

Winter 2022 Estimation Theory & Applications ELEE 5810

Introduction to Estimation Theory with Applications in Signal Processing and Robotics

Instructor: Nart Shawash. Office E 202c. ✉ shawasnm@udmercy.edu
http://shawasnm.faculty.udmercy.edu/ELEE5810_W22.html

Class Time: **19:15-20:30**, Monday and Wednesday.
Office Hours: **13:00-13:50**, Monday and Wednesday.

Catalog description of the course: An introduction estimation theory in general, which includes: Minimum Variance Unbiased Estimation, Cramer-Rao bounds, Linear Models, General MVU Estimation and BLUE. Applications to estimation in probabilistic robotics is studied and cover a range of topics such as Bayes filters in general for recursive state estimation, Kalman filters, robot kinematics, robot perception, and Mobile Robot Localization including Particle Filters. In addition, applications to signal processing are presented. Examples include topics such as further applications of Kalman filters and adaptive filters: RLS and LMS, with applications to system identification, tracking, and communication channel equalization.

Prerequisites: ELEE 5620 Random Variables and Random Processes
(Minimum Grade of C, May not be taken concurrently)

Textbooks: FUNDAMENTALS OF STATISTICAL SIGNAL PROCESSING, ESTIMATION THEORY VOL 1 by Steven M. Kay Prentice Hall, ISBN 978-0-133-45711-7. Chapters 1–6.

PROBABILISTIC ROBOTICS by Sebastian Thrun, Wolfram Burgard and Dieter Fox MIT Press, ISBN 978-0-262-20162-9. Chapters 2, 3, 5, 6, 7, 8.

Grading: The final grade of the course is determined by the following percentages
Quizzes and HW: 30%
Computer Projects: 40%
Final Project: 30%

The Alphabetical grade is determined by the following schedule

A	92%-100%	B-	80%-81.9%	D+	68%-69.9%
A-	90%-91.9%	C+	78%-79.9%	D	60%-67.9%
B+	88%-89.9%	C	72%-77.9%	F	0%-59.9%
B	82%-87.9%	C-	70%-71.9%		

Important Dates: Last day to drop class without “W” grade: January 16
Last day to withdraw with “W” grade: March 30

Comp. Assgnts.: MATLAB will be used to implement the algorithms discussed in class.
GNU Octave is an open source alternative to MATLAB.

Late turn in: Every assignment will be at least a week due after the announcement.
You are highly encouraged to ask for help if needed during office hours.
No assignments turned in past due date will be accepted.

Topics & objective: The class begins with first 6 chapters of S. M. Kay, mainly an introduction to the problem of estimation in general. These include *Minimum Variance Unbiased Estimation*, *Cramer-Rao bounds*, *Linear Models*, *General MVU Estimation* and *BLUE*. Then we address applications to signal processing. These will include material from books by T. K. Moon & W. C. Sterling, and Haykin's "Adaptive Filters", including further applications of Kalman filters, and adaptive filters: *RLS* and *LMS*, with applications to system identification, tracking, and if time permits, communication channel equalization (aka inverse modeling). Next application to estimation in probabilistic robotics is studied from the book of Thrun et al. Here we turn to Bayes filters in general for *recursive state estimation*, followed by Kalman filters, then *robot kinematics*, *robot perception*, followed by *Mobile Robot Localization* including *Particle Filters*.

Syllabus

Week of	sections		Week of	sections	
January 10	FIR & IIR	Ch2-3 Kay	March 7	Mid-Winter/Spring Break	
January 17	MLK day,	Ch3 Kay	March 14	Ch5 Thr,	Ch5 Thr
January 24	Ch4 Kay,	Ch4 Kay	March 22	Ch6 Thr,	Ch6 Thr
January 31	Ch5 Kay,	Ch5 Kay	March 29	Ch7 Thr,	Ch7 Thr
February 7	Ch6 Kay,	Ch6 Kay	April 5	Ch7 Thr,	Ch8 Thr
February 14	Ch2 Thr,	Ch2 Thr	April 12	Ch8 Thr,	RLS
February 21	Ch3 Thr,	Ch3 Thr	April 19	RLS+LMS,	LMS
February 28	Ch3 Thr,	Ch5 Thr	April 26	Finals	

- Further guidelines related to this syllabus can be found [here](#).
- The tentative class timeline/schedule and the entire syllabus are “subject-to-change”.
- For the first two weeks of this semester this class will be meeting on Blackboard only. After January 24 the class is presumed to continue meeting on campus in person in room E 140.

