

TTK 4190 Guidance and Control of Vehicles

The course is given both Spring and Fall 2014, and then only in the Fall semester

Lectures Spring 2014: Tuesday 08:15-11:00 (Room: EL1)

Assignment guidance: Thursday 16:15-18:00 (Room: F2)

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NTNU students, please use It's learning for communication and educational materials.

Description: Methods for design and implementation of guidance, navigation, and control (GNC) systems for ships, semi-submersibles, underwater vehicles, aircraft and unmanned vehicles (AUV and UAV). This includes simulation and testing of motion control systems during failure situations and for varying environmental loads. This covers 6-DOF mathematical modeling of vehicles and the environment (waves, ocean currents and wind). Emphasis is placed on kinematics (Euler angles and unit quaternions), rigid-body kinetics, hydrostatics, hydrodynamics, aerodynamics and vectorial mechanics. Applied control theory and synthesis in terms of linear-quadratic optimal control and state estimation (Kalman filtering), nonlinear observer theory, MIMO PID control with extensions to nonlinear systems, Lyapunov methods, sliding-mode control, feedback linearization, backstepping designs, passivity, and observer-based feedback. Observers for integration of global navigation satellite systems (GNSS) and inertial measurements (gyros and accelerometers), observer-based feedback, and observers for global navigation satellite systems (GNSS) and inertial measurement units.

Mandatory Text:

Fossen, T. I. (2011). »*Handbook of Marine Craft Hydrodynamics and Motion Control*«. John Wiley & Sons Ltd.

Fossen, T. I. (2013). »*Mathematical Models for Control of Aircraft and Satellites*«. Department of Engineering Cybernetics, April 2013.

- [Lecture notes](http://www.itk.ntnu.no/faq/gnc/Wiley/slides.html) (<http://www.itk.ntnu.no/faq/gnc/Wiley/slides.html>)
- [Errata](http://www.itk.ntnu.no/faq/gnc/Wiley/errata.pdf) (<http://www.itk.ntnu.no/faq/gnc/Wiley/errata.pdf>) for the «Handbook of Marine Craft Hydrodynamics and Motion Control»
- [Literature](http://www.itk.ntnu.no/faq/gnc/pensum.htm) (<http://www.itk.ntnu.no/faq/gnc/pensum.htm>)
- [Exams with solution sets](http://www.itk.ntnu.no/faq/gnc/exams.html) (<http://www.itk.ntnu.no/faq/gnc/exams.html>)
- [Matlab and Simulink scripts](http://www.itk.ntnu.no/faq/gnc/matlab.htm) (<http://www.itk.ntnu.no/faq/gnc/matlab.htm>)
- MSS toolbox at www.marinecontrol.org (<http://www.marinecontrol.org>)

Prerequisites: [TTK 4105 Control Engineering](http://www.ntnu.edu/studies/courses/TTK4105#tab=omEmnet) (<http://www.ntnu.edu/studies/courses/TTK4105#tab=omEmnet>). It is recommended to have some background on Lyapunov stability theory (for instance Ch. 4 in *Nonlinear Systems* by Hassan K. Khalil, Prentice Hall, 2002 or [TTK 4150 Nonlinear Control Systems](http://www.itk.ntnu.no/faq/TTK4150/) (<http://www.itk.ntnu.no/faq/TTK4150/>) or similar.

Assignments: The assignments are mandatory. Details are given on *Itslearning*. Note that the assignments count for 30 % of the grade while the final exam counts for 70 % of the grade.

The problems sets are not mandatory. Solutions to these will be made available after the lecture.

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