# Kursanalys - KTH[1]

Formulär för kursansvarig.
Kursanalysen utförs under kursens gång.
Nomenklatur: F – föreläsning, Ö – övning, R – räknestuga, L – laboration, S – seminarium)

## KURSDATA Obligatorisk del [2]

**Kursens namn**
Applied Estimation
(Tillämpad estimering)

**Kursnummer**
EL2320 / FEL3320

**Kurspoäng och poäng fördelat på exam-former**
7,5hp

- TEN1 3,5hp
- PRO1 2hp (EKF)
- PRO2 2hp (PF)

**När kursen genomfördes**
3rd quarter 08/09

**Kursansvarig och övriga lärare**
Patric Jensfelt

**Undervisningstimmar, fördelat på F, Ö, R, L, S**
F: 24h, R: 8h

| | |
|---|---|
| **Antal registrerade studenter** | 24 |
| **Prestationsgrad efter 1:a examenstillfället, i %** | 93% |
| **Examinationsgrad efter 1:a examenstillfället, i %** | 71% |

## MÅL

**Ange övergripande målen för kursen**

The goal with this course is that the student should know the theory behind and be able to apply (through hands-on experience) the (Extended) Kalman Filter and Particle Filter to solve estimation problems. The student should also have a basic knowledge about other estimation methods such as the Unscented Kalman Filter (UKF), Rao-Blackwellized Particle Filter (RBPF) which are a commonly used estimation methods today. The ability to apply the estimation methods presented in the course will be tested with the labs and the project assignments and the theory will be tested with the exam and the project.

**Ange hur kursen är utformad för att uppfylla målen**

The course mixes lectures where the underlying theory and some tips regarding important considerations when applying this theory is introduced with labs/projects where the students get to apply the knowledge on concrete and realistic problems.

## Eventuellt deltagande i länkmöte före kursstart

[1] Instruktioner till kursanalysformulär sist i dokumentet
[2] Rektors beslut: http://www.kth.se/info/kth-handboken/II/12/1.html

| | |
|---|---|
| **Synpunkter från detta** | |

## Kursens pedagogiska utveckling I

**Beskriv de förändringar som gjorts sedan förra kursomgången. (Berätta även för studenterna vid kursstart)**

## Kontakt med studenterna under kursens gång

| **Studenter i årets kurs-nämnd:** | **Namn** | **E-post** (lämnas blank vid webbpublicering) |
|---|---|---|
| | **Soban Naderi** | **sobhannp@kth.se** |
| | **Hossein Azizpour** | **azizpour@kth.se** |

| | |
|---|---|
| **Resultat av formativ mittkursenkät** | |
| **Resultat av kursmöten** | |

## Kontakt med övriga lärare under kursens gång

**Kommentarer**

## Kursenkät; teknologernas synpunkter Obligatorisk del [3]

**Att komma ihåg:**
1) Uppmana, mha kursnämnden, till ifyllande av kursenkät i anslutning till / just efter slutexaminationen
2) Delge kursnämnden enkäten
3) Publicera enkäten under en kortare tid

| | |
|---|---|
| **Period, då enkäten var aktiv** | 2009-06-04 – 2009-07-01 |
| **Frågor, som adderades till standardfrågorna** | The entire course evaluation is attached |
| **Svarsfrekvens** | 14 out of 24 students answered |
| **Förändringar sedan förra genomförandet** | |
| **Helhetsintryck** | Overall rather positive response from the students |
| **Relevanta webb-länkar** | |

## Kursansvarigs tolkning av enkät

| | |
|---|---|
| **Positiva synpunkter** | The students seem to like the course quite well overall. |
| **Negativa synpunkter** | Some students did not like the discussions that I had with some of the more interested/outgoing students. They thought that it destroyed the lectures partly. This is very difficult because as a teacher one likes when students asks things and shows interest. |
| **Var kursen relevant i förhållande till kursmålen?** | yes |
| **Syn på förkunskaperna** | I think that overall students had enough prior knowledge |
| **Syn på undervisningsformen** | There was some students questioning the labs since not everyone did it and this meant that the session when these where discussed become to simple for the ones who had understood well and too difficult for those that had dne nothing to prepare. |

