

# Outline

- Acoustic emission education.
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- Material science.
- Acoustic emission apparatus.
- Acoustic emission applications.
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- Academic program.
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# **When We Prepare a New Methodology of Inspection We Ask Common Questions**

- What are operational conditions of the structure, stress distributions, properties of material?
- What kind of flaws developing in this structure.
- How to build an examination plan?
- What type of the equipment and schemes to use?
- Which methods of data analysis to apply?

# Acoustic Emission Education

- Acoustic emission is a multidisciplinary science that combines different fields of material science, engineering, physics and mathematics.
- Today, academic study and research of AE are relatively small despite its huge potential comparing with other non-destructive test methods like ultrasonics.
- Presently, there are no dedicated education academic programs for preparation of AE specialists.
- Existing ASNT topical outlines of requirements for qualification of AE testing personnel do not cover necessary topics in material science and methods of data analysis. Also, they are more technology rather theory oriented.

# Goals of Education Program

Development of the education program is necessary in order to:

- Systemize the education process and knowledge given to new specialists.
- Provide a comprehensive overview of the AE science.
- Give a common theoretical and practical background.
- Reduce time necessary for preparation of new specialists.

# Process of Education Program Development

The process of education's program development includes the following steps:

- Structurizing and mapping acoustic emission science.
- Creation of topical outline with weight and volume of study for each subject. This topical outline is used for preparation of list of courses.
- Providing syllabus for each course.
- Preparation of reference literature lists.

# Acoustic Emission Science



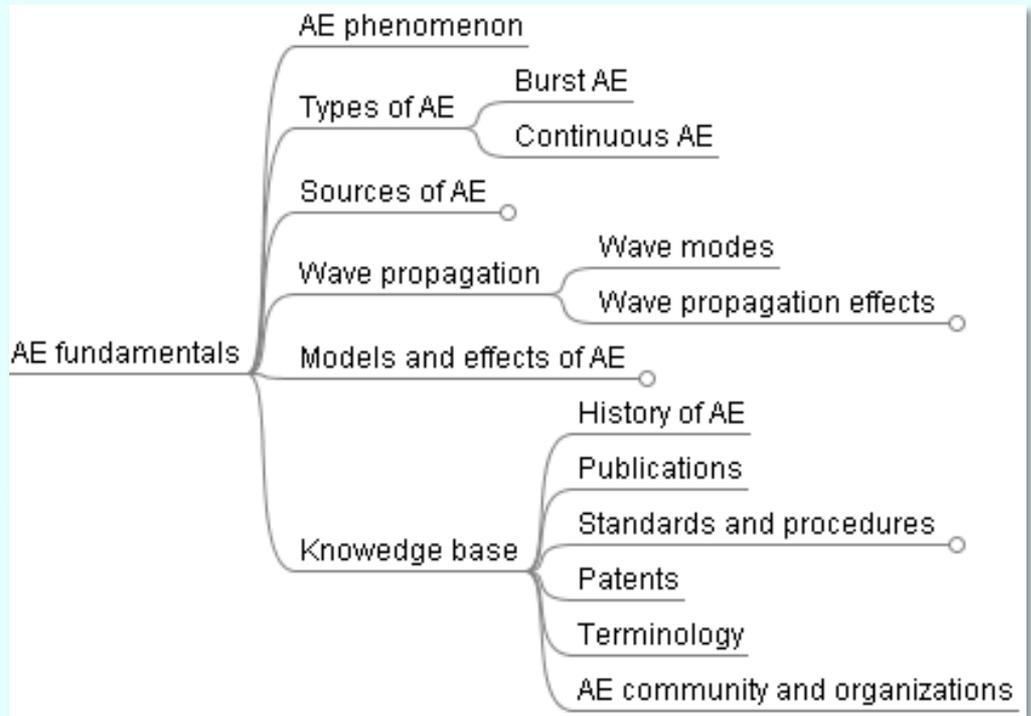
The AE science can be divided on two main parts: theoretical and technological.