ACADEMIC INTEGRITY

As members of an academic community engaged in the pursuit of truth and with a special concern for values, University of Detroit Mercy students must conform to the highest standard of honesty and integrity in their academic work. The fundamental assumption under which the University operates is that work submitted by a student is a product of their own efforts. Among the most serious academic offenses is plagiarism, submitting the ideas or work of another source without acknowledgment or documentation. The consequences of plagiarism or any act of academic dishonesty may range from failure in a course to dismissal from the university.

MISSED EXAM or QUIZ POLICY

In cases of university-authorized absences:

1. University-Authorized Absences for University-Sponsored Activities

Absences from classes are authorized for students who represent the university, either as individuals or as members of teams or groups. Students who will be absent for university-sponsored activities are responsible for communicating conflicts with their instructors at the **beginning of the semester** or as soon as conflicts arise.

2. University-Authorized Absences for Religious Observances

It is the policy of University of Detroit Mercy to respect the faith and religious obligations of each student. Students with exams or classes that conflict with their religious observances should notify their instructor at the **beginning of the semester**.

3. University-Authorized Absences for Exigent Circumstances

In rare cases, the **Dean of Students** may authorize absences for individual students in exigent circumstances such as a medical concern or family crisis. In these cases, faculty will be informed by the Dean of Students. Students should communicate with instructors as soon as possible about a plan to make up missed work.

instructor shall provide students the opportunity to make up missed work without penalty up to 10% of the course meeting time, that is 4 lectures.

Source: https://udmercy.libguides.com/ld.php?content_id=62671772

Disability and Accessibility Support Services

If you require an accommodation due to a disability, pregnancy, emergency medical condition or need special arrangements in case of a building evacuation, please contact:

Laura Bagdady

Assistant Director Disability & Accessibility Support Services

Student Success Center Room 319, McNichols Campus Library

Email: bagdadlm@udmercy.edu

313-993-1158

It is very important for students to be proactive with regard to requesting their disability accommodations every semester. While it is never required that you disclose your disability to your professors, all students at Detroit Mercy are encouraged to talk with their professors to discuss their needs and concerns. However, you must be registered with Disability & Accessibility Support Services, and your faculty must receive official notification from their office before they can make arrangements for your accommodations.

Title IX:

Detroit Mercy encourages any student experiencing potential sexual harassment, sex or gender-based discrimination or sexual misconduct to contact Marjorie Lang, Title IX Coordinator, at 313-993-1802 or langma@udmercy.edu to obtain resource information and reporting options. Faculty are committed to supporting students and promoting a safe, respectful environment. Therefore, if a student shares information regarding potential sex or gender-based discrimination or misconduct with a faculty member, that faculty member will share this information with Title IX Coordinator Marjorie Lang, so that she can provide you with comprehensive information regarding your rights, options, and available resources. When sharing information with a faculty member or other employee of the University, you may choose to withhold identifying information until you have spoken to a confidential resource at the University. With the exception of the Wellness Center or School of Dentistry Office of Health & Wellness, all employees at the University are mandatory reporters. For additional information about policies, resources and reporting options, please visit udmercy.edu/titleix.

Title IX protections include assistance with pregnant and related parenting accommodations. Requests for such accommodations should be submitted with appropriate medical documentation to Laura Bagdady, Student Disability and Accessibility Support Services, bagdadlm@udmercy.edu. Questions or concerns regarding provision of medically necessary accommodations related to pregnancy or parenting may also be submitted to Marjorie Lang, Title IX Coordinator, at 313-993-1802 or langma@udmercy.edu.

Religious Observances Statement

It is the policy of the University of Detroit Mercy to respect the faith and religious obligations of each student. Students with exams and classes that conflict with their religious observances should notify their instructor at the beginning of the semester in order to work out a mutually agreeable alternative. Please note that, regardless of whether an absence is “excused” or “unexcused,” the student is responsible for all missed course content and activities.