse **Code Modulation format**
   b. **speech** signal
   c. audio **recordings**
   d. transmission **bandwidth**
   e. **transmission** channel
   f. digital **resource**s
   g. (to) overcome **limitations**
   h. **digital sound** storage
   i. *n* -bit **code words**
   j. **frequency** range
   k. **audio** coding
   l. **programs** transmission.

II Reducing Bit Rate Requirements for Audio Signal Storage and Transmission

1. **Vocabulary presentation. Can you explain …? Instructions.** Students may work out the meaning of the notions by discussing them in pairs, thus they not only work on the meaning but practise speaking as well. Hold a feedback session afterwards unless they compare, confirm or check their answers in 2 that follows. For answers see the **Key** to **2**.

2. **Reading and vocabulary work.**

   a. True.
   b. False because it allows for high fidelity with a minimum number of bits.
   c. True.
   d. True

e. False. It is the other way round, it is a ratio between the amount of data required to encode the digital signal using the PCM method and the bit-stream produced by the coding algorithm.
f. True.
g. False. A time domain sample shows how a signal changes over time.
h. False. A frequency domain shows how much of the signal lies within each given frequency band over a range of frequencies.
i. False. Because decoded sound samples are no longer identical.
j. True.
k. False. Because it is both, a sensory and perceptual phenomenon. Mechanical sound waves undergo neural action in which the human brain takes part.
l. True. By means of the pinna (a flap of cartilage and skin which funnels incoming sounds into the ear canal).
m. True.
n. True.
o. False. Although the AAC stands for Advanced Audio Coding, it is the **successor** of MP-3.

3. **What are the full versions …? Instructions.** Do not provide the full names to the class. Tell students to find (some of) the answers in the text in **4.** ITU – International Telecommunication Union, AC – Audio Codec, ATRAC – Adaptive Transform Acoustic Coding, MD – Mini Disc, PAC – Perceptual Audio Codec, MPEG – Motion Picture Experts Group (later adopted for the name of the audio codecs).

4. **Reading. Read the text, find some of the answers … .**

a. The ITU has standardized coding algorithms allowing voice transmission with a low bit-rate being the evolution of the PCM format.
b. It is an audio codec operating similarly to the PCM-based codecs standardized by the ITU.
c. Compression ratio does.
d. The ratio of the amount of data required to encode the digital signal using the PCM method to the bit-stream produced by the coding algorithm.
e. Time-domain samples provide relatively low compression ratio, that is why in the 80's and 90's various companies focused on the research related to the high efficiency methods encoding the frequency domain samples.
f. The ones related to the highly efficient methods encoding the frequency domain samples because time-domain samples are transformed into the frequency-domain before encoding.
g. Lossy means that the decoded sound samples are no longer identical to the samples of the original signal. The efficiency of the lossy methods is not only related to the compression ratio, but also to the subjective quality of the audio material they provide assuming a particular bit-rate.
h. The simplest method to compare the efficiency of various lossy methods is to compare the lowest bit-rate they require to encode the audio signal, so that the introduced distortions are imperceptible to the listener.
i. Transparent coding quality can be ensured by exploring the limitations of the human auditory system.
j. AC–1, AC–2 and AC–3.
k. It allows for data rate adjusting between 32 and 640 kbps depending on the number of encoded audio channels and other factors.

l. Dolby Digital – AC-1, A-2, A-3 (for digital cinema sound applications); Sony – ATRAC (Adaptive Transform Acoustic Codec) optimized for the Mini Disc (MD) recorder requiring 140 kbps bitrate for encoding of a single channel; AT&T – Perceptual Audio Codec (PAC) and its multichannel version.
m. The aim was a standardized, high-quality and efficient audio codec. The effect was the MPEG-1 standard defining codec comprised of three layers. The first and second layer are time-domain codecs, the third layer is the transform, perceptual audio codec. The third layer of the MPEG-1 is commonly called MP3.
n. The first and second layers are time-domain codecs, the third layer is the transform, perceptual audio codec. The third layer of the MPEG-1 is commonly called MP3.
o. Advanced Audio Coding (AAC) was proposed. Instead of MPEG-1 and 2, the MPEG-4 standard contains more than only a well-defined codecs description. The MPEG-4 specifies the number of coding tools starting from transform codec, through speech codec, to the codec employing advanced parametric coding techniques
p. The MPEG-4 specifies the number of coding tools starting from transform codec, through speech codec, to the codec employing advanced parametric coding techniques.

5. **Language. What is wrong …?** *Not only* stands before the verb *related* instead of preceding the noun phrase *compression ratio*. The correct sentence is as follows: *The efficiency of the lossy methods is related* ***not only*** *to the compression ratio, but also to the subjective quality of the audio material they provide.* ***Not only*** refers to the same kind of sentence components in both parts of the compound sentence.

6. **Language. Decide if these sentences … .**

a. Incorrect. Corrected sentence: The MPEG-4 standard not only contains a well-defined codecs description but it also specifies the number of coding tools.
b. Correct. Here *not only* refers to the same type of sentence components, i.e. noun phrases (*audio recordings storage* and *transmission of speech signal*).
c. Incorrect because *not only* should stand before *its sensitivity*. Correct version: In order to recognize whether an electronic measurement and test instrument is capable of making a particular measurement it is necessary to know not only its sensitivity and resolution but its uncertainty as well.
d. Correct.

7. **Language. How different …?** *Not only* is placed at the very beginning of the sentence. Note the use of the auxiliary verb *does* before the sentence subject.

8. **Language. Rewrite … . a.** Not only does the MPEG-4 contain well defined codecs but it also specifies the number of coding tools. **b.** Not only was the Pulse Modulation format used for audio recordings storage on CD's but it was also employed for the transmission of speech signal … . *Note that you need to add another verb (e.g. employed) in the second part of the sentence to ensure its correctness.* **c.** Not only is it necessary to know its sensitivity and resolution but its uncertainty as well. **d.** Not only may the oscilloscope be employed in electronics but also in other disciplines … .

Note. Tell the class to modify only the fragment of sentence **c** from the words "it is necessary …" (after the square brackets).

III Towards Transparent Coding Quality

1. Vocabulary presentation. Match … .

hearing threshold	the minimal sound level that can be heard by a human with an average ear with normal hearing[1, 2]
quantization	in analog to digital signal processing – mapping of a large set of values to a smaller set as a result of the rounding of values, e.g. choosing the digital amplitude value closest to the original analogue amplitude value[3]
audio masking	perception of sound affected by another sound[4]
psychoacoustic model	It describes which parts of a digital audio signal can be removed or compressed without considerable losses in the perceived quality of the sound
quantization noise	a difference between an actual continuous sample value and its quantized value

2. Reading. Read the text and answer … .

a. To keep quantization noise below the hearing threshold.
b. For modeling masking phenomena which occur in the human auditory system.
c. It simulates only basic processes related to simultaneous masking.
d. Tone-Masking-Noise and Noise-Masking-Tone.
e. Because tone-like and noise-like stimuli have completely different masking properties.
f. Up to some modulation ratios frequency and amplitude modulated stimuli have similar simultaneous masking properties. For instance the vibrato effect.
g. When frequency and amplitude modulated stimuli components dominate in some critical bands of a processed signal, classifying them improperly as noise-like components may affect the hearing threshold estimate and result in the deterioration of the coding quality.
h. It fails when tone-like signal components are modulated in frequency or/and amplitude.
i. Because of their relatively high complexity and ongoing research related to the novel modeling scheme.
j. They are usually hybrid, they combine techniques known from parametric approach to signal coding with the classic transform coding methods. In those codecs the role of the tonality estimation method may not be limited only to be part of the psychoacoustic model.
k. The Perceptual Noise Substitution (PNS) technique which allows to further increase the efficiency of audio coding. Signal subbands which contain only noise-like components are detected by the encoder and further synthesized with locally generated noise by the decoder, instead of being quantized and encoded in the usual way.
l. For PNS module implementation.

3. Pronunciation. How do you pronounce …? Instructions. Encourage pair work for deciding how to pronounce the highlighted words.

---

1 Durrant J D., Lovrinic J H. 1984. Bases of Hearing Sciences. Second Edition. United States of America: Williams & Wilkins
2 Gelfand S A., 2004. Hearing an Introduction to Psychological and Physiological Acoustics. Fourth edition. United States of America: Marcel Dekker
3 Read more texts by user George Maxwell on **https://en.wikipedia.org/wiki/Quantization_(signal_processing)**
4 Additionally and optionally, for explanation of what audio masking is go to a video on **https://www.youtube.com/watch?v=FJb6DCFykYw**

4. **Pronunciation (Rec. 31). Listen to these … . Instructions.** Focus on the pronunciation of the words like *quantization* [kwɒntai'zeiʃən] – BE, *simultaneous* [sɪməl'teiniəs], *stimuli* ['stɪmjulai] (comes from sing. stimulus) *deterioration* [dɪ'tɪərɪəreiʃən], *hybrid* ['haibrɪd], *tonality* [təʊˈnæləti] as students may tend to mispronounce them.

quantization noise, simultaneous masking, psychoacoustic model, stimuli, hearing threshold, estimate, deterioration, hybrid, tone-tonality.

Activity

Revision and summary in diagram form

Instructions. Diagram drawing or mind-mapping is a way to revise and remember the content of a lecture / seminar / text / etc. To devise a diagram or mind map students need to go over the unit texts and activities. By working in pairs they need to communicate using the language of the unit. In this way the activity becomes speaking practice as well. Allow time of at least 20 minutes. At the end, arrange for a presentation slot where students show their diagrams to the class or swap them with other pairs to compare and discuss. Encourage comments from the class. This activity is also a small contribution to the development of learner autonomy.

Optional activity – Enjoying pronunciation

This Unit lacks a drill in absurd sentences. You may go to the drill in Unit Two, section II. ex. 3 to play it again (for the first time for those who have not done Unit Two) to remind students what is expected of them. Devise one absurd sentence together with the class as a warming up before you pair them off for making their own drills.