- The theoretical part includes AE fundamentals and material science.
- The technological part can be divided on three main subjects: apparatus, applications and methods of data analysis.

# AE Fundamentals

AE fundamentals, one of the core subjects, include 6 topics:

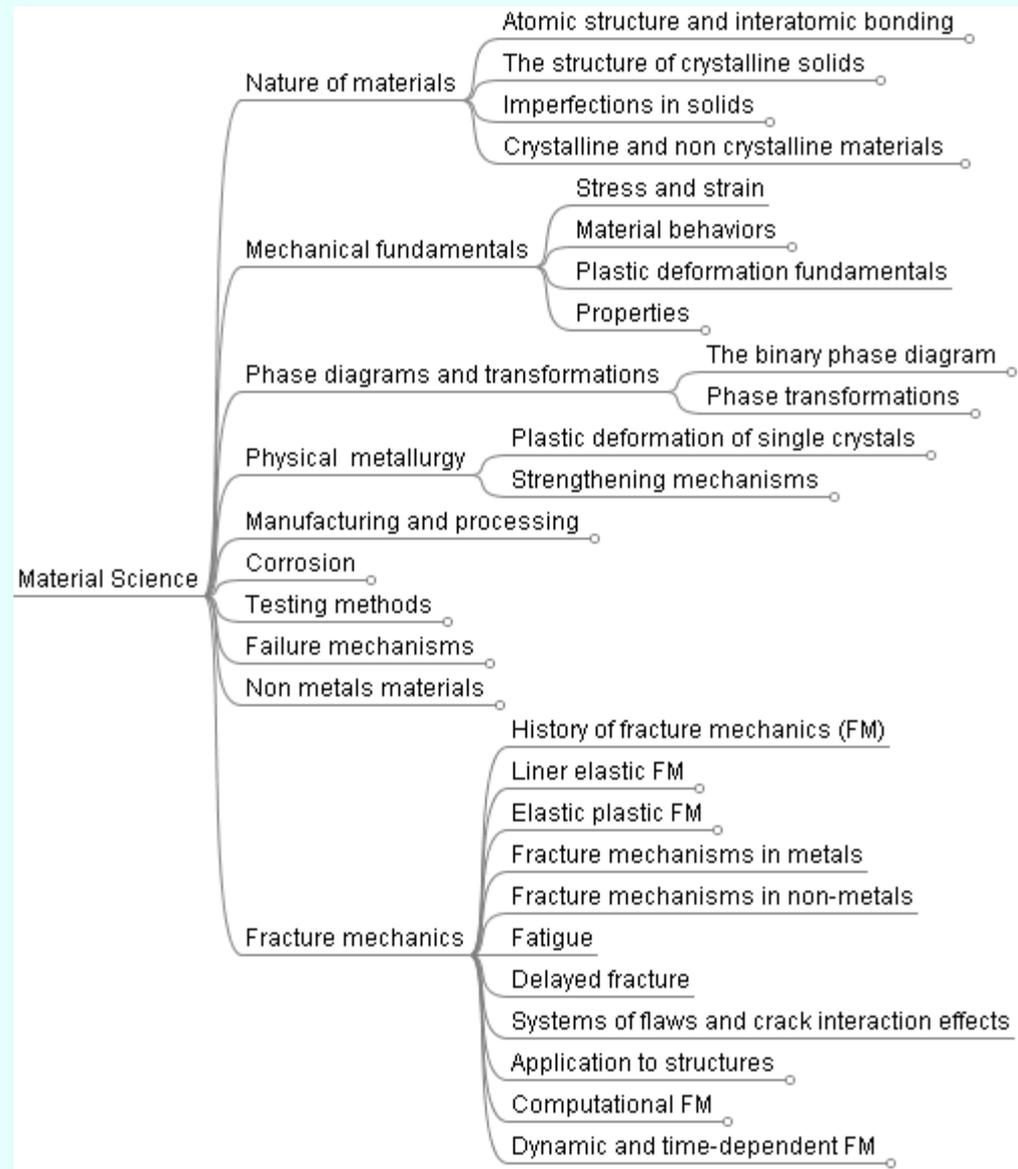
- AE phenomenon.
- Types of AE.
- Sources of AE.
- Wave propagation.
- AE effects and models .
- Knowledge base.



