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|  | **Course Syllabus** |

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

Nonlinear Acoustic Systems

**2. Academic Level:**

Master

**3. ECTS Credits:**

5 ECTS

**4. Semester:**

3, autumn semester

**5. School/Department:**

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

**6. Location:**

Taganrog Campus, 2 Shevchenko St., Taganrog

**7. Instructor:**

Prof. Sergey Tarasov, d.e.s. email: [sptarasov@sfedu.ru](mailto:sptarasov@sfedu.ru) , Prof. Nikolay Chernov, d.e.s. email: [nnchernov@sfedu.ru](mailto:nnchernov@sfedu.ru)

**8. Language of Instruction:**

English

**9. Course Description:**

The course is focused on 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:**

**Topics**

**1** Characteristics of nonlinear wave phenomena. Classification of acoustic nonlinearity types. Equation of nonlinear acoustics. Nonlinear wave equation.

**2** Solution of the equation of nonlinear acoustics. Burger’s equation. Burger’s equation of the dimensionless form. Riemann solution.

**3** Kinematics of nonlinear effects developments. Distortion of the wave form at distribution. Development of nonlinear effects at high Reynolds number. Description of a wave profile before ruptures formation.

**4** Spectral structure of waves in the nonlinear environment. Nonlinear absorption and saturation. Focusing of waves in the nonlinear environment. Distribution of spherical and cylindrical converging and dispersing waves to the nonlinear environment.

**5** Waves in environments with a dispersion. Korteweg-de Vries equation. Stationary wave in the nonlinear environment. Concept of soliton.

**6** Nonlinear interaction of waves, the case of biharmonic (two-frequency) and peak-modulated signals. Parametrical radiating aerial. Mathematical and physical model and expressions for calculation of the basic characteristics of the parametrical aerial.

**7** Characteristics of the parametrical radiating aerial. Spatial distribution of amplitude of sound pressure of waves of differential frequencies, peak and peak-frequency characteristics.

**8** Model of parametrical aerial reception. Structure of construction and basic characteristics of parametrical aerial reception.

**9** Calculation of parametrical profilograph characteristics. Features of construction. Application of the parametrical radiating aerial as a part of parametrical profilograph for research of sedimentary structures of a sea-bottom.

**13. Intended Learning Outcomes:**

Knowledge: information and communication technologies for academic and professional interaction; basic terminology of the chosen professional field; grammatical forms and constructions characteristic of everyday and professional communication; modern systems and technologies designed to solve engineering problems.

Abilities: to apply information and communication technologies for academic and professional interaction; to use common, academic, business, research, professional vocabulary; to apply grammatical skills that ensure communication without distortion of meaning when presenting the results of activities in the field of acoustics; to propose new ideas and approaches to solve engineering problems using information systems and technologies.

Skills: basic techniques of annotation, abstracting and translation of simple authentic texts related to the field of acoustics, skills of oral and written presentation of research outcomes.

**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 the University.

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

**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. [Electronical source] <http://biblioclub.ru/index.php?page=book&id=232684>
2. Electromagnetic fields and waves: textbook / V. A. Zamotrinsky-Tomsk: TUSUR, 2012. - 184 p. [Electronical 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. [Electronical source] <http://biblioclub.ru/index.php?page=book&id=57202>

4. Zarembo L. K. Nonlinear acoustics [Text] - Moscow: MSU Publishing house, 1984. - 104 p.

5. 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.

Assessment methods are interviews, individual assignments, particularly:

Work in practical classes – 40 points.

Individual assignment (presentation) – 20 points.

Individual assignment (report + defense) – 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.