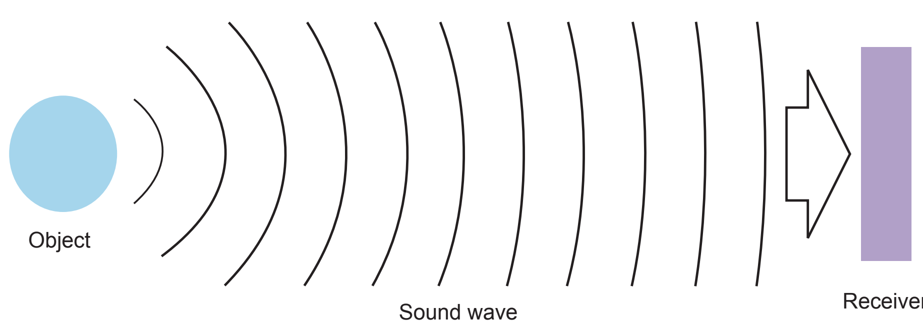
unit 6 MODERN NAVIGATION SYSTEMS

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in

1. **This picture shows a computer display … .** It provides information about the location of a vessel during berthing manoeuvres (bringing a ship to a place where it can be "parked" / moored). In the original text[1] Figure 1 was labelled as Figure 4 *The basic configuration of the system's computer display (used by a berth dispatcher).* However, students may label it differently and in a way that makes more sense to them, e.g. A computer display of a ship's berthing manoeuvres.
2. **Which of these words …? jetty** (because it is near where a vessel is moored or anchored; **berth / berthing** (an act of bringing a ship to a place where it can be "parked"); **anchor, precision** (the manoeuvres need to be very precise so as not to damage the vessel); **GPS** (is used although it is not very precise in berthing operations); **navigation**; **complicated manoeuvres; sound propagation** (because sound navigation systems are used in berthing, i.e. sonar); **visibility** (it is crucial in traditional berthing); **dock** (as a verb *to dock* because a vessel is docked, i.e. it is brought to a dock); **sonar** (because in acoustic location sonar systems are used); **echo** (because sonar systems use are based on the sound being reflected in the form of echo); **hydroacoustic** (the word *hydro* is connected with water and *acoustics,* related to sound behaviour which is exploited in sea underwater navigation).
3. **What does the acronym SONAR …? So**und **N**avigation **A**nd **R**anging.
4. **Figure 2 shows … . Instructions.** Allow students to draw the picture in Fig. 3. Drawing is a relaxing activity. Although the task is very simple the underlying idea is to distinguish between active (sound waves travel both ways) and passive (sound waves generated by a noisy object travel one way, from the object to the receiver only). Optionally, you may ask a student to draw the picture on the board.

   The picture in Figure 3 will have no sender and no reflected waves but the direction of the original wave is from the object to the receiver. Ask the class if they know the sound of a ping (an onomatopoeic word), a typical sound of a reflected sound wave in submarine sonars. To hear the sound go to a recording on **http://en.wikipedia.org/wiki/Sonar**



[1] Marszal, J. "Hydroacoustic ship berthing aid systems in Gdańsk North Harbour." **http://www.wir.eti.pg.gda.pl/english4ict** Retrieved 2015-02-28.

I Hydroacoustic Ship Berthing Aid System at the Gdańsk North Harbour

1. **Reading. Read the introduction … .** Answers to questions:

a. It may be useless during aircraft landing when the aircraft approaches the land at limited visibility and the landing isn't possible without the ILS (Instrument Landing System).
b. No, it is not because the berthing of ships is an extremely complicated task that requires decisions on the movement of ships, based on a large number of variables.
c. Many variables, such as wind, visibility, speed and the distance from the jetty make it complicated.
d. The risk of a collision goes up as the mass of the ship increases.
e. Ship berthing aid system has been developed.
f. It measures four distances of a ship to the jetty using the sonar echo method, and the system signal processor calculates the bow and stern speed and distances to dolphins.
g. It is large enough to be seen by the pilot from the bridge of the ship.

2. **Vocabulary. Match the words … . GPS –** Global Positioning System. **Bow** is the front part of a ship. **Berth** is a place where a ship can be stopped and moored. **Mooring dolphins** are points used for mooring and securing the vessel by means of ropes. **Stern i**s the back part of a ship. **Jetty** is a wall or a platform built out into water and used for getting on and off ships or for protection against waves.

3. **Pronunciation. (Rec. 32). Listen and repeat. Instruction.** Draw students' attention to the pronunciation *of ultrasound.* Prefixes of the Greek and Latin origin tend to be pronounced by Polish learners of English the way they are pronounced in Polish, e.g. *multi* – in *multiply, multitude* – [m u: l t ɪ] instead of [m ʌ l t ɪ]; *ultra* pronounced as [u: l t r a] instead of [ʌ l t r a], and *hydro* – in *hydrogen, hydroacoustic* pronounced as ['h ɪ d r o] instead of ['h a i d r o u ə]/. Note that [c] is missing in the pronunciation of *luminescence* like in the word *scene* [si:n].

jet – jetty berth – berthing manoeuvre – manoeuvring moor – mooring dolphins luminescent – luminance acoustic – hydroacoustics ultrasound – ultrasound transducers echo – echo pulses

3a. **Instructions. How do you pronounce ... ?** Allow paired off students to work out the pronunciation of the words on their own**.** The idea is to focus on the relation between the letter -u- and the pronounced short vowel [ʌ]; the relation between letter -y- in *hydro* and the pronunciation of this letter as the diphthong [ai]; between the presence of the letter c and its pronunciation as [s] in *fluorescent*. And the pronunciation of *echo* ['ekəu] and of *gecko*[`gekəu] – a lizard, and *reecho* [ri:'ekəu] – a repeated *echo*.

4. **Reading and text completion.**

a. ultrasound transducers, b. electronic system, c. display board, d. transducers, e. pulses, f. generated.

5. **Reading and diagram completion.**

1. Receiver, 2. High luminance LED display board, 3. Printer, 4. Computer.

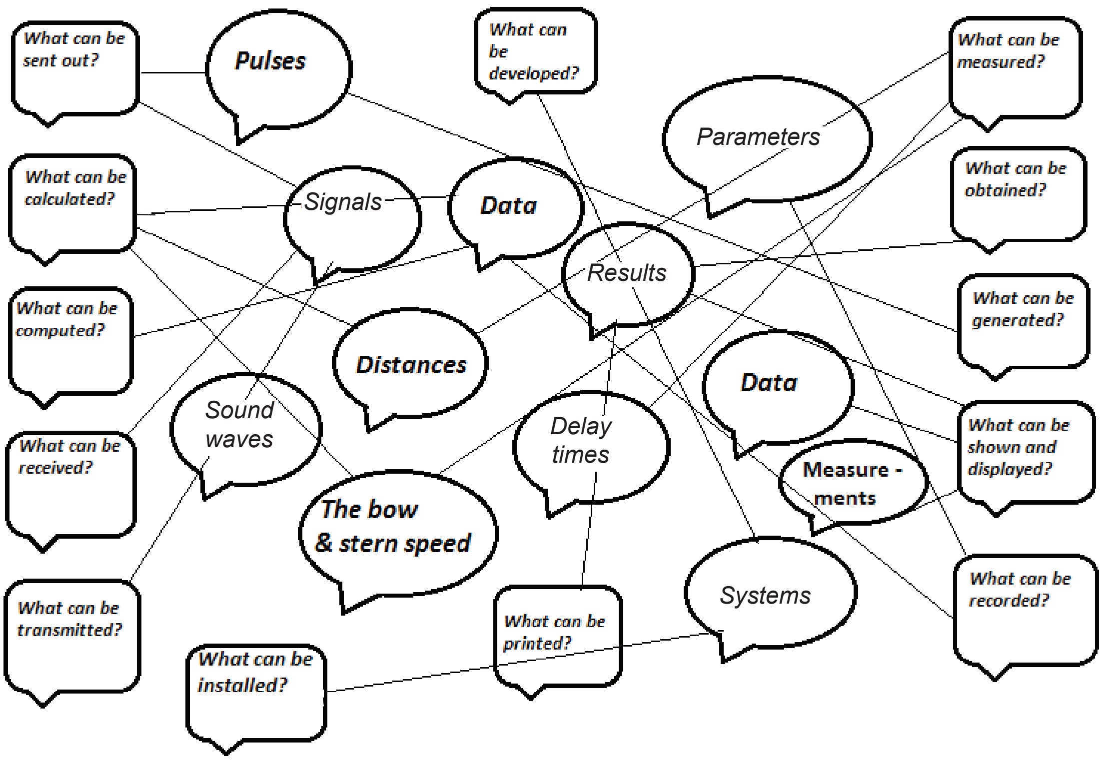
6. **Reading and speaking. Instructions.** Pair work is advised for answering the questions.

a. Echo pulses are pulses reflected from the ship's side and received by the system's receiver.
b. The receiver measures delay times t_i between the known moments of sending out sounding pulses and the moments of receiving echo pulses. Also see the explanation in the answer to c. below.

c. Given the speed of the acoustic wave propagation *c*, the computer computes the distances d_i between the ship's side from *i*-of the transducer in the following way: $d_i = 0.5\ ct_i$. (d_j equals 0.5 c multiplied by t_j – delay time). In water, sound travels at about 1500 m/s. The speed of sound in seawater depends on pressure (hence depth), temperature (a change of 1 °C ~ 4 m/s), and salinity (a change of 1‰ ~ 1 m/s)

d. The displacement of the dolphins is measured additionally.