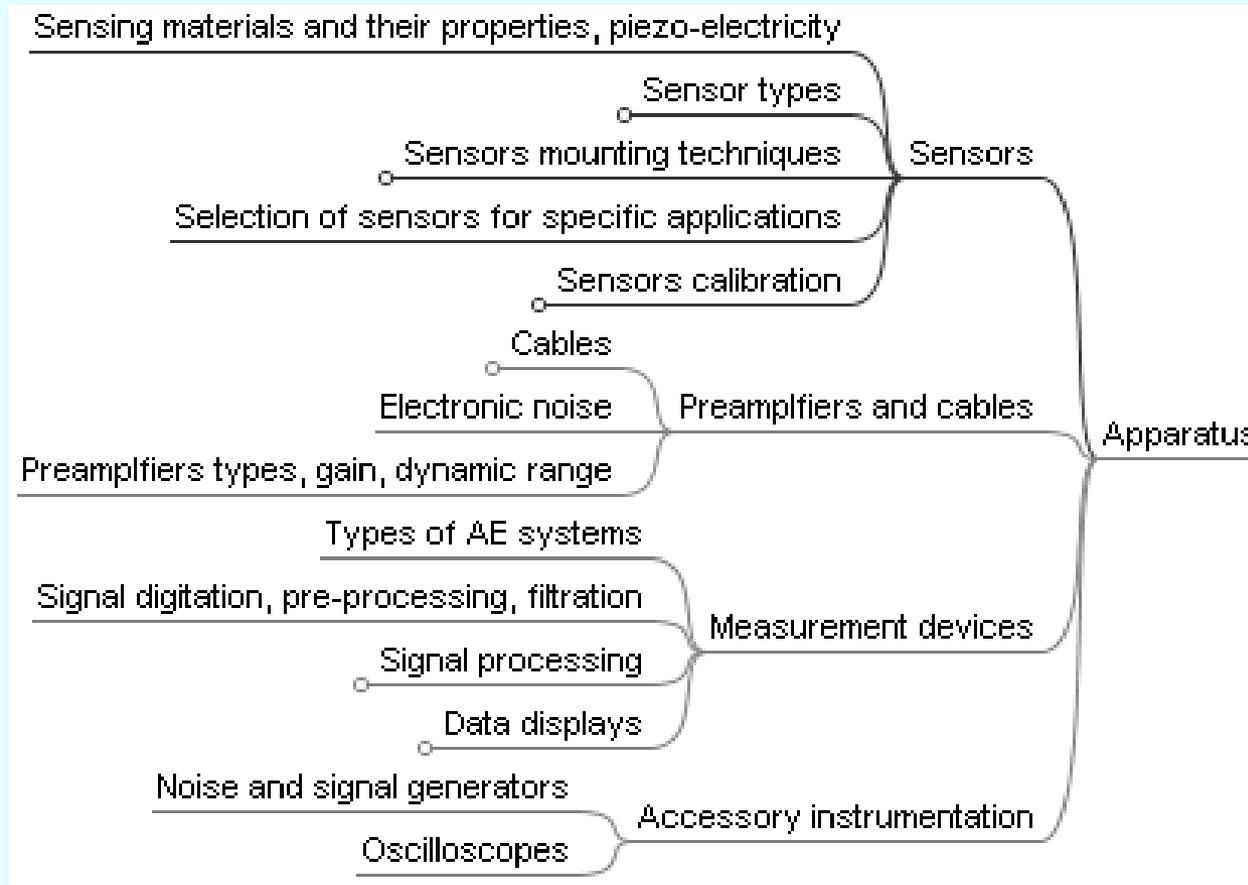
AE fundamentals have to be studied after studying material science, fracture mechanics, wave propagation, and dynamic behavior of materials. Generally, a course on AE fundamentals can cover in great detail all relevant topics during one semester with 13 lectures of 3 hour duration.

