EK2370 Build your own Radar System, Project Course 7.5 credits

Bygg ditt eget radarsystem, projektkurs

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for EK2370 valid from Autumn 2018

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Electrical Engineering

Specific prerequisites

The course level is adapted to students enrolled in an engineering master programme at KTH. A PhD student version of the course is offered under a separate course code.

The students must have basic knowledge in electrical engineering, engineering physics, or an equivalent basic education. It is recommended that the students have some knowledge in basic electromagnetics. Practical experience with programming using engineering tools, such as Matlab, is advantageous.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The objective of this course is to provide an introduction to radar systems, both hardware and software, and radar signal processing by building and testing a radar system capable of measuring range, radial velocity and forming synthetic aperture radar (SAR) images. During the course, the student will implement a radar front end using of the shelf components along with the implementation using a fully functional state-of-the-art software-defined radio system. Furthermore, the course develops the student's ability toapply radio frequency (RF) circuits, antennas, analog circuits, signal processing and basic electromagnetics. Upon successfully completing the course, the student will be able to:

- understand and design the block diagram of radar front-ends for different real-world applications.
- use radars to measure range with time of flight and radial velocity with Doppler shift.
- understand the functioning of synthetic aperture radar (SAR) and the use of the radar to take SAR images.
- perform signal processing of received radar signals to extract the required information.
- understand the functioning of the basic RF components in a radar front end, including low noise amplifier (LNA), mixer, power amplifier (PA), power divider/combiner, oscillator, attenuator, modulator, isolator/circulator and antenna.
- understand the terms used in RF circuit, antenna and waveguide designs.
- implement the radar front-end using a state-of-the-art software defined radio (SDR) system.
- use GNU Radio and Matlab for simulation and real-time SDR radar or communication system.
- characterize RF components using state-of-the-art measurement equipment, including a Vector Network Analyzer.
- write a project report.
- present and defend the results to a critical audience.
- work in a small team, including taking management responsibility from project plan writing to work distribution and task assignment to the team members.
- optional: design and implement 3-D printed antennas for radar applications.

Course contents

This is a project course worth 7.5 ECTS credits, which is equivalent to 200 work hours of full-time study. As the course runs about 8 weeks, this implies that about 25 hours a week must be devoted to the various course activities, including introductory lectures and reading

of course material, together comprising about 20% of the course activities, and carrying out the project work, which comprises 80% of the course work.

The introductory lectures on fundamentals of radar, antennas, modular radar design and SAR imaging will be taught by the course responsible. The course includes a guest lecture by the head of the Radar Systems Department of FOI (Swedish Defence Research Agency). Attendance of the introductory lectures is compulsory. The learning progress during the lecture part is monitored by online quizzes. During the project work, weekly progress review meetings are carried out with the assigned teacher.

The project work is supervised by senior researchers, assisted by PhD students and the course responsible.

The course completes with the final project report writing and the final presentation to a critical audience.

Disposition

The course consists of initial lectures for providing basic knowledge (20% of course) followed by supervised project work in small teams (3 to 4 people) as the main task (80%).

Course literature

Essential reading material will be distributed during the course.

PDF versions of the introductory lecture slides, including video tutorials and lectures, will be made available before the lectures through KTH's Canvas learning management system, and it is required to read this material before the respective lectures.

For deepening the background knowledge to the course, the following source books may be consulted:

- Merrill I Skolnik, Introduction to Radar Systems, McGraw-Hill, 3rd edition (December 20, 2002), ISBN-10: 0072881380, ISBN-13: 978-0072881387.
- Mark A. Richards, Fundamentals of Radar Signal Processing, McGraw-Hill, 2nd edition (January 14, 2014), ISBN-10: 0071798323, ISBN-13: 978-0071798327.
- Bassem R. Mahafza, Radar Systems Analysis and Design Using MATLAB, Wiley, 3rd edition (May 20, 2013), ISBN-10: 1439884951, ISBN-13: 978-1439884959

Examination

- PRO1 - Project, 7.5 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Other requirements for final grade

The student’s final grade in the course will be based on

- attendance of the introductory lectures (pass/fail criteria)
- passing of the learning-assessment quizzes
- project work: overall evaluation of the project work of the project team as a whole, including the project report and the final project presentation to a critical audience. Individual adjustments within the group might be done. Criteria for the evaluation of project work, report, and presentation are stated on the course webpages before the course start.

The course is worth 7.5 ECTS points; grading will be on a scale from A to F, with A being the highest mark and E being the lowest mark for passing the course, and F being a failing mark.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.