7. **Vocabulary. Collocations.**



8. **Speaking or / and writing. Instructions.** Before students write the answers get them to say them in pairs.

a. Distances are measured / calculated.
b. Results are obtained / printed /displayed / shown.
c. Sound waves are transmitted / sent out / received /reflected.
d. Signals are generated / sent out / received.
e. Parameters are recorded
f. Pulses are generated / sent out.
g. The bow and stern speed is /are calculated.
h. Data is computed / processed.
i. Delay times are measured.
j. A system / systems / is / are developed / installed.

Note. There may be more sentences, e.g. Measurements are displayed / shown.

9. **Speaking. Instructions.** Get the class to have a brief discussion. Let them think about what size ships may pose a problem to the precision of the system. Do not provide straightforward answers. They will find them in the text in 10.

10. **Reading. In the text, … .** Generally, the system is successful. However, acoustic disturbances which occur when small ships with no cargo use their own propulsion during manoeuvres makes the system imperfect. In spite of that, the pilot who gets warned may cope with the problem and steer the small ship precisely enough to perform the berthing manoeuvre successfully.

II Other Ship Berthing Aid Systems

1. **Viewing. Reading. Speaking.** The system seems to be more precise and is not hydroacoustic. Lasers are employed to measure distances. In spite of the fact that the system provides better accuracy, it is not without drawbacks and can be unreliable in poor visibility caused by fog or in very bright sunlight. **Note.** To view click on **http://www.marimatech.com/products/berthing-aid** and go to a video clip DOCKING.

COMMUNICATION ACTIVITY

Expected vocabulary. You may highlight it before the activity starts, i.e. *oil and gas tankers, container ships, bulk carriers, dock, moor, mooring dolphins, berth, berthing manoeuvres, display, laser, laser beam, measure, distance, the bow, stern, side (ship's side), calculate, Laser Docking System, large display mounted on the jetty, accurate, accuracy, precision, reliability*, etc.

Expected structures: Present Progressive for two simultaneous actions, e.g. *As the ship is approaching the jetty, a laser beam is being sent out to measure the distance between the ship and the jetty. While … . Etc.*

Note. You may revise the vocabulary and the structures before the activity starts.

Teaching aids. You will need a computer with the access to the Internet in the classroom. For a recording session you will also have to use some recording programme on the computer or more traditional audio recording and playing equipment.

Group division. Divide the class into very small groups (pairs or groups of three); in bigger groups some students will have no chance to get engaged in the task.

Aim:
– to activate the vocabulary related to berthing and hydroacoustic navigation presented and practised in the Unit;
– to practise describing simultaneous actions.

PROCEDURE

<u>In class</u>

1st part. The introduction to the activity. The introduction to the Activity should have been done in activity **1** in section **II** of this Unit. However, show the video again several times and allow students to study the texts (especially the first two texts at the top of the website: **http://www.marimatech.com/products/berthing-aid**: Berthing Aid System and Presentation of Information), or have them photocopied to hand out for reading in class.

2nd part. Commentary preparation. In groups, students prepare the commentary. The video lasts only 2 minutes and 57 seconds so the commentary needs to be very concise. They may write it down together in groups but in the recording session they should sound natural as if they were saying things rather than reading.

3rd part. Preparation for the recording session. Prepare the recording session. Be ready with the equipment, do the recording test. Tell students to rehearse saying the commentary aloud prior to the recording. When they have mastered the timing of the commentary with the video, arrange the groups in the "recording" order: Team 1, Team 2, Team 3, etc.

4th part. Recording session. If conditions allow, have only one recording team in the classroom at a time. If it is not possible, make sure the other teams keep absolutely quiet during the recording. Play the film and recording at the same time. Otherwise, the commentary may be too quick or, what is more likely, it may be rather delayed. Check the recording after each team have recorded their commentary. Ideally, the teams should not know about the other teams' commentaries. They should hear them in the video viewing/commentary listening time, for the first time. I imagine it would be a lot of fun to hear the other groups' commentaries.

5th part. Presentation of the recordings. Play the video and the commentaries, one by one. Students may choose the best one / most enjoyable one / or just enjoy all of them**.**

unit

7 DESIGN OF ADVANCED INTEGRATED CIRCUITS

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in

1. **What do these pictures show?** Figure 1 – A view of the layout of a designed integrated circuit. Figure 2 – A picture of a devised advanced integrated circuit. Figure 3 – A picture of semi-conductor structures of an unpacked Application Specific Integrated Circuit. Figure 4 – A picture of a series of manufactured advanced integrated circuits

2. **What terminology do these acronyms stand for? Instructions.** Some acronyms may be unknown to students. Allow pair work for this activity. See the answers in **3** but DO NOT provide them until students have listened to the recording in 3.

3. **Listening (Rec. 33). Listen to the recording, check our answers and complete them if necessary.**

IC – Integrated Circuit
ASIC – Application Specific Integrated Circuits
SoC – System on Chip
CAD – Computer Aided Design
IP – Intellectual Property
HDL – Hardware Description Languages
VHSIC – Very High Speed Integrated Circuit
VHDL (**VHSIC HDL**) – Very High Speed Integrated Circuit Hardware Description Language
FPGA – Field-Programmable Gate Array
DFT – Design For Test
JTAG – Joint Test Action Group
CPU – Central Processing Unit
GPU – Graphics Processing Unit

I Advanced Integrated Circuits. Introducing terminology

1. **Vocabulary and reading. Label definitions … .** a. middleware, b. gate array, c. FPGA, d. netlist, e. peripheral, f. microprocessor, g. memory, h. driver, i. bus, j. clock, k. core clock, l. flip-flops, m. state, n. clock gating.

   a. **middleware**[1] – is the software layer that lies between the operating system and the applications on each side of a distributed computer network. It facilitates creation of business applications, and provides core services for service-oriented architecture applications.
   b. **gate array** – is a prefabricated silicon chip circuit with no particular function, in which transistors and other active devices are placed at regular predefined positions and manufactured on a wafer, usually called a *master slice*. Creation of a circuit with a specified function is accomplished by adding a final surface layer or layers of metal interconnects to the chips.
   c. (**FPGA**) **field-programmable gate array**[2] – is an integrated circuit designed to be configured by a customer or a designer after manufacturing.

[1] "What is Middleware?". *Middleware.org*. Defining Technology. 2008. Retrieved 2015-03-20
[2] Architecture for the Challenge **http://www.eecg.toronto.edu/~vaughn/challenge/fpga_arch.html** Retrieved 2015-03-20

d. **netlist** – describes the connectivity of an electronic design. A single one is a list of all the component terminals that should be electrically connected for the circuit to work.
e. **peripheral** – is a "device that is used to put information into or get information out of the computer."[3] Any auxiliary device such as a mouse, keyboard, hard drive, etc. that connects to and works with the computer in some way.
f. **microprocessor**[4] – is a computer processor that incorporates the functions of a computer's central processing unit (CPU) on a single integrated circuit (IC), or - at most - a few integrated circuits.
g. **memory –** is a medium of data storage, it usually refers to RAM. When a computer boots up, it loads the operating system into its memory, or RAM. This allows the computer to access system functions, such as handling mouse clicks and keystrokes.
h. **driver –** is a software program that enables a specific hardware device to work with a computer's operating system.
i. **bus –** is a collection of wires through which data is transmitted from one part of a computer to another. It is like a vehicle on a highway on which data travels within a computer. It connects all the internal computer components to the CPU and main memory.
j. **clock –** is an internal device that regulates the rate at which instructions are executed and synchronizes all the various computer components. The CPU requires a fixed number of its ticks (*cycles*) to execute each instruction. The faster it is, the more instructions the CPU can execute per second.
k. **core clock –** is the actual speed at which the graphics processor on a video card operates. It is measured in megahertz (MHz). Its speed can sometimes be changed on newer cards where users want to gain a performance boost.
l. **flip flops** – is a type of circuit which is interconnected with like circuits to form logic gates in digital integrated circuits, such as memory chips and microprocessors. The name comes from the circuit's nature of alternating between two states when a current is applied to the circuit. It will maintain its state.
m. **state** – is the last-known or current status of an application or a process.
n. **clock gating**[5] – is one of the power-saving techniques used on the Pentium 4 processor. To save power, it refers to activating the clocks in a logic block only when there is work to be done.

2. **Pronunciation. (Rec. 34). Listen and repeat … .**

a. Don't you dare to fiddle with the middleware!
b. Did Flip and Flap wear flip-flops or were they into hip-hop?
c. We do care about the fate of our state!
d. Do you know the driver who drives this bus full of electronic fuss?
e. This feral peripheral makes my life a bit criminal.
f. Hey, what a gate array!
g. M like microprocessor and M like memory. How about M like megabytes?
h. The core-clock in my heart beats for you in megahertz.
i. Clock-gating is increasingly irritating. Is it not?

[3] Fisher, T. About Tech **http://pcsupport.about.com/od/termsns/g/peripheral.htm** Retrieved 2015--3-20
[4] Osborne, A.(1980). *An Introduction to Microcomputers*. Volume 1: Basic Concepts (2nd ed.). Berkely, California: Osborne-McGraw Hill.
[5] Adapted from Webopedia **http://www.webopedia.com/TERM/C/clock_gating.html** Retrieved 2015-03-20

II Application Specific Integrated Circuits (ASIC's). Challenge to Designers

1. **Speaking. Explain … .**

ASIC'S as opposed to general purpose IC's are customized for a particular use. "An ASIC (application-specific integrated circuit) is a microchip designed for a special application, such as a particular kind of transmission protocol or a hand-held computer. ASICs are used in a wide-range of applications, including auto emission control, environmental monitoring, and personal digital assistants"[6].