# Material Science

- Acoustic Emission is a phenomenon that accompanies deformation and fracture processes in materials. AE characteristics are directly dependent on material type, their properties and condition.
- Study of material science has to cover multiple topics related to nature of materials, their properties, mechanical and environmental behavior, manufacturing, failure mechanisms, fracture mechanics and testing methods.



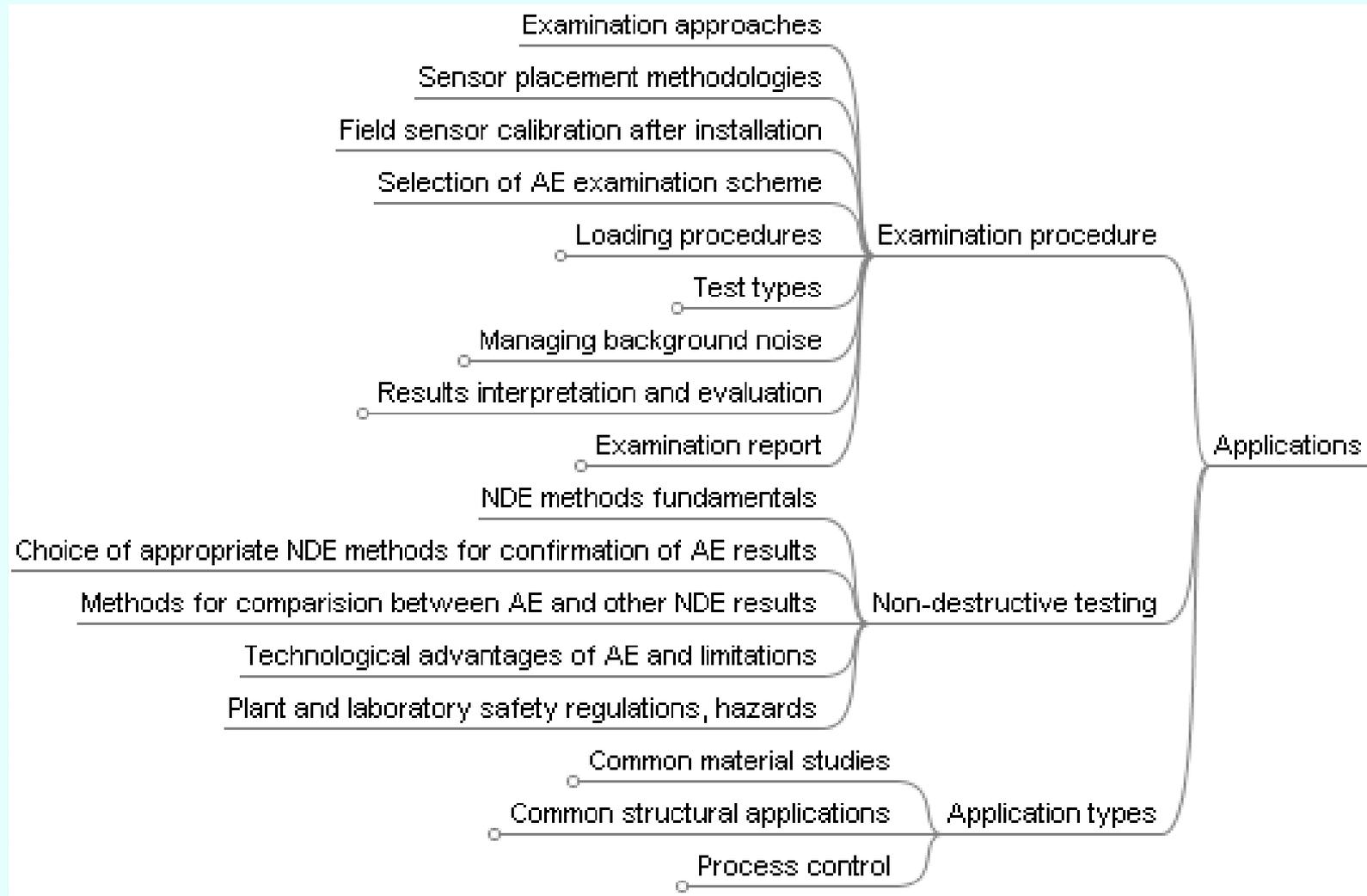
# AE Apparatus



AE apparatus subject describes principals and methods for AE sensing, processing and collection of data. Also, it covers topics related to selection and operation of appropriate equipment for performing AE examinations. Study of AE apparatus should combine theoretical and practical classes.