[3] Rektors beslut: http://www.kth.se/info/kth-handboken/II/12/1.html

| | |
|---|---|
| **Syn på kurslitt/kursmaterial** | The course book is a bit to big and covers a bit more than necessary but the interested students like it because it provides a lot of help with the projects |
| **Syn på examinationen** | The exam was considered a bit too simple by some. The projects were considered meaningful by almost everyone |
| **Speciellt intressanta kommentarer** | Make sure that everyone understands that the deadlines are strict and that it is bad to miss them. Missing some mechanism to ensure that both students helps with the project. |

## Synpunkter från övriga lärare efter avslutad kurs

| | |
|---|---|
| **Vad fungerade bra** | |
| **Vad fungerade mindre bra** | |

## Resultat av kursnämndsmöte efter examination

| | |
|---|---|
| **Studenternas sammanfattn.** | |
| **Förslag till förändringar** | 1) Much clearer about the deadlines. Make it clear what the penalty is for not meeting deadline<br>2) Not so clear what the course was about from the start<br>3) Be much more clear what you expect from the report. (Patric's comment: I want to know that the student has understood and not that it is a brilliant report from a language point of view). Make sure to make it more clear in the feedback what gave lower points and what was just suggestions.<br>4) Make the exam part of the grade. It was not so difficult, testing basic understanding.<br>5) Make sure that there is enough time to do the projects.<br>6) Try to use more examples from other fields so that you see that the tools are not localization specific.<br>7) Could make lab2 be the E-level for PRO1 and lab3 E-level for PRO2<br>8) Introduce more concenpts in the course, like MHT |
| **Länk till kursnämndsprot.** | |

## Kursansvarigs sammanfattande berättelse

| | |
|---|---|
| **Helhetsintryck** | The course went very well I thought expect for some students that did not hand in the projects on time. I am still too nice here and this means that students abuse it. |
| **Positiva synpunkter** | Students like the content of the course overall |
| **Negativa synpunkter** | The labs do not really work as intended as some students do not do them at all and then have problems with the projects that they would not otherwise have. |
| **Syn på förkunskaperna** | People mostly have what they needed but some would have benefited from some more probability theory. |
| **Syn på undervisningsformen** | Worked well, expect labs as mentioned above |
| **Syn på kurslitt/kursmaterial** | The book is still the best I can find on the topic although it is a bit too much robotics |

| | |
|---|---|
| **Syn på examinationen** | The exam needs to be taken into account into the grade. Some students did terrible on the exam but teamed up with a good student in the project and thereby managed to get a good grade. This is not fair. Also in some cases the students divided the work so that one person did one project and the other student the other. This is also completely wrong since each student will only learn half of what is needed. |

## Kursens pedagogiska utveckling II Obligatorisk del [4]

| | |
|---|---|
| **Hur förändringarna till denna kursomgång fungerade** | Two more lectures were added to give some more room for the material and have a chance to go through the labs |
| **Förändringar som bör göras inför nästa kursomgång** | The labs should be made mandatory and it is a good suggestion from the students to make them the E level for he projects.<br>The exam should be made to count towards the grade.<br>Make sure to have time to go through all the topics that was planned for.<br>Invite guest lectures so that the students get to see that the stuff they learn in the course is useful |

## Övrigt

**Kommentarer**

[4] Rektors beslut: http://www.kth.se/info/kth-handboken/II/12/1.html

# EL2320 Applied Estimation

## Results from the course evaluation

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### Some questions to answer

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1. What is your overall impression of the course?

    1. 64% (9 st) Very good
    2. 36% (5 st) Good.
    3. 0% (0 st) OK.
    4. 0% (0 st) Not so good.
    5. 0% (0 st) Really bad.

2. Where the goals and content of the course clear from the start?

    1. 21% (3 st) Very good
    2. 50% (7 st) Good.
    3. 14% (2 st) OK.
    4. 7% (1 st) Not so good.
    5. 7% (1 st) Really bad.

3. Do you consider your theoretical background sifficient for the course?

    1. 86% (12 st) Yes
    2. 14% (2 st) No.

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4. What did you think about the lectures?

    1. 36% (5 st) Very good
    2. 50% (7 st) Good.
    3. 14% (2 st) OK.
    4. 0% (0 st) Not so good.
    5. 0% (0 st) Really bad.

5. How did you like going through lab2 and lab3 during the lectures?

    1. 14% (2 st) Very good
    2. 71% (10 st) Good.
    3. 7% (1 st) OK.
    4. 7% (1 st) Not so good.

5. 0% (0 st) Really bad.