2. **Reading. In the text, find answers … . Instructions.**

It is a good idea to find out how much students know and if they can answer at least some of the questions without referring to the text. Relating to students' background knowledge is always good preparation for performing the actual task. So get students to speculate what the answers are before they read the text. Besides, going over the questions and trying to answer them draws the class' attention to what they need to look for in the text.

a. The manufacturing costs of modern integrated circuits are very high and the process itself is time consuming, thus the design must be as perfect as possible which is no easy task (as described in the further parts of the text).
b. a whole system platform consisting of hardware and software, including an operational system, middleware, drivers and applications, microprocessor, memory, busses and peripherals.
c. Analog blocks may be part of SoC (but not necessarily so).
d. High manufacturing costs and the requirement of reliability of ASIC.
e. Specialized software. Also special design and verification techniques.
f. Computer Aided Design (CAD) software.
g. Analog blocks are difficult to design because designing them requires specialized knowledge and skills.
h. Signal interference / mixed signal.
i. Yes, it may be an issue because digital signals may interfere with each other.
j. The smaller the technology, the greater the problems become to design error-free circuits. The smaller the transistors, the lower the supply voltages need to be. The smaller the technology, the more topology/layout design rules are used.
k. They decrease the dynamic range of the signals.
l. The requirements are physical, electrical, functional. The system must work within a range of specific frequencies, including digital clock (usually as fast as possible), power requirements are very important because low power systems contradict high operational speed. To satisfy all of those is no easy task. Integrated circuit area is also important. Area = cost of IC.

3. **Vocabulary presentation. In the text in 2, examine … .** "large-scale" and "multi-million".

4. **Vocabulary practice. Make these phrases … .** a multi-functional robot, a cost-effective method, a hand-held multimeters, auto-ranging, an analog-to-digital converter, an input-signal conditioner, a three-dimensional real-time display, high-voltage power supply, cell cycle-related factors, Greater London-area residents, a 40-year old man, a 50-metre long tape, two-tonne cargo.

[6] Adapted from Rouse, M. WhatIs.com **http://whatis.techtarget.com/definition/ASIC-application-specific-integrated-circuit** 2015-03-22

5. **Vocabulary presentation. Find … .** Manufacturability. The meaning is related to "testing a pre-release (potentially unreliable) version of a piece of software by making it available to selected users. This term derives from early 1960s terminology for product cycle checkpoints, first used at IBM but later standard throughout the industry." [7]

6. **Vocabulary work. Can you provide …? Instructions.** Allow pair work for this activity. Students will inspire each other to come up with the words. It is a good idea to look for words rhyming with "manufacturability". The Internet offers rhyming words.

7. **Vocabulary building. Build nouns … . Instructions.** Students need to be careful with the spelling of some words, especially some long ones like *maneuverability*.

   inflame – inflammability / flammability, impregnate – impregnability, biodegrade – biodegradability, move – movability / movableness, interchange – interchangeability, impermeable – impermeability, manoeuvre – maneuverability, convert – convertibility, sustain – sustainability, attain – attainability, navigate – navigability

   Note. Tell students that *inflammability* and *flammability* can be used interchangeably.

8. **Pronunciation. (Rec. 35). Listen to the words … .** Each primarily stressed syllable has been highlighted in the script.

   *manufactura**bi**lity, flamma**bi**lity, biodegrada**bil**ity, mova**bi**lity, inter**cha**ngea**bi**lity, impermea**bi**lity, maneuvera**bi**lity, converti**bi**lity, sustaina**bil**ity, attaina**bi**lity, naviga**bi**lity*

9. **Speaking. Discuss … . Instructions.** Students work in pairs. Afterwards you may hold a whole class feedback session.

   Sample issues to consider by students plus possible answers:

   a. How much time is needed to develop the product, complexity of design – requirement of specialized knowledge, product reliability, demand on the market, etc.
   b. All kinds of fuels (gasoline, coal, various chemicals have high in/ flammability).
   c. Sustainability of intelligent buildings is all about energy preservation by recuperation, using renewable sources of energy, etc.
   d. (See Unit Six – Modern Navigation Systems) Ship maneuverability is certainly an important factor which probably depends on its weight, cargo, volume, steering systems, etc.

III Application Specific Integrated Circuits. Design Stages

1. **Reading. Read the text and write in … .**

   Paragraph 1 – USE OF HDL LANGUAGES
   Paragraph 2 – FPGA – A PROTOTYPING METHOD
   Paragraph 3 – PROCESS OF SYNTHESIS
   Paragraph 4 – WHY CLOCK-GATING?
   Paragraphs 5–6–7 – TESTING & VERIFICATION
   Paragraphs 8–9 – IMPLEMENTATION PROCESS
   Paragraphs 10–11 – MODEL CREATION & SUBMISSION TO MANUFACTURER

[7] FOLDOC Słownik terminów komputerowych [In:] **http://ling.pl/manufacturability**. Retrieved 2015-03-24

2. **Vocabulary work. Collocations. Redirect the arrows … .**

schematic diagram, combinatorial circuits, specialized software, HDL code, signal integrity, clock gating, flip-flops, voltage drops, design entry, FPGA platforms, silicon dies, Intellectual Property, test-bench

3. **Vocabulary work. Find in the text in 1 … .**

a. latency, b. equivalence, c. self-explanatory, d. from scratch, e. illegible (not legible), f. parasitic effects.

4. **Pronunciation. (Rec. 36). Listen and repeat.** Primarily stressed syllables have been highlighted in the script.

***la**tency*	*e**qui**valence*	*self-ex**pla**natory*	*il**le**gible*	*para**si**tic e**ff**ects*

5. **Vocabulary work. Put the verbs … .**

a. described
b. replaced
c. verified
d. implemented
e. routed
f. simulated
g. redesigned
h. connected / read out.

6. **Vocabulary work. Complete the box … .**

design (advanced IC), create (advanced IC), mount (components on a circuit board), incorporate (digital – IP blocks in a designed advanced IC), place (hardware blocks are placed), interchange (information between CAD); check (signal integrity is checked); route (power supply lines are routed), obtain (a netlist is obtained); cut (silicon dies are cut), packed (silicon dies are packed); interconnect (gates, flip flops and memories are interconnected), synthesize (net list is synthesized).

7. **Language. What functional language … . Instructions**. If students have ever done a team presentation based on a visual, they may contribute their background knowledge and facilitate the revision of the functional language before the COMMUNICATION ACTIVITY which follows on from activity 7. You may also refer to David Bonamy, *Technical English 4.* Coursebook. Longman Pearson. 2008, activities 4, 5, 6, 7 on page 9. In Language Box I students will find useful phrases.

COMMUNICATION ACTIVITY

Team presentation based on a visual. Instructions. This activity is aimed at better comprehension of the text, developing presentation skills and communication for developing a common product (visual + presentation). The effort of illustrating the text even though it may be difficult, is a way for students to get insight into the content of the text. Communication is inspired by the fact that team members have to discuss and agree on the format of the visual which will follow on from their discussion on the content of the text. Later on, at the presentation stage where students have to demonstrate their visuals and deliver the content referring to the visual, their understanding of the text and presentation skills will be tested.

Aim: to improve and check reading comprehension; to reach a consensus in a debate, to develop presentation skills as part of academic skills based on visual materials.

Time: 45 minutes

Materials / teaching aids: big sheets of paper (one per a team of 3–4 students) or access to a computer room (one computer per 3–4 students to use a graphic design program).

PROCEDURE

Before class

Bring big sheets of paper (one big sheet per team plus some spare ones just in case) and a set of possibly different colour markers (at least two per team). Alternatively, in the preceding class, ask students to bring paper to the next class.

In class

1. Explain the task, draw students' attention to the diagram illustrating Paragraph 1. Tell them they may use another format to illustrate the content of the text.
2. Divide the class into teams. Hand out the sheets of paper and markers. Set the time limit of 25– 30 minutes, and occasionally check how the teams are doing time-wise. They all need to finish their posters at the same time and be ready for presentations. Make sure they divide their work evenly so that every team member has things to do and every team member has a share in the presentation.
3. Teams present their visuals on posters in front of the class and talk about how AIC's are designed. They refer to the visuals. They may use phrases like: *As you can see in the poster … . This is illustrated in the form / shape of … . Look at … . Etc. I will now hand over to Jarek … . Now let' go on to the next stage, … . X has been explaining … and I would like to relate / refer to it by … -ing … . Etc.*
4. Allow a whole-class debate and the emergence of the winner by popular vote.
5. Provide feedback. Students will probably know more and will explain things to you, rather than the other way round.

unit

8 PROPAGATION OF RADIO WAVES

KEYS AND INSTRUCTIONS FOR THE TEACHER

Lead-in

1. **Which names …?**

A. Reflection and refraction, B. Diffraction, C. Tropospheric scattering, D. Multipath propagation, E. Absorption (The order of the appearance of the descriptions: E, C, D, A, B.)

I Frequency Bands

1. **Electromagnetic waves may exist … . Instructions.** Before the exercise starts, you may revise the meaning of prefixes used in measurement units: pico p – a factor of one trillionth, nano n – a factor of one billionth, micro µ – a factor of one millionth, mili m – one thousandth of a unit, kilo k – a factor of a thousand, hecto h – a factor of 100, deca da – a factor of 10, deci d – a factor of one tenth. And frequency ranges are denoted as follows: tera T – 100 000 000 000; giga G – 1 000 000 000; mega M – 1 000 000, Myria – 10 000. The revision may then help students decode the labels of the waveband ranges.

