

*Session 3. Space education***TWO NEW GNSS MASTER PROGRAMS AT SSAU**

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Since autumn 2014 Samara State Aerospace University (SSAU) introduces two new English spoken GNSS master programs. One is centered round Algorithms and Software and another round development of hardware and software receivers.

The initiative was undertaken because it was evident that Global Navigation Satellite Systems (GNSS) has an important influence on many aspects of contemporary human life. Any type of navigation benefits from GNSS, and especially many space activities.

Previous development

The new master programs partly build on a curriculum that was tested at Aalborg University (AAU) in Denmark during the period 2000–2013. In the 1990s the first GPS related courses were given to surveying students at AAU.

The 7th semester course included Matlab, digital signal processing, scientific writing, etc. Tables 1 and 2 present the specific courses on the later semesters. The 10th semester was devoted to writing master thesis. The education consisted of lectures and practical exercises which were supported by numerous Matlab scripts. Half the time was devoted to project work which is the characteristic teaching model at AAU.

We tried hard to make the new concepts and ways of thinking as easy understandable as possible for the students. But even after these efforts they found the topic difficult to understand. So we came up with a new pedagogical idea of splitting the topic into small pieces starting from RINEX observation and navigation files. The result was the EASY Suite I which was published in 2003 and was downloaded more than 180,000 times in the first year.

The program only was aimed at Danish surveying students. We received numerous enquiries from foreign students. Consequently, in February 2000 we started with 10 international students attending a revised and augmented English spoken program in GPS Technology.

In February 2013 the AAU education was suspended by the university management. Over the years more than 60 students received their master diploma and about 40 students were guests for one or two semesters.

Table 1: AAU, 8th Semester: GPS Fundamentals and Algorithms

Basic GPS Theory	2 ECTS
Engineering Responsibilities	1 ECTS
Adaptive Systems	1 ECTS
Reference Frames and Basic Units	1 ECTS
Datum and Geoid	1 ECTS

Table 2: AAU, 9th Semester: GPS Systems and Kinematical Applications

GPS Applications	1 ECTS
Discrete-Time Kalman Filtering	2 ECTS
Receiver Technology	2 ECTS
Propagation of GPS Signals	1 ECTS

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The SSAU Master Program in GNSS

Based on the experiences from AAU two new programs are now announced at SSAU. They both include a core of the AAU tested courses, but also include several courses with specific relevance to SSAU.

Obviously GNSS has and will have an enormous impact on several societal activities in near and far future. It is very obvious that we need future research on signals which are resistant to jamming, and detection of spoofing and signal authentication. Indeed, GNSS security will be the emphasis of the current decade. In this way, we can see the following progression for GNSS:

- 1970's building the satellite constellations to enable availability;
- 1980's improving accuracy with differential GNSS (DGNSS);
- 1990's providing integrity for safety critical applications with GNSS augmentation;
- 2000--2010: extending GNSS coverage to downtown and indoors using assisted GNSS (A-GNSS);
- 2010 to 2020: security against denial of service attacks (jamming) and counterfeiting GNSS signals (spoofing).

Encountering these challenges state-of-art GNSS receivers should perform complicated signal processing, advanced hardware solutions and also obtain some side information in order to complement usual technique. Aircraft and spacecraft applications require specific algorithms, taking into account essential flight dynamics, requirements of onboard applications and so on. So professionals of the future decade should have specific competencies in digital and analog electronics and profound knowledge of GNSS algorithms. On the other hand, it is likely, that a lot of applications will use OEM modules and other similar hardware solutions.

The two programs established at SSAU aim at reflecting these two approaches: firstly implying the development of low-level GNSS modules and specific algorithms, and secondly concentrate on algorithms used for end-user applications. Certainly, the programs contain some identical basic courses; moreover the first semester is identical. Tables 3--7 present content of the programs.

Table 3: SSAU, 9th Semester: Algorithms and Software plus Receivers: Hardware/ Software

History and Methodology of Science	3 ECTS
Modern Problems of Science and Stable Development	4 ECTS
Radio Receiver's Theory (Including Communication on Noisy Channels)	3 ECTS
Basic GPS Theory	3 ECTS
Digital Signal Processing Algorithms	3 ECTS
Matlab Programming (Free Study Activity)	3 ECTS
Academic English	2 ECTS
Course Project	10 ECTS

Table 4: SSAU, Semester A: Algorithms and Software

Introduction to Aerospace Navigation	3 ECTS
Introduction to Flight Dynamics	3 ECTS
Discrete-Time Kalman Filtering	3 ECTS
Reference Frames, Datum, and Geoid	3 ECTS
English (Presenting Research)	3 ECTS
Matlab Programming (Free Study Activity)	3 ECTS
Course Project	15 ECTS

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Table 5: SSAU, Semester B: Algorithms and Software

Optimal Planning of Navigation Measurements	2 ECTS
GPS Modules and Application in Aircraft and Spacecraft	3 ECTS
Position Computations	3 ECTS
Introduction to Inertial Navigation and Integration with GNSS	3 ECTS
Course Project	20 ECTS

Table 6: SSAU, Semester A: Receivers: Hardware/Software

Radio Navigation Theory and Radars	4 ECTS
Design and Applications with FPGA	4 ECTS
Receiver Technology (SDR)	3 ECTS
Reference Frames, Datum, and Geoid	3 ECTS
Basics of Nanoelectronics	4 ECTS
English (Presenting Research)	3 ECTS
Course Project	10 ECTS

Table 7: SSAU, Semester B: Receivers: Hardware/Software

Optical Methods in Navigation	2 ECTS
Algorithms of Acquisition and Tracking	3 ECTS
Altium Designer and PCB Development	3 ECTS
GPS Modules and Application in Aircraft and Spacecraft	3 ECTS
DSP Processors and Hardware	3 ECTS
Position Computations	3 ECTS
Analog and Digital Electronics	3 ECTS
Course Project	10 ECTS

Education provides a good part of research activity for students of both programs with regard to the requirements of Russian standards. Formally this activity is concentrated in course projects, provided in all semesters. These course projects are individual and their goal is to provide a practical skill of research and autonomous work for every student. These course projects are to be made during the whole semester under regular supervision of dedicated professors.

Both programs are English spoken and supposed to be offered to the students from different countries, having different level of language skill, so the course of English is essential to obtain skills in written academic language and a capability to present results of research in oral.

The last semesters are dedicated to the preparation of master theses. Due to several agreements with university-partners, students have a chance to work within research groups in Europe and USA. This approach seems to be essential in our century in order to have different levels of experiences in research and practical engineering.