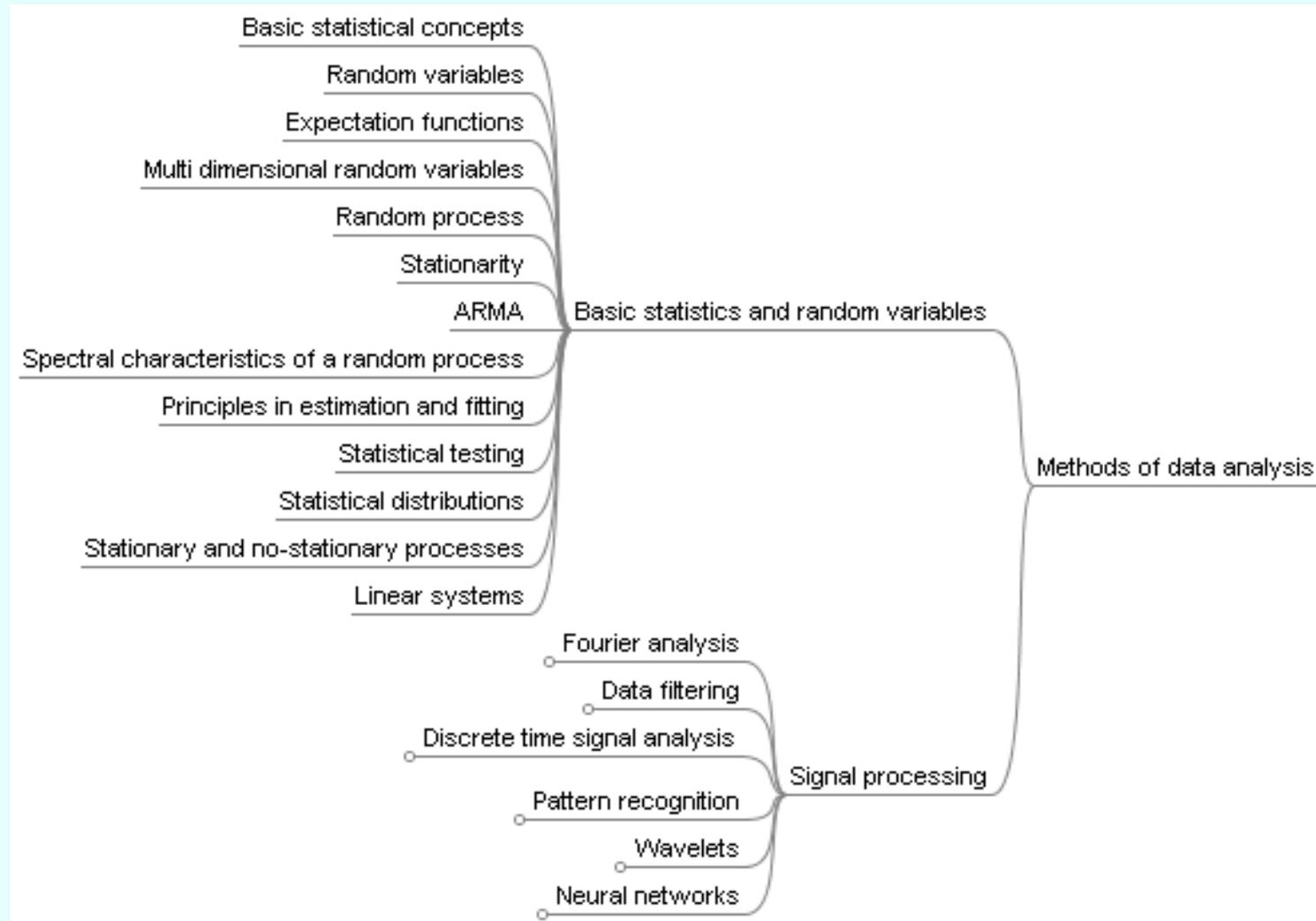
# AE Applications

The subject of applications describes approaches and methods for developing procedures and other aspects related to performing AE examinations, other non-destructive examination (NDE) techniques, and confirmation of AE findings.



# Signal Processing and Data Analysis

This subject describes different methods that are used for analysis of AE data.



# Academic Program Overview

- The program is appropriate for students studying for Master of Science degree in mechanical or material engineering.
- The program consists of 494 study hours dedicated to the core AE education and is appropriate for one academic year.
- Other academic mandatory or non-mandatory courses usually given in the frame of Master of Science degree or courses from the Bachelor degree necessary for studies in the developed program are not described in this work.
- In addition to the courses and practical classes, individuals have to participate in two AE seminars.
- At the end of the program students submit final project work or thesis on one of the research subjects related to AE. The thesis or final project has to be an original work of research, design, or development.

# Academic Program

| Course | Name of course                            | Subjects covered  | Recommended literature | Duration                  |
|--------|---|---|------------------------|---------------------------|
| 1      | Fundamentals of AE                        | AE phenomena, types of AE, sources of AE, wave propagation theory, AE effects and models and AE knowledge base  | [1], [5], [6], [23]    | Semester, 3 hour lectures |
| 2      | AE technology, apparatus and applications | AE technology, sensors, equipment, applications, inspection procedures  | [1], [5], [7]          | Semester, 3 hour lectures |
| 3      | Materials I                               | Nature of materials, mechanical fundamentals, phase diagrams and phase transformations, physical metallurgy, non-metal materials  | [8]-[11], [21], [23]   | Semester, 3 hour lectures |
| 4      | Materials II                              | Manufacturing and processing, testing methods, failure mechanisms, corrosion  | [12]-[22], [24]        | Semester, 3 hour lectures |