Table of the Nomenclature for Frequency Bands[1]

Symbol	Frequency range	Wavelength	Corresponding metric subdivision of wavebands
ELF	<300 Hz	>1000 km	**Note**. Make sure that students leave out this first space empty. They start to fill the table with the second one below with: Hectokilometric.
ULF	300 Hz – 3 kHz	1000 – 100 km	Hectokilometric
VLF	3 – 30 kHz	100 – 10 km	Myriametric
LF	30 – 300 kHz	10 – 1 km	Kilometric
MF	300 kHz – 3 MHz	1 km – 100 m	Hectometric
HF	3 – 30 MHz	100 – 10 m	Decametric
VHF	30 – 300 MHz	10 – 1 m	Metric
UHF	300 MHz – 3 GHz	1 m – 100 mm	Decimetric
SHF	3 – 30 GHz	100 – 10 mm	Centrimetric
EHF	30 – 300 GHz	10 – 1 mm	Milimetric
	300 GHz – 3 THz	1 mm – 100 µm	Decimillimetric
	3 – 30 THz	100 – 10 µm	Centimillimetric
	30 – 300 THz	10 – 1 µm	Micrometric
	300 – 3000 THz	1 – 0,1 µm	Decimicrometric

[1] For more information go to **https://www.itu.int/dms_pubrec/itu-r/rec/v/R-REC-V.431-7-200005-S!!PDF-E.pdf**

2. **Pronunciation (Rec. 37). Script** – see the content of the third (frequency in hertz) and last column (metric division of wavebands) in the table in 1, in the Student's Book. **Instructions.** Focus mainly on teaching students to read and say the frequency ranges. Write several examples and get students to read them, e.g. 200 Hz; 1.5 GHz; 15 KHz; 30 MHz; 1200 THz (hertz, gigahertz, kilohertz, terahertz, etc).

II Propagation in Free Space

1. **Reading. Are these sentences …? a. T, b. F, c. T, d. F** (False because it travels at the speed of light. See the constant of the speed of light in 2 below)
2. **What does this constant** $(3 \cdot 10^8 \frac{m}{s})$ **…?** It stands for the speed of the propagation of an electromagnetic wave in free space, in popular terms – the speed of light (its value being exactly 299 792 458 meters per second).
3. **Vocabulary. Complete this text … .** The answers have been highlighted. The text describes the formula for **power flux density**.

A **transmitter** with **power** *P* in free space which radiates isotropically (uniformly in all directions) gives a **power flux density** *S* at **distance** *r* of:

$$S = \frac{P}{4 \cdot \pi \cdot r^2}$$

Where:

S – the power flux **density** $\left[\frac{W}{m^2}\right]$,
P – **transmitter power** [W],
r – distance from **transmitting source** [m].

4. **Vocabulary and reading. Can you define …? Instructions.** Elicit the answer from the class before they read the text. PFD is a measure of the energy that flows through a unit area each second. W – watts, m^2 – square meter as a square linear unit[2].
5. **Equation completion. This time put in … .**

Using logarithmic ratios and practical units:

$$S_{db} = -41 + P_{dBkW} - 20 \log d \text{ [1st equation]}$$

Where:
S_{dB} – the power flux density in decibels relative to $1 \frac{W}{m^2}$,
P_{dBkW} – transmitter power in decibels relative to 1kW,
d – distance [km].

The corresponding field strength *E* is given by:

$$E_{sk} = \frac{\sqrt{30 \cdot P}}{r} \text{ [2nd equation]}$$

Where:
E_{sk} – field strength $\left[\frac{V}{m}\right]$
P – transmitter power [W],
r – distance from transmitting source [m].

[2] The definition of power flux density has been adapted from http://www.ehow.com/how_7802045_calculate-power-flux-density.html Access: 02.12.2014

6. **Reading. Study the text … .**

a. *Lr* – real transmission losses [dB], L_o – free-space transmission losses [dB], $L_{additional}$ – additional transmission losses [dB].
b. They depend on the electric length of the propagation distance, in other words, the distance of the propagation *d* referred to the wavelength λ, i.e. *d/ λ*, in the case of isotropic radiation. **Note.** Transmission losses (i.e. attenuation) also depend on the frequency of the signal and the distance from the source.
c. The actual propagation losses which we face in practice are usually larger than free-space transmission losses.
d. Additional transmission losses.
e. Symbols denote: *d* – for distance, λ – wavelength; *f* – frequency; L_o – free space basic transmission losses; *Lr* – real transmission losses [dB] – expressed in decibels; $L_{additional}$ – additional transmission losses [dB] – in decibels. The logarithmic way is easier.

Instructions: Encourage volunteers to demonstrate the derivation of the equations in **5**. Invite them to do that by writing the equations on the board and simultaneously commenting on them

7. **Speaking.** Allow students to speculate in pairs on the answers to the questions before they find them in the text in 8.

8. **Reading and speaking.**

a. An antenna affects energy losses by its directional properties (because it does not propagates uniformly in all directions, i.e. isotropically – but in a defined direction), also energy losses to heat.
b. ***g*** stands for **antenna gain** and S_{max} stands for **power flux density on the main antenna direction**;
c. $S_{max} = \left[\frac{\mathrm{W}}{\mathrm{m}^2}\right]$.

III Power Budget

1. **Reading and equation writing. Instructions**. The equation may seem to be more difficult to the teacher than to the students themselves, they can simply figure it out from the information in the text.

$$P_{rec} = P_{trans} + G_{trans} - L_{prop} + G_{rec}$$

2. **Reading and identifying notions.** 1 c; 2 a; 3 b.

3. **Vocabulary and speaking. Instructions.** Before you provide the definitions of the antennas, get students to do it. You may help with elicitation questions, e.g. How many conductive elements does the monopole antenna have, one or two? What is the meaning of *mono*-? (Single) What is the meaning of *di*? (Double / Two). Etc.

A. Monopole antenna, **B.** Dipole antenna.

A **monopole antenna** is an antenna consisting of a straight rod-shaped conductor, often mounted perpendicularly over some type of conductive surface, called a *ground plane*. The driving signal from the transmitter is applied, or for receiving antennas the output signal to the receiver is taken, between the lower end of the monopole and the ground plane. One side of the antenna feedline is attached to the lower end of the monopole, and the other side is attached to the ground plane, which is often the

Earth. This contrasts with a dipole antenna which consists of two identical rod conductors, with the signal from the transmitter applied between the two halves of the antenna[3].

The dipole antenna consists of two conductive elements such as metal wires or rods which are fed by a signal source or feed energy that has been picked up to a receiver[4].

An aerial half a wavelength long, consisting of two rods connected to a transmission line at the center, a pair of equal and opposite electric charges or magnetic poles separated by a small distance[5]

4. **Pronunciation (Rec. 38). Listen and repeat. Instructions.** The words have been assembled in phonetically similar patterns. After the listen-repeat session allow students to play with the pronunciation of the words. They may do it in the intimacy of pairs but let them be noisy.

propagation – determination; isotropic – isotropically ; monopole – dipole; fidget – budget; flux – influx; capacity – velocity – density; devour – flux density power; loss – floss; mission – transmission; traditional – additional; real transmission losses – free-space transmission losses – additional transmission losses

5. **Pronunciation (Rec. 39). Listen …**

Instructions. The absurdity of the sentences helps "switch off" the logical mind and allows for free phonetic play. After the repetition allow time for students to practice the sentences in pairs. Pronunciation drills are a nice change to class routine on condition that they are done in a relaxing way. After practicing the words and phrases in pairs or individually, students may take part in a pronunciation competition in which individual students will compete to perfectly pronounce all the words and phrases in 4 and 5. For this purpose select at least 3–5 contestants, preferably volunteers. Make sure all class member are listening attentively to the individual performances by the selected contestants. Each class member casts a (secret) vote on one contestant who in their opinion has pronounced the phrases with perfect or near perfect pronunciation. Collect the votes, count them and announce the winner. Both, taking part in the competition and listening to the contestants is of equal educational value. The listeners need to focus and be attentive to be able to decide if the pronunciation as "performed" by the contestants was correct. Students usually enjoy this activity and it draws their attention to the importance of correct pronunciation.

a. *You need great determination to obstruct radio wave propagation..*
b. *Monopole or dipole, polytropic or isotropic, choose whatever is your favourite topic.*
c. *Bridget's is a horrible fidget which jeopardizes her power budget.*
d. *The growing flux density power will soon devour her lovely flowers.*
e. *Free space losses are not the only losses, they need to consider real transmission losses and additional losses, which gives a headache to their bosses.*

IV Fresnel Zones

1. **Speaking. Is it important if … . Here is … . Instructions.** The definition and description of Fresnel zones will be provided in the exercise that follows on from 2 below. As a warm-up students may speculate, or if they know, they can explain what Fresnels zones are.

Only some radio waves between a transmitter and receiver may travel along a straight path. If there are any obstructions, such as buildings, trees or hills, located in the 1st Fresnel Zone, the signal will be affected by these and would therefore be weakened at the receiver. In other words, as a result of

[3] For more information go to **https://en.wikipedia.org/wiki/Monopole_antenna**
[4] **http://www.radio-electronics.com/info/antennas/dipole/dipole.php** Retrieved 2015.02.03
[5] Wordnet Dictionary on **http://ling.pl/dipole** Retrieved 2015.02.04

diffraction radio waves may travel off the axis. Consequently, their transmission may take longer due to a longer distance they have to cover, and as a result, there may occur a shift in their phase. There are an infinite number of calculable Fresnel Zones but the Fresnel Zone that has the biggest effect on the performance of the Wireless Network is the 1st Fresnel Zone.

