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|  | **Course Syllabus** |

**1.** **Course Title:**

Nonlinear Wave Phenomena

**2. Academic Level:**

Master

**3. ECTS Credits:**

5 ECTS

**4. Semester:**

2, spring semester

**5. School/Department:**

Taganrog Campus, 2 Shevchenko St., Taganrog

Institute of Nanotechnologies, Electronics and Equipment Engineering / Department of Electrohydroacoustic and Medical Technology

**6. Location:**

**7. Instructor:**

Prof. Sergey Tarasov, d.e.s. email: [sptarasov@sfedu.ru](mailto:sptarasov@sfedu.ru) Prof. Alexandr Voloshchenko, PhD, email: [apvoloshhenko@sfedu.ru](mailto:apvoloshhenko@sfedu.ru)

**8. Language of Instruction:**

English

**9. Course Description:**

The course concerns the theory of nonlinear phenomena and nonlinear interactions in liquids, gases both firm deformable bodies and application of methods of nonlinear acoustics for construction of devices and systems operating on new principles.

**10. Course Aims:**

* to study basic theoretical preconditions of nonlinear phenomena;
* to study nonlinear equations of hydrodynamics and elasticity theory;
* to master basic processes of waves occurring at distribution in nonlinear dissipative environment;
* to study nonlinear phenomena in nonlinear dissipation environment with a dispersion;
* to be able to use methods of nonlinear acoustics studying the focused sound waves;
* to develop methods of solving the problems of nonlinear acoustics and parametrical interaction of nonlinear waves.

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**11. Specific entry requirements (if any):**

English B1

*Knowledge:* key features of information and communication technologies for academic and professional interaction; basic terminology of acoustics and engineering; grammatical forms and constructions characteristic of everyday and professional communication.

*Abilities:* to carry out research in the field of engineering, to estimate its results and prospects.

*Skills:* basic techniques of annotation, abstracting and translation of simple authentic texts related to the field of acoustics.

**12. Course Content:**

**Unit 1: Basics of nonlinear acoustics.**

Characteristics of nonlinear wave phenomena. Nonlinear wave equation. The way of solving the equation of nonlinear acoustics by the method of successive approximations.

**Unit 2:** **Physics of nonlinear processes.**

Kinetics of nonlinear processes. Description of the wave profile before and after discontinuities. Spectral composition of waves in nonlinear environment. Nonlinear absorption and saturation. Propagation of spherical and cylindrical convergent and divergent waves in a nonlinear medium.

**Unit 3:** **Nonlinear effects in dispersion media.**

Waves in media with dispersion. Nonlinear interaction of waves on the example of biharmonic (two-frequency) and amplitude-modulated signals.

**Unit 4:** **Parametric antennas.**

Mathematical and physical model and expressions for calculating the basic characteristics of a parametric antenna. The use of a parametric radiating antenna as part of a parametric profilograph for the study of sedimentary structures of the seabed.

**13. Intended Learning Outcomes:**

Knowledge: nonlinear equations of hydrodynamics and theory of elasticity; the main processes occurring in the propagation of acoustic waves in a nonlinear dissipative medium; nonlinear phenomena in a nonlinear dissipative medium with dispersion.

Abilities: to apply methods of nonlinear acoustics for the study of focused sound waves.

Skills: to apply methods of solving problems of nonlinear acoustics and parametric interaction of nonlinear waves.

**14. Learning and Teaching Methods:**

**Passive:** lecture-visualization using presentation material, oral questioning.

**Active:** independent work with literature, scientific, educational and reference digital resources, performance of analytical tasks, creation of reproductive individual works (essays, scientific reports), independent production of texts with new settings.

**Interactive:** participation in practical classes, participation in discussions, development, and presentation of project assignments in English.

The course can be carried out partly or as a whole using electronic and distant educational system of University.

**15. Methods of Assessment/Final assessment information:**

Project assignments, particularly:

Parametric antennas (abstract) – 15 points.

Physics of nonlinear processes (abstract) – 15 points.

Nonlinear effects in dispersion media (abstract) – 15 points.

Work in classes – 15 points.

Final control work – 40 points.

Students are expected to get at least 60 points in order to complete the course and up to 10 extra points manifesting impressive results during the study of the course reflected in presenting reports at international conferences.

**16. Reading List:**

1. Kucher N. A. Nonlinear boundary conditions problems on the plane: tutorialie / N. A. Kucher; O. V. Malyshenko-Kemerovo: Kemerovo state University Moscow state University, 2012, 116 p. [Electronic source] <http://biblioclub.ru/index.php?page=book&id=232684>
2. Electromagnetic fields and waves: textbook / V. A. Zamotrinsky-Tomsk: TUSUR, 2012. - 184 p. [Electronic source] <http://biblioclub.ru/index.php?page=book&id=480475>

3. Dobyshev. Yu. N. Oscillations and waves / Yu. N. Dobysheva - Novosibirsk: Siberian University publishing house, 2004. - 328 p. [Electronic source] <http://biblioclub.ru/index.php?page=book&id=57202>

4. Ultrasound in medicine [Text]: physical bases of application / ed. by K. hill [et al.]; TRANS. ed. by L. R. Gavrilov [et al.] - 2nd ed., reprint. and add. - M.: Fizmatlit, 2008. - 539 p.

6. Crandall I. B. Acoustics [Text]: TRANS. from English - 4th ed. - Moscow: LIBROKOM, 2009. - 171 p.

1. Perunova M. Oscillations and waves: textbook / M. Perunova - Orenburg: OSU, 2012. - 386 p. URL: http://biblioclub.ru/index.php?page= book&id=259216