| 5      | Fracture mechanics                        | Linear elastic and elastic-plastic fracture mechanics, parameters of fracture mechanics, fracture mechanisms, dynamic fracture mechanics, flaw assessment diagrams, remaining life time evaluation, computational fracture mechanics. | [24], [25]             | Semester, 3 hour lectures |
| 6      | Methods of AE data analysis I             | Statistics and random variables   | [26], [27]             | Semester, 3 hour lectures |
| 7      | Methods of AE data analysis II            | Advanced signal processing  | [28]- [34]             | Semester, 3 hour lectures |
| 8      | AE training class                         | Sensors, equipment operation, signal processing and location  | -                      | Semester, 4 hour lectures |
| 9      | AE laboratory                             | Laboratory material testing and characterization by AE.   | -                      | Semester, 4 hour lectures |
| 10     | Non-destructive testing                   | NDT methods, typical applications, confirmation of AE results, certification bodies and programs, safety at site, hazards   | [2], [3], [35], [36]   | Semester, 3 hour lectures |
| 11     | AE seminar I                              | Presentation and discussion of different AE scientific subjects   | -                      | Semester, 3 hour lectures |
| 12     | AE seminar II                             | Presentation and discussion of different AE scientific subjects   | -                      | Semester, 3 hour lectures |

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# Conclusions

In this work, academic program for preparation of AE specialists was developed. This program consists of theoretical and practical studies that intend to develop a necessary knowledge and skills for performing effective AE academic research and diagnostic work.

Next steps in development of education systems can be:

- Provide an explicit syllabus for each course.
- Create a database of exercises for a practical study.
- Develop a flow diagram of AE education process that considers the sequence of studied topics from different scientific fields.

# Thank you!!

More education materials can be downloaded from [Muravin.com](http://Muravin.com).

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