

## 1. Institution

1. Institution's name	Novosibirsk State Technical University
2. Faculty (department)	Radioengineering, Electronics and Physics
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4. Contact person/coordinator (name, phone, e-mail, position)	Prof. Alexey G. Vostretsov, +7 3832 464872 <a href="mailto:vostretsov@first.nstu.ru">vostretsov@first.nstu.ru</a> , vice-rector for research of Novosibirsk State Technical University Prof. Vasily N. Vasyukov, +7 3832 461378 <a href="mailto:vasyukov@ktor.ref.nstu.ru">vasyukov@ktor.ref.nstu.ru</a> , professor of fundamentals of radioengineering department

## II. Course's profile

5. Course title	<b>Modern methods of digital signal processing in radio systems</b>
6. Course profile (please give some key words to specify the focus)	Digital signals, signal processing, detection, distinguishing, hypotheses testing, estimation, nonbiased tests, invariance tests, robustness, realization of algorithms
7. ECTS points available? (Yes/No)	No
8. Class hours/week	20 hours/week
9. Integrated Russian language course for beginners (Yes/No, hours/week)	No
10. Language of instruction	English
11. Integrated practical training/ research program (Yes/No, brief description)	Yes (educational research and computer hands-on training in synthesizing, modeling of algorithms and estimating of their effectivenesses)
12. Integrated cultural program: excursions etc. (Yes/No, brief description)	Excursions to the Centre of Siberian Folklore and ethnography, Regional Studies Museum, Museum of Geology, Museum of Birch-bark Art; Picture Gallery; City-guide tour. Visiting of ancient Siberian cities, as Tomsk, Omsk, Barnaul and others are available (the main aim is getting acquaintance with its history, culture, architecture, economical life). Inter-cities transfer expenses are covered by students' group additionally. Meetings and discussions with Novosibirsk students, journalists and intelligentsia.
13. Number of students (min-max)	10.. 14
14. Tuition fees (o / month / person)	500 €/month/person
15. Course's duration	4 weeks

## III. Accommodation

17. Accommodation conditions: student hostel (description of accommodation facilities, incl./excl. food, costs (o / month / person)	"Universitetskaya" hotel: blocks, consisting of 2-person and 3 person rooms, toilet and bathroom. Students' canteen: meals 3 times/a day. Full costs: 20 €/day/person
18. Accommodation conditions: guest family (optional): Yes/No, incl./excl. food, costs (D / month / person)	No

## Modern methods of digital signal processing in radio systems

The course include 40 hours of lections and 40 hours of educational research and computer hands-on training in synthesizing, modeling of algorithms and estimating of their effectivenesses.

To answer the purpose of the course students are to know mathematics (probability theory, mathematical statistics, complex )

### Aim of course.

After studying the course students:

- Will have a notion of modern theory of detection, distinguishing and estimating of signals, use of probability theory, mathematical statistics, signal theory, spectral analysis etc.;
- Will be acquainted with the methods of detecting, recognizing and estimating of signals by means of classical theory and authors' theory of stable detecting, recognizing and estimating of signals in conditions of priori uncertainty (about signals and interferences using principles of invariance, unbiasedness and combination of both principles with approximation of distributions as well;
- Will be able to model on computer detection, recognition and estimation problems, synthesized algorithm with the aim to test their effectiveness.

### Principal subjects of lection course.

#### *1. Foundation of digital signal processing theory (20 hours of lections and and 20 hours of educational research and computer hands-on training)*

- Digital signal processing: advantages, problems, prospects
- Space of sequences (discrete signals, discrete convolution and its properties)
- Representation of sequences by polynoms and formal series, z-transform, Fourier transform
- Structure of impulse response of finite-order linear shift-invariant (LSI) circuit
- Phase circuits and minimal-phase circuits, forms of LSI-circuits realization
- Stationary random sequences and their influence on LSI-circuits
- Interrelation of analog, pulse and discrete signals
- Jitter, its mathematical model and influence on effectiveness of statistical algorithms
- Effects of quantization
- Hardware and program realization of digital filters

#### *2. Foundation of synthesis of statistical algorithms of digital signal processing in radio systems (20 hours of lections and 20 hours of educational research and computer hands-on training in synthesizing, modeling of algorithms and estimating of their effectivenesses)*

- Review of modern theory of detection, distinguishing and estimating of signals
- Problem of providing of structure and quality stability in conditions of a prior uncertainty about signals and interferences
- Theory of uniformly most powerful tests of signal detection and distinguishing
- Synthesis and analysis of uniformly most powerful tests of signal detection and distinguishing
- Theory of unbiased tests of signal detection and distinguishing
- Examples of synthesis and analysis of unbiased tests
- Theory of invariant tests of signal detection and distinguishing
- Synthesis and analysis of unbiased tests of signal detection and distinguishing
- Joint using of the unbiasedness and invariance principles for stable signal detection and distinguishing algorithm synthesis
- Distribution approximation method and its using for synthesis of stable algorithms
- Synthesis and analysis of stable tests of signals detection and distinguishing based on distribution approximation method
- Methods of synthesis of stable estimation algorithms based on the theory of unbiased estimation of parameters of distribution having complete sufficient statistics
- Synthesis of stable estimation algorithms based on the moment method
- Synthesis of stable algorithms of unknown form signal parameters (energy, duration, frequency) estimation in Gauss noise
- Features of realization of stable estimation and detection algorithms in analog-digital location and communication systems