Comments on the lectures:

*It is really helpful to discuss different approaches and different understandings about the labs.*
---
*The lectures spent on implementation of the labs could be more brief or quick.*
*The lectures were expressive enough about the content of the course but throughout the lectures I was always waiting for a much harder parts to emerge.*
---
*Couldn't unfortunately participate during those lectures*
---
*Since I have a weak background of coding and I don't know the filters before, it could be a good idea to go through the qustions and put the answers and code on line. So that I can review them later, or I'll gave no clue regarding the questions of the lab.*
---
*Nice that it was your own responsibility to understand the labs and no report had to be handed in.*
---
*Lab 3 helps a lot for me to finish the project 2.*
---
*The lectures were top notch! Patric is a good lecturer and this was obviously a topic he knew well and have had a great deal of experience working within. This, and the applied focus of the course, made attending the lectures worthwhile. Another plus is that Patric scanned his own handwritten lecture notes and made them availible on the web; an obvious thing to do that almost nobody else does. The only bad thing about the lectures were that Patric frequently allowed students to interupt him with long winded comments. These could have been handled during the breaks.*
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*Patric is a great teacher. He always stays on the subject, really knows what he's talking about and knows how to teach it in an intuitive way. So I have only good things to say about him, except for one point. There was one student who kept interrupting Patric with every pointless thought that popped up in his head. That made it impossible to follow what Patric was saying. It would have been much better if Patric had a private talk with him in the beginning. I am sure that many of the other students suffered from this as well.*
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*Lectures were more concentrated on doing the projects, especially writing some codes only, I think it could be better to give deeper insight of the concepts and then starting to coding.*
---
*Sometimes you got into discussions with individuals, which not always gave that much to the rest.*
---
*It was perfect as long as the significant guest lecturer was not dominating. I understand that the material is better conveyed when there is an interactive environment but this should not mean that we have to listen the "uneducated guesses" of one/a few particular students almost half of the time. This probably will not be the case for all terms that this course is to be given, but when it does, it might be better to ask the student to discuss such things after class, may be?*

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6. Would you say that you now know how to use a Kalman filter for a general problem?

    1. 57% (8 st) Yes.
    2. 43% (6 st) Maybe.
    3. 0% (0 st) Only if it is about localization.
    4. 0% (0 st) No.

    Comments:

    *Working with Jacobians and derivatives of a complex mathematical expression and extracting that useful information out of that was just exciting for me.*
    ---
    *I think some examples in control will make it better!*
    ---
    *I finally understood the concept of observability while working with the gyro. Patric also made a short proof that showed how you could solve an equation system with measurements and 'omega' for x0. I liked it a lot.*
    ---
    *It is not because of the lectures, because of two weeks that we devoted to do the EKF project. I mean, presenting at the lectures and taking notes were not sufficient. Of course, it is the way it should be.*
    ---
    *Would probably have some problems with time dependence.*

7. Would you say that you now know how to use a Particle filter for a general problem?

1. 50% (7 st) Yes.
2. 43% (6 st) Maybe.
3. 7% (1 st) Only if it is about localization.
4. 0% (0 st) No.

Comments:

*The idea with particle filtering was much simpler than kalman in my point of view. But still, it was interesting.*
---
*Would have been nice to maybe have done Kalman for localization and particle for another problem, to get a broader understanding.*
---
*Not only that but also when and when not to use it.*
---
*I think PF could be presented in this course better and could be devoted more time.*

---

8. An idea with the course was to illustrate some techniques in robotics in addition to estimation. How well do you think that this worked overall?

   1. 36% (5 st) Very well.
   2. 36% (5 st) Well.
   3. 21% (3 st) Ok.
   4. 0% (0 st) Not so well
   5. 0% (0 st) Not at all

   Comments on the robotics aspect of it:

   *If there is no strict reason for solving the same problem both with kalman and particle filtering, I would say it could be much more rewarding if a new problem were introduced in the particle filtering project.*
   ---
   *Can't pinpoint what "some techniques in robotics" refer to, but how to include estimation in robotic problems were illustrated well.*
   ---
   *A friend of mine always writes "More robots!" on these kind of evaluations (seriously, he does). For me, the number of robots where just fine. They are not an essential part of the course, and shouldn't be either.*
   ---
   *Ok, but not very good. May be it was a good idea to look at the other applications of these filters.*

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9. Did you buy the course book (Probabilistic Robotics)?

1. 57% (8 st) Yes.
2. 43% (6 st) No.

