**Name of the course:** Nonlinear wave phenomena

**Department responsible for the course or** **equivalent:** Dpt. Electrohydroacoustical and medical technology, Institute of Nanotechnologies, electronics and electronic equipment engineering

**Lecturer (name, academic title, e-mail):** Dr. Sergey Tarasov, professor, [sptarasov@sfedu.ru](mailto:sptarasov@sfedu.ru), Dr. Mark Denisenko, associate professor, [dema@sfedu.ru](mailto:dema@sfedu.ru)

**Semester when the course unit is delivered**: 2

**Teaching hours per week**: 6

**Level of course unit**: Master level

**ECTS credits:** 5

**Admission requirements**: Course «Nonlinear wave phenomena» concerns a cycle of disciplines of a direction. The purpose of its teaching is the substantiation of the theory of the 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.

**Course aims**:

* studying of the basic theoretical preconditions of the nonlinear phenomena;
* studying of the nonlinear equations of hydrodynamics and the elasticity theory;
* mastering of the basic processes of waves occurring at distribution in nonlinear dissipative environment;
* studying of the nonlinear phenomena in nonlinear dissipation environment with a dispersion;
* ability to use methods of nonlinear acoustics at studying of the focused sound waves;
* development of methods of the decision of problems of nonlinear acoustics and parametrical interaction of nonlinear waves.

**Course contents:**

The course is comprised of 4 units. Each unit assumes interview with students and preparation of abstracts.

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

Characteristics of nonlinear wave phenomena. Classification of types of acoustic nonlinearity. The equation of nonlinear acoustics. Nonlinear wave equation. The way of solving the equation of nonlinear acoustics by the method of successive approximations. Burgers equation. Burgers equation in dimensionless form. The Solution of the Riemann.

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

Kinetics of nonlinear processes. Distortion of the shape of the propagating wave. Development of nonlinear effects at large Reynolds numbers. Description of the wave profile before and after discontinuities. Spectral composition of waves in nonlinear

environment. Nonlinear absorption and saturation. Focusing waves in a nonlinear medium. 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. The Korteweg de Vries equation. A stationary wave in a nonlinear medium. The concept of soliton. Nonlinear interaction of waves on the example of biharmonic (two-frequency) and amplitude-modulated signals.

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

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

**Learning outcomes**: Students will study:

* the basic theoretical prerequisites of nonlinear phenomena;
* 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;
* methods of nonlinear acoustics for the study of focused sound waves;
* methods of solving problems of nonlinear acoustics and parametric interaction of nonlinear waves.

**Planned learning activities and teaching methods:** practical and seminar classes, self-study, abstracts and control work.

**Assessment methods and criteria**

Assignments for this course consists of: 4 abstracts, midterm control work.

1. Parametric antennas abstract: one week from end of unit 15%

2. Physics of nonlinear processesabstract: one week from end of unit 15%

3. Nonlinear effects in dispersion media abstract one week from end of unit 15%

4. Parametric antennasabstract one week from end of unit 15%

5. Final control work \_\_\_\_\_\_\_\_\_\_\_\_40%

**Course literature (recommended or required):**

1. Crandall I. B. Acoustics [Text ]: per. s angl. - 4th ed. - Moscow: LIBROKOM, 2009. - 171 p.
2. Perunova M. Oscillations and waves / M. Perunova. Orenburg: OSU, 2012. - 386 p. URL: http://biblioclub.ru/index.php?page= book&id=259216
3. Kucher N. A. Nonlinear boundary value problems on the plane / N.. Kucher, O. V. Malyshenko - Kemerovo: Kemerovo state University, 2012. - 116 p. URL: http://biblioclub.ru/index.php?page= book&id=232684
4. Perunova M. Oscillations and waves: textbook / M. perunova - Orenburg: OSU, 2012. - 386 p. URL: http://biblioclub.ru/index.php?page= book&id=259216