

## Estimation Theory

Course number: 430.714  
Time: M/W 9:30-10:45AM  
Location: Building 301 Room 104

Instructor: Prof. Songhwai Oh (오성희)  
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Course description: This course introduces classical and modern topics in estimation theory to graduate level students. Topics include minimum variance unbiased estimators, the Cramer-Rao bound, linear models, sufficient statistics, best linear unbiased estimators, maximum likelihood estimators, least squares, exponential family, multivariate Gaussian distribution, Bayes risk, minimum mean square error (MMSE), maximum a posteriori (MAP), linear MMSE, sequential linear MMSE, Bayesian filtering, Kalman filters, extended Kalman filters, unscented Kalman filters, particle filters, data association, multi-target tracking, and Gaussian process regression. Lectures will be in English.

Textbooks: There is no required textbook for this course. Recommended textbooks will be announced later.

Grading: Quiz or homework (30%), midterm (30%), and final (40%). Note that the percentages are approximate and the actual weights used to compute the final grades may be different.

Prerequisites: A solid background in probability and linear algebra.

Academic honesty: Same as the academic integrity policy of the university and the school.

Weekly plan (subject to change):

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|---------|--|
| Week 1  | Review of probability and linear system theory                             |
| Week 2  | Minimum variance unbiased estimators, Cramer-Rao lower bound               |
| Week 3  | Linear models  |
| Week 4  | Sufficient statistics, Best linear unbiased estimators, Maximum likelihood |
| Week 5  | Least squares, exponential family  |
| Week 6  | Bayesian approaches, Multivariate Gaussian distribution                    |
| Week 7  | Bayes risk, Minimum mean square error (MMSE), Maximum a posteriori (MAP)   |
| Week 8  | Linear MMSE and sequential linear MMSE                                     |
| Week 9  | Bayesian filtering   |
| Week 10 | Kalman filter, Information filter  |
| Week 11 | Smoothing  |
| Week 12 | Extended Kalman filter   |
| Week 13 | Unscented Kalman filter, Particle filter                                   |
| Week 14 | Data association and multi-target tracking                                 |
| Week 15 | Gaussian process regression  |