A physicist Augustin-Jean Fresnel (pronounce it as [freɪˈnɛl]) found out there are ellipsoidal ring zones located around the direct path of the radio waves which have an effect on the signal strength experienced by the receiver[6]. Further exercises will allow for more detailed information. You may also go to **http://www.4gon.co.uk/solutions/technical_fresnel_zones.php**

2. **Vocabulary. What do the symbols in Fig. 2 denote?**

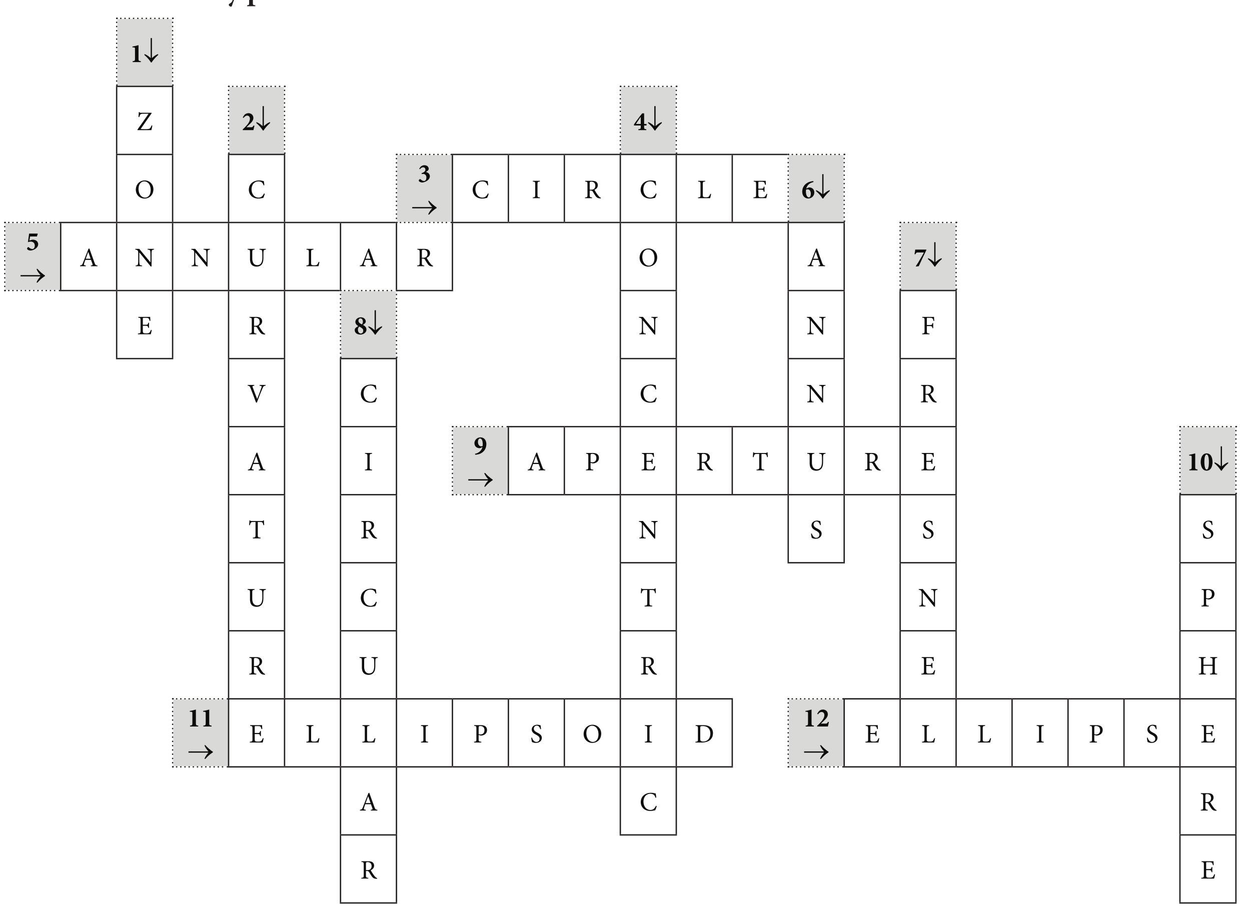
T stands for the **transmitter**. R denotes the **receiver**, d_1 is the distance from the transmitter, d_2 is the **distance** from the **receiver** counted in kilometers, r denotes **radius** and r_{max} stands for the **radius** of the innermost circle situated in the middle of the radio wave propagation path.

3. **Speaking and writing.** Fresnel zones are a (theoretically infinite) number of concentric ellipsoids which define the volumes of radiation patterns of a circular aperture. The first Fresnel zone is circular and the subsequent zones are annular in cross section.

4. **Pronunciation (Rec. 40). Listen and repeat.**

*Fres**nel** zo**ne**; **cir**cle – **cir**cular – con**cen**tric; **el**lipsoid – ellip**so**idal; **cur**vature – **a**perture; **an**nulus – **an**nular – **pop**ular.*

5. **Vocabulary practice. Fresnel Crossword Puzzle.**



[6] **http://www.4gon.co.uk/solutions/technical_fresnel_zones.php** Retrieved 2015.02.08

Across

3. A flat round shape – **circle**
5. An adjective which comes from a corridor-like ring – **annular**
9. A photographer's camera has it, too. It to controls the amount of light that a film is exposed two – **aperture**
11. A three-dimensional analogue of an ellipse – **ellipsoid**
12. A longitudinal section of an ellipsoid – **ellipse**

Down

1. An area or a sphere restricted or limited for some purpose – **zone**
2. The Earth's not flat. You can see its ____________ from high above, in an aircraft or spaceship – **curvature**
4. If two or three, or more circles have the same centre, they are _________ – **concentric**
6. A corridor-like ring – **annus**
7. Concentric ellipsoidal zones which show radiation patterns and have his name – **Fresnel**
8. An adjective that comes from "circle." – **circular**
10. A ball is like this shape – **sphere**

V Fresnel clearance

1. **Reading. What is Fresnel clearance? Instructions.**

   Do not provide the answer unless students have read the text in **2.**

2. **Reading.** Answer **b**. is confirmed in the text.

3. **Reading. Examine … .** Answers to questions**. a.** Circle. **b.** On the wavelength λ and the relative position of the selected plane of the antennas. **c.** In the middle of the radio wave propagation path. **d.** On the length of the radio link, and the frequency of the radio wave. **e.** Yes, it is achievable, but if there is some obstruction in a 1st Fresnel zone then it is best to ensure at least 60 % of the area to be clear of obstruction. If the clear of obstruction area is less than 60%, there occurs substantial attenuation of radio waves.

4. **Identifying equations.** Equation 1 – B; Equation 2 – A.

5. **Language. Reading mathematical equations and formulas. Instructions.** Students may give it a try but they will get instructions for reading the equations in the recording in 6.

6. **Listen and learn how to read the equations A and B in 4 (Rec. 41).**

A. $r_{\max} = \frac{1}{2}\sqrt{(d_1 + d_2)\cdot \lambda}$ – *The maximum radius* r_{max} *is equal to the half of the square root of the sum of* d_1 *(distance 1) and* d_2 *(distance 2) multiplied by the wavelength λ (lambda).*

B. $r = \sqrt{\frac{d_1 \cdot d_2 \cdot \lambda}{d_1 + d_2}}$ *Radius r equals the square root of* d_1 *times* d_2 *times the wavelength λ (lambda) divided by the sum of* d_1 *and* d_2*.*

ACTIVITY

Problem-solving.

The first step is to calculate the maximum radius of the First Fresnel zone $\boldsymbol{r}_{\mathbf{max}}$

$$r_{\max} = \frac{1}{2}\sqrt{d\ddot{e}} = \frac{1}{2}\sqrt{d\,\frac{c}{f}} = \sqrt{50[\mathrm{m}]\cdot\frac{3\cdot 10^{8}\ [\mathrm{m/s}]}{2{,}4\cdot 10^{9}\ [1/\mathrm{s}]}} = \sqrt{6{,}25\,[\mathrm{m}^{2}]} = 2{,}5\,[\mathrm{m}]$$

Answer. The antennas need to be placed at the height of 2.5 m.

Optional follow-up activity. You may get students to read their calculations in the equations they have used in solving the problem in Activity.

KEYS AND INSTRUCTIONS FOR THE TEACHER

1. **What is radio?** Radio is the wireless transmission of electromagnetic signals through the atmosphere or free space.[1]

2. **How is an electromagnetic signal prepared …?**

Mixer creates new frequencies from two signals applied to it.
Demodulator recovers the information content from the modulated carrier wave.
Transmitter generates a Radio frequency alternating current, which is applied to the antenna. When excited by this alternating current, the antenna radiates radio waves.
Modulator conveys a message signal inside another signal that can be physically transmitted. Modulation of a sine waveform transforms a baseband message signal into a passband signal.
Amplifier makes the output signal stronger.
Filter separates the desired radio frequency signal from all the other signals picked up by the antenna.

I Defining Software Defined Radio

1. **You need to have these … .** Antenna (receiver) has not been described in 2 in the Lead-in.

   A. Phase detector – mixer – creates new frequencies.
   B. Amplifier – strengthens signal.
   C. Modulator/ demodulator – conveys a message signal inside another signal that can be physically transmitted
   D. Antenna – picks up or sends out signals. More info on **http://mxh.strefa.pl/pliki/tech/book2006/11.pdf**

2. **What is SDR? Instructions.** Even though students may not have heard of SDR at this stage, they can figure out what it is. In further activities they will find more answers.

   It is a programmable radio with a mobile terminal that can cooperate with different radio standards by means of software. The hardware is universal and the functionality does not depend on the fixed in the hardware components such as mixers, amplifiers, modulators and demodulators, etc. Their function is reprogrammed by software.

[1] Dictionary of Electronics By Rudolf F. Graf (1974). Page 467. "Radio-Electronics", "Radio Receiver Technology." Radio-electronics.com. Retrieved 2014-08-02.

3. **Optional. Listening – viewing. Instructions (Rec. 42, video).** Viewing is optional but more interesting, so if you have access to the Internet in the classroom, go to You Tube on **https://www.youtube.com/watch?v=kWfU1G3Jq4w** and play the initial fragment, 00.00 – 01.15 on the video counter. The video is over 50 minutes long so at the end of the class or in a class to follow you may arrange for a longer video session by showing the whole video. However, the idea of the initial fragment is for the students to get familiarized with the concept of SDR and possibly with the block diagram of how SDR is built (01.15 –04.23 on the video counter).

Schuyler [s'kailəʳ] explains what SDR is with these words: *"Instead of having hardware to demodulate and receive your signal you're gonna use software to do it. So what does this mean is that you can receive many more signals with a single piece of hardware; but you still need hardware to receive a signal"* (original language version from the clip).