10. How much of the course book did you read?

    1. 7% (1 st) Did not buy it
    2. 0% (0 st) Nothing
    3. 43% (6 st) less than 20%
    4. 43% (6 st) 20-40%
    5. 7% (1 st) 40-60%
    6. 0% (0 st) More than 60%

    Comments on the book:

    *It is impossible to read an entire book in 2 months when one has 3 courses!*
    ---
    *The book is good but I have little time and just going through the book without other application is a waste of time in my opinion.*
    ---
    *Good book!*
    ---
    *It is a good book that cover all you need to know about the subject in order to pass (or excel in) the course. Comments about shortcommings of certain algorithms, as well as tables with pseudo-code were very usefull. Perhaps there are too much topics for one book. The piece on the KF by Welch and ? were better the one in Thrun etc. Another minus is that the proofs in Probabilistic Robotics are carried in a rather dull way (losts of normal distributions).*
    ---
    *Being from a computer science background a lot of the concepts which kalman filters were built on (control- and signal theory) was foreign to me. Reading the book however, cleared everything up for me.*
    ---
    *Consistent and well written, but time was tough to read more parts of it.*

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11. Do you think that the exam tested what was taught in the course?

    1. 43% (6 st) Very well.
    2. 50% (7 st) Well.
    3. 0% (0 st) Ok.
    4. 7% (1 st) Not so well.
    5. 0% (0 st) Really bad.

12. Do you think that you learned something from the exam?

    1. 21% (3 st) Yes, a lot.
    2. 79% (11 st) Yes, a bit.
    3. 0% (0 st) No, nothing.

13. How difficult did you find the exam?

    1. 0% (0 st) Very difficult.
    2. 14% (2 st) Difficult.
    3. 57% (8 st) Just right.
    4. 21% (3 st) Simple.
    5. 7% (1 st) Very simple.

    Comments on the exam:

    *It was really great. It should not be always the difficulity of the problems which asses one's knowledge about the field, but, since it is not possible to easily evaluate one's knowledge without hard questions, most of the lecturers either focus on the hard problems or lower their expectations! Patric managed to asses sutends' knowledge with a simple yet great exam.*
    ---
    *Good decision not to grade the exam. A course should not have to many graded parts and complicated rules for calculating their average (perhaps one could use some discrete state-space filter :) ?).*
    ---
    *Having been on almost every lecture the exam was not a problem. But If I hadn't been it would have been very difficult.*
    ---
    *I failed the first exam, since I could not read PF for the exam, but I felt that it is a bit hard, and it could be considered as a part of students score. However, the re-exam was milder.*
    ---
    *It was too simple for an exam that we had to get 25 out of 50 points. I would strongly suggest that it to be made harder or graded like a regular exam. Otherwise it should be passed by anyone that attended to the classes with no hassle.*

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14. What is your overall impression about the labs (not the projects)?

    1. 0% (0 st) Not sure
    2. 36% (5 st) Very good.
    3. 57% (8 st) Good.
    4. 7% (1 st) Ok.

5. 0% (0 st) Not so god.
6. 0% (0 st) Really bad.

15. How did you like lab1?

    1. 7% (1 st) Did not do it
    2. 21% (3 st) Very good.
    3. 57% (8 st) Good.
    4. 7% (1 st) Ok.
    5. 0% (0 st) Not so god.
    6. 0% (0 st) Really bad.

16. How did you like lab2?

    1. 7% (1 st) Did not do it
    2. 29% (4 st) Very good.
    3. 57% (8 st) Good.
    4. 7% (1 st) Ok.
    5. 0% (0 st) Not so god.
    6. 0% (0 st) Really bad.

17. How did you like lab3?

    1. 7% (1 st) Did not do it
    2. 43% (6 st) Very good.
    3. 29% (4 st) Good.
    4. 14% (2 st) Ok.
    5. 0% (0 st) Not so god.
    6. 0% (0 st) Really bad.

18. How much time did you spend on the labs in total?

    1. 7% (1 st) No time at all
    2. 14% (2 st) up to 4 hours
    3. 36% (5 st) 4-8 hours
    4. 29% (4 st) 8-12 hour
    5. 14% (2 st) 12+ hours

    Comments on the labs:

    *They really help to understand parts of the problems before one gets to the projects.*
    ---
    *Lab3 is really perfect. It helps a lot toe understand the reborn part of the particle fitler.*
    ---

*Good preps for the projects*
---
*First one was the most difficult. Took a while to understand what everything meant and how it was used. The question could have been formulated better (this goes for all labs).*

*I do not like the try and observe technique used to evaluate KF parameter choice. Better to use a criteria that could be measured quantitatively.*
---
*Before starting projects we had to read the labs carefully in order to be given an idea about how to start the project.*
---
*Make it mandatory to hand in reports*

---

19. What is your overall impression about the project assignments?

    1. 71% (10 st) Very good.
    2. 29% (4 st) Good.
    3. 0% (0 st) Ok.
    4. 0% (0 st) Not so god.
    5. 0% (0 st) Really bad.