4. **Sentence reading. Decide if these sentences … .** a. T, b. F (false because signal processing blocks are not in the hardware suited only to specific frequencies but in the universal, not dedicated software which has flexible functionality), c. T, d. F (false because it is more flexible by the use of software; however, the hardware may not receive an unlimited scope of signals but generally it is the software that makes it flexible in a SDR), e. T.

II Software Defined Radio vs Analog Radio

1. / 2. **Diagram, completion / Reading** (see the completed diagrams).

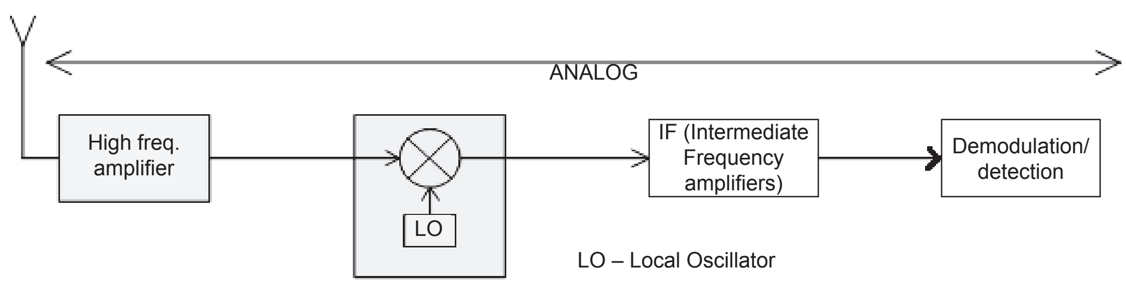


Figure 1. Block Diagram of Analog Receiver

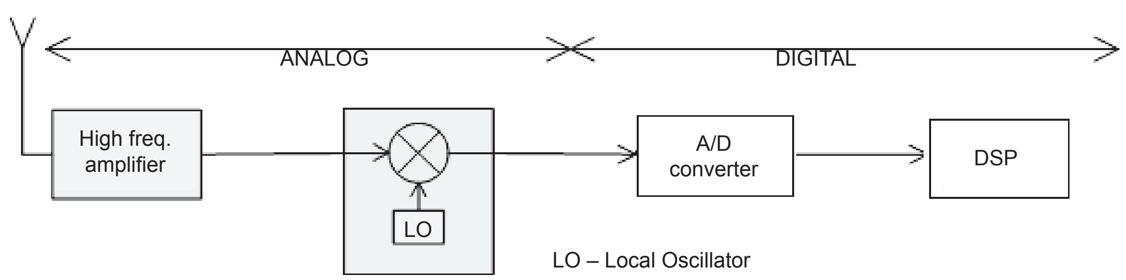


Figure 2. Block Diagram of Software Defined Radio

3. **Reading and speaking.** Answers to questions.

a. The variety of standards for radio systems makes it necessary to create technical possibilities of co-operation with different radio standards. SDR seems to satisfy this need.
b. A programmable radio is based on a universal hardware layer, with only a layer of software determining its functionality. The idea is to implement signal processing blocks of a radio transceiver in software rather than in dedicated hardware.
c. The system of SDR can be divided into two different parts:
– hardware (analog radio) in the form of a set of classic radio components,
– software (digital), whose main element is a fast signal processor DSP (Digital Signal Processor).
d. Properties: reconfigurable RX/TX architecture controlled by software, most part of the radio functionality performed by software, system specification (bandwidth, bit rate, demodulation) can be updated whenever needed to do so.
e. The task of the analog radio part is to appropriately strengthen and convert the received radio signal from a high-band radio frequency to a lower frequency band (usually intermediate frequency IF).
f. In the "digital" part a received analog signal is converted into its digital form by means of a fast A/D converter (Analog- to- Digital Converter). The processing is performed in a properly programmed digital signal processor.
g. The processing is performed in a properly programmed digital signal processor.
h. A broadband receiver and analog-to-digital high-frequency sampling with high dynamics.
i. Time.
j. It is recommended to obtain the strongest possible CPU (Central Processing Unit) for a PC.

4. **Vocabulary presentation. Do you know …? Instructions.** Students may use dictionaries for this activity, or even better the Internet, if accessible in the classroom. Do not provide answers unless they have done activity **5**.

5. **Vocabulary practice.**

a. spyware,
b. leatherwear,
c. wood ware.

6. **Vocabulary practice.**

a. footwear,
b. eyewear,
c. sportswear,
d. warfare,
e. leatherwear.

Note. Note the difference between leather ware (all kinds of articles made of leather) and leatherwear (things made of leather that people wear).

7. **Pronunciation (Rec. 43). Listen and repeat. Instructions.** After choral and individual repetition done after the recording, allow time for students to practice these somewhat absurd sentences in pairs. Note the similar pronunciation of *-ware*, *-wear* and *-fare* endings.

Make hardware your warfare!
Thank God, software's always there!
Beware of spyware!
Hello there! Software and Hardware!
Which department shall we visit first? Footwear, eyewear or sportswear?

III SDR. Amplified Definition

1. **Language. Here is an amplified definition … . Instructions.** The idea of the activity is to elicit from students this aspect of academic writing which has to do with devising formal definitions which usually consist of four main components of:

   a. what it is and what are its characteristics,
   b. what it is composed of,
   c. how it operates, and
   d. where it is used.

   The word "amplified" refers to an enlarged form of definition. Obviously, those definitions can be even more amplified in technical and academic writing, and in academic presentations by additional and more in-depth information.

   Text fragments: **a.** from: "SDR is a radio communication system … – to … embedded system." **b.** "A basic SDR system may consist of … – … by some form of RF fron end." **c.** "Significant amounts … – … software used." **d.** "Software radios have significant utility … – … of the cognitive radio."

2. **Language. You may be familiar …… . Write sentences ……… .** Sample ideas for sentences.

   a. The underlying idea of Wikipedia is / was to allow free access to knowledge.
   b. The concept behind the PC, and computers in general, was to create a "machine" capable of fast and efficient data processing, carrying out complex computing operations, controlling devices, etc.
   c. Smartphones – mobile telecommunications combined with the ability to connect with the Internet and other multifunctional use;
   d. Optical fibers – sending information quickly and efficiently, diagnostic and therapeutic use in medicine.
   e. Graphene as the strongest and lightest compound, and as transparent material – to be used universally in optoelectronics, medicine, photovoltaic cells, energy storage and ultrafiltration.
   f. Etc.

3. **Writing. Instructions**. Get students to hand in papers with the amplified definitions of the cognitive radio and embedded systems, to be checked word by word and marked for organization of ideas and accuracy.

FROM TELEPHONY TO NEXT GENERATION NETWORK

KEYS AND INSTRUCTIONS FOR THE TEACHER.

Lead-in

1. **Can you identify this instrument?** Alexander Graham Bell's first telephone
2. **Work with another student. Instructions.** By asking questions students communicate to obtain information in order to fill in the missing fragments. Instead of reading a longer text students get engaged in communication and the ultimate communicative purpose is to get familiarized with the earliest history of telephony. Sample questions: Student A. *When / In which year was Bell's telephone patented?* / Student B. *Who made his first telephone call in 1876?*

   Note. Correct questions are not the target of the activity, but you may go over some sample questions with the whole class if you feel question formation is your students' soft spot.

   The answers to both tables have been highlighted.

Development	Year
Bell's first telephone was patented	**1876**
Bell made his first telephone call	1876
Commercially usable telephone was developed by Graham Bell	After 1876
The first telephone system known as exchange which allowed **communication between many people** was installed	in **Hartford, Connecticut** – in **1877**
President Rutherford B. Hayes had the first telephone installed in the **White House**	**1878**
The first exchange linking two major cities was established between **New York** and **Boston**	**1883**
The first exchange outside the United States was built in **London.** The exchange involved a group of operators working at a large **switchboard**. The operators would answer an incoming telephone call and connect it **manually** to the called party.	1879
The first automatic telephone exchange was patented and installed by **Almon Strowger of Kansas City**, but manual switchboards remained in common use until **the middle of the twentieth century.**	1891 (patented) 1892 (installed)

I Technology Related Telephony or Telephony Related Technology?

1. **Vocabulary and notions. Presentation.**

POTS – Plain Old Telephone Service,
SPC – Storage Program Control;
ISDN – Integrated Service Digital Network,
B-ISDN – Broadband Integrated Service Digital Network,
HDTV – High Definition Television,
ATM – Asynchronous Transfer Mode,
ITU – International Telecommunication Union,
GII – Global Information Infrastructure,
NGN – Next Generation Network

2. **Reading comprehension. Match the terms … .**

POTS – Plain Old Telephone Service	Original basic voice telephony service provided by PSTN (Public Switched Telephony Network) comprised mainly of copper wires linked the subscribers homes with the central switch offices (exchanges) connected in the form of the network.
SPC – Storage Program Control	In 1963 digital carrier techniques were introduced and at the beginning of the seventies of the 20th century digital SPC nodes were introduced with it.
ISDN – Integrated Service Digital Network	Till now it supports sending voice, video and data over digital lines up to 2 Mb/s.
B-ISDN – Broadband Integrated Service Digital Network	It offers a large variety of services such as video telephony, video surveillance, high volume file transfer, High Definition Television (HDTV) and many more services not offered by ISDN. The designated technology for it was Asynchronous Transfer Mode (ATM).
ATM – Asynchromous Transfer Mode (ATM).	It was the designated technology for B-ISDN and it was intended to carry both synchronous voice and asynchronous data services on the same transport. Apart from typical ISDN it is based on transmitting data in cell of fixed size using fiber optic line which can carry data rates from 155 Mb/s to 622 Mb/s and beyond.
NGN – Next Generation Network	One network transports all information and services (voice, data, and all sorts of media such as video) by encapsulating these into packets, similar to those used on the Internet.
ITU – International Telecommunication Union	It is a specialized agency of the United Nations responsible for issues that concern information and communication technologies.
GII – Global Information Infrastructure	Future environment which unifies in one infrastructure all aspects regarding telecommunications, information technology, consumer electronics and content provision for delivery of existing and future information services including multimedia and interaction applications.