20. How did you like project1 (EKF)?

    1. 57% (8 st) Very good.
    2. 43% (6 st) Good.
    3. 0% (0 st) Ok.
    4. 0% (0 st) Not so god.
    5. 0% (0 st) Really bad.

21. How much time did you spend on project 1?

    1. 0% (0 st) up to 8 hours
    2. 14% (2 st) 9-15 hours
    3. 14% (2 st) 16-24 hours
    4. 71% (10 st) 24+ hours

    Comments on project 1:

    *Grading can be improved a little.*
    ---
    *The SLAM is really good but make my easter holiday a living hell... :)*

    *My suggestion is maybe we can have some help session?*
    ---

*Very good. The file that explain different settings should be more verbose. I never understood the one that sets the robots turning radius for example.*
---
*You kidding!! I think no one could do that project in less than one week.*

22. How did you like project 2 (Particle filter)?

    1. 71% (10 st) Very good.
    2. 21% (3 st) Good.
    3. 7% (1 st) Ok.
    4. 0% (0 st) Not so god.
    5. 0% (0 st) Really bad.

23. How much time did you spend on project 2?

    1. 7% (1 st) up to 8 hours
    2. 7% (1 st) 9-15 hours
    3. 14% (2 st) 16-24 hours
    4. 71% (10 st) 24+ hours

    Comments on project 2:

    *I think this course deserves more credits. I spent a lot of time on it...*
    ---
    *Good. Went smoother than the first, since we already knew the robots dynamics, runlocalization.m etc.*
    ---
    *It took us like 2 weeks full time.*

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24. Things that were good about the course:

    *Getting in depth practical knowledge about KF and PF.*
    ---
    *Focus of attention was always on two of the mostly known and widely used estimation methods namely EKF and particle filtering.*
    ---
    *One of the best lecture series I have attended. Very easy to follow, and thought through. Impressive! Both projects also felt relevant and interesting.*
    ---
    *Now I have a good understanding of the two filters.*
    ---
    *One of the more interesting courses I've read during my time at KTH. Good teacher.*

---
*The labs and projects are good.*
---
*The focus on applying the (E)KF and PF to different problems.*
---
*Patric*
*The content*
---
*Content of the course was very useful. I think it should be a mandatory course for all the technical students.*
---
*The grading with the projects was fair and well balanced. It was very nice that we received detailed comments to our reports.*

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25. Things that should be improved:

    *I think it is better to have something like "help" sessions planned before the end of the course. Maybe 3 sessions will be enough and maybe those 3 sessions can save lots of time specially for students' not having sufficient background about the course.*
    ---
    *There could be more subjects included in the course.*
    *Even these two basic topics (EKF and particle filtering) were rewarding enough to be truly thought about during the course but, from the beginning of the course I was always waiting for more amount of theoretical issues to be brought into question.*
    ---
    *The EKF-project included too many obstacles due to (apart from own mistakes) errors in the book and the "Dummies" document, also errors not included in the errata. This could be corrected to next round*
    ---
    *Tutorial sessions should be exciting!*
    ---
    *Maybe make the course "broader", so that it does not only deal with localization.*
    ---
    *The exam is a little bit difficult...*
    ---
    *It took Patric a long while to grade the reports. Still, he did give comments, which is nice.*
    ---
    *- Not letting students like Marin take up more then 5% of the lecture times (as opposed to maybe 50-60% at times).*

*- This course should be mandatory for anyone studying "Autonoma system" at Datateknik. It is very useful.*

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*sometimes your lectures are not clear. you take some basic knowledge for granted, I mean you don't explain some basic concept from the start and you think people know about it. Bu maybe just some in class know! For example about particle filter when I was doing the project I found the basic concept not in lectures. I didn't even undrestand it in class!!!*

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*Projects: They can be about other things than localization.*

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*The projects could be done on an individual basis or there could be some other control to check how both partners contributed to the work. And *at the beginning of the course* it could be made clear that the deadlines are hard, and not like in scientific programming.*

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