3. **Vocabulary. Presentation and practice. Complete sentences … .**

a. designated,
b. surveillance,
c. carrier,
d. comprises,
e. encapsulated – packets,
f. synchronous,
g. asynchronous,
h. node.

4. **Pronunciation** (**Rec. 44**). **Listen and repeat. Instructions.** When students repeat the words, focus specifically on their pronunciation of the words: *synchronous, asynchronous and surveillance.*

designate – designated; carry – carrier; comprise – comprises; encapsulate – encapsulated; pack – packet; synchronous – asynchronous; node – nodes; survey – surveillance

5. **Pronunciation** (Rec. 45). **Listen and repeat these somewhat absurd sentences.**

a. *Are you designated or encapsulated, or perhaps both?*
b. *Carrying heavy carrier bags is her main occupation. And I'm more into digital carriers.*
c. *Synchronous or asynchronous? That's not the question about phosphorous!*
d. *Do they know of the node? No, they don't. They think, the node is not worth their note.*
e. *The Prize comprises money and a big-size vase.*
f. *To protect ourselves from violence we need surveillance.*

6. **Speaking and writing. Instructions.** You will need at least 45 minutes altogether for quiz preparation and the quiz itself (activity 7). Divide the class into teams of not more than 4, 5 people at the most. In bigger teams some students are bound to be uninvolved. You may appoint team leaders to ensure efficient work within a time limit of, say, 20 minutes and to ensure that each student in the team comes up with a question or two. The teams need to have more questions up their sleeve in case some questions overlap with the other teams' questions during the quiz. Focus students' attention on the importance of correct question formation because they are going get points for each correct question (or zero points for an incorrect question), not just for a correct answer. Also highlight the importance of questions being related to technology, not just historical facts.

7. **Speaking. Grand Quiz on the History of Telephony**

The running of the quiz requires organizational skills. You may number the teams or get the teams to invent a name, each. The rounds work clockwise, questions go from team to team like the hands of a clock. Avoid a situation in which only one person in the team asks all the questions. It is the team leader's task to make sure that in every round a different person in the team has a chance to ask a question. Completing 10 rounds means that each team has asked and answered 10 questions. The team that have asked a question must, of course know the answer to it; in case there is a controversy as to the correctness of the answer, you may act as the judge and last resort but you may also get the whole class to decide by popular vote. The teacher keeps the score on the board. In this version of the quiz only one team answers a question at a time. They have a minute or two to negotiate and provide the answer. The other teams keep quiet.

Optional procedure. One teams asks a question, and all the other teams provide answers on slips of paper distributed before the quiz starts. Each slip of paper contains the answer and the team's name or number initially assigned to the team. The teacher collects the slips, check the answers and puts the score up on the board.

II Next Generation Network

1. **Reading. What does the cited text below describe?** It describes the Next Generation Network (NGN).

2. **Reading. Decide if these … .**

a. T,
b. F,
c. F,
d. T,
e. T,
f. F.

3. **Vocabulary presentation.**

a. ubiquitous,
b. mobility,
c. underlying,
d. unfettered,
e. reassembled.

Note. You may need to help students pronounce correctly the words "ubiquitous" [ju'bıkwıtəs] and "unfettered" [ʌn`fetəd].

4. **Vocabulary work. Put the appropriate words … .**

a. unfettered,
b. ubiquitous,
c. underlying – mobility,
d. reassembled.

5. **Pronunciation (Rec. 46). Listen … .**

ubiquity – ubiquitous; mobile – mobility; underlie – underlying; fettered – unfettered

6. **Pronunciation (Rec. 47). Listen … .**

a. *You can see her everywhere. She is such a ubiquitous actress.*
b. *Being fettered cannot be better than unfettered.*
c. *Provision has nothing to do with collision.*
d. *What is dismantled must be reassembled.*

7. **Language. Examine … . Instructions.** Elicit from the class what purpose do the verbs serve in the cited paragraph. Ask students: *Do the verbs express positive or negative features?* For further conclusions refer to Language Box I.

8. **Language practice. Work in pairs … . Instructions.** The activity is more personalized, it allows students to talk about their own devices, instruments, etc. Get them to use the verbs and structures from Language Box I.

III More on the Next Generation Network

1. **Vocabulary presentation. Decide … .**

The words similar in meaning to CONVERGE: intercept, gather, unite, integrate, concentrate, come closer.

2. **Vocabulary work. Word building … .**

Noun – convergence. Opposite – diverge (verb) – divergence (noun).

3. **Speaking. What do you think …? Instructions.**

Hold a brief whole class discussion to prepare background for the reading in **4**. Students may have some knowledge of the subject. Allow them to reveal it. The answers are provided in the text in **4**.

4. **Reading. Read the text to confirm … .**

The "convergence of services and networks" is the answer; all kinds of services and networks come together to form one network which makes it all available and of high standard on the NGN. "[the] Internet on steroids" is not quite explained in the text but it may be assumed that it is like a human body whose function is enhanced and improved by means of the application of steroids.

5. **Reading for details. Examine … . Instructions.**

Students work individually and then compare their notes in pairs. Text fragments may not be obvious to fall under a particular category. It is open to discussion how students decide. The point is to study the text more carefully and get more than in the previous activity in **4**.

See the completed table but be open to other suggestions by students.

Services	– a wide range of services (even services not yet known). That includes conversational voice teleservice; – support for other important real-time services such as video, conferences and non-real time services including data transfer and access to streaming and multimedia content; – the delivery of IPTV – interactive Internet Protocol Television available via Internet (over IP)
Openness	– the ease of new service creation – unrestricted access to the broadband services, which should be considered as an access to services demanding more than 2 Mbit/s. – every user will have similar, unrestricted access to services offered by various operators and service providers no matter which technology is used, particularly that aspect regards to mobility of the user
Technology	Voice over Packet, or more precisely Voice over Internet Protocol (VoIP). – conversational voice teleservice; – architecture which distinguishes and separates transport layer (connected with packet transport and delivery in different network technologies), control layer (connected with network control and management) and application layer (in which special servers for application and content access or service realisation are present).
Quality	Quality of Service (QoS) which regards all aspects (including special network architectures, service and traffic management and control, packet transport mechanisms) connected with providing end-to-end guarantees for bandwidth, packet loss, packet delay and delay variation which results in Quality of Service perceived (or experienced) by the user. NGN focus on QoS also means that some measures important for quality in traditional networks, for example call setup time also will be guaranteed.
Security	– new services will provide extraordinary high security level; – the goal of high security will be achieved in new network architecture (*see under the category of Technology*)

6. **Vocabulary work. In the text in 5, … .**

a. conversational voice teleservice
b. IPTV – Internet Protocol Television
c. transport layer
d. end-to-end guarantees for bandwidth
e. control layer
f. application layer
g. call set-up time
h. streaming (e.g. streaming content and media)
i. Internet Protocol
j. Voice over Packet or Voice over Internet Protocol
k. Quality of Service (QoS).

7. **Vocabulary work. Explain … .** Real-time services – performed and received by the user "now" – with strict demands regarding delay between information generation and delivery, e.g. voice (conversation). Non-real – done, performed earlier in advance and received "later" – without strict demands between information generation and delivery. E-mail – non-real time, chat – real time, video-conference – real time, a phone call – real time.

8. **Note-taking and speaking. On the basis of the texts … .** General differences which make the NGN superior: *its ubiquity / its ability to make use of multiple broadband / QoS-enabled transport technologies / service-related functions will be independent from underlying transport-related technologies / unfettered access for users to networks and to competing service providers and/or services of their choice / It will support generalized mobility which will allow for consistent and ubiquitous provision of services to users.*

More specific technological innovations that make the NGN superior: *conversional voice tele service - in the NGN that will be Voice over Internet Protocol (VoIP) / support for real-time services such as video, conferences and non-real time services including data transfer and access to streaming and multimedia content / delivery of IPTV – Interactive Television available via the Internet (over IP) / Quality of Service (QoS) connected with providing end-to-end guarantees for bandwidth, packet loss, packet delay and delay variation which results in Quality of Service perceived (or experienced) by the user / focus of the NGN on QoS also means that some measures important for quality in traditional networks, for example call set-up time will also be guaranteed / NGN will provide unrestricted access to the broadband services with the access to services that demand more than 2 Mbit/s / it will provide an extraordinarily high security level through separated transport layer, control layer and application layer (in which special servers for application and content access or service realisation are present) / users will have similar, unrestricted access to services offered by various operators and service providers no matter which technology is used.*

Global social impact – *Creating equal opportunities and access to knowledge and experience to all countries, backward or civilized, impact on political systems and the development of societies. Cooperation and collaboration worldwide, etc.*

9. **Writing. Instructions.** The aim of the writing task is to activate the use of the vocabulary of the Unit and the structures from the language boxes of the Unit. If you decide on doing the speech rather than the essay, allow time for speakers to get ready (about 15 minutes) but do not allow reading during the speech delivery. Essay writing is useful as training for diploma thesis writing so do not skip it. You may make it part of the end-of-term assignment for students to get the credit for the course. Useful phrases / structures for argumentative essay writing: *On the one hand … On the other hand, ……… However, … , Although ……, ………… .* Advice on the organizational aspect of the essay: 1st paragraph – description of "the state of affairs" in technology, i.e. on the Internet (problems / difficulties, needs) 2nd paragraph – arguments against the NGN; 3rd paragraph arguments for NGN and all kinds of innovations that it will bring; 4th paragraph balancning pros and cons and presenting the conclusion.