

UiO : **Institutt for teknologisystemer**
Det matematisk-naturvitenskapelige fakultet

Cybernetics courses and Msc thesis

Paal Engelstad

Professor, Section leader



According to the agenda...

- **Welcome and overview of ITS**
By Cecilie Rolstad Denby, Department leader
- **Practical info (common)**
By Kaja Elisabeth Mosserud-Haavardsholm, Study leader
and Ida Elisabeth Rydning, Study advicer
- **Cybernetics courses and MSc thesis (Cybernetics-students only)**
By Paal Engelstad, Prof., Section leader Autonomous Systems and Sensor Techn.
and Jonas Moen, Ass. Prof. ITS & Senior Researcher FFI
- **Lunch and social**

Basic structure of the Master programme

- 2 «studieretninger»:
 - Robotikk og intelligente systemer (IFI – Blindern)
 - **Kybernetikk og autonome systemer** (ITS – Kjeller)
- 120 credits in total over 4 semesters (2 years)
 - Long master: 60 credits in courses + 60 credits in thesis work
 - Short master: 90 credits in courses + 30 credits in thesis work
- One course typically gives 10 credits
- You are given flexibility to structure your study as you wish (examples follow)
- Teaching in Norwegian unless there are any specific demand for English
 - Important to learn Norwegian now if wanting to have a good chance to work in Norway later!

Basic examples

- Short master example

4. semester	Master thesis	Master thesis	Master thesis
3. semester	Master course	Master course	Master course
2. semester	Master course	Master course	Master course
1. semester	Master course	Master course	Master course
	10 credits	10 credits	10 credits

Overwhelmingly the most popular choice among students

- Especially those from «Ingeniørhøyskole» (about 90%). They have also experience with «prosjektoppgave». Recommended.
- Learning-oriented and industry-oriented

- Long master example

4. semester	Master thesis	Master thesis	Master thesis
3. semester	Master thesis	Master thesis	Master thesis
2. semester	Master course	Master course	Master course
1. semester	Master course	Master course	Master course
	10 credits	10 credits	10 credits

Attractive for research-oriented students

- e.g. those planning to do a PhD later
- research-oriented study

Example the long thesis work starts earlier

- Long master example (This «1 – 2 – 3» model is recommended)

4. semester	Master thesis	Master thesis	Master thesis	<- No courses last semester
3. semester	Master thesis	Master thesis	Master course	<- Flexible
2. semester	Master thesis	Master course	Master course	
1. semester	Master course	Master course	Master course	
	10 credits	10 credits	10 credits	

- **Students with long master need to start very soon to find a master thesis topic and a supervisor**
- Selecting long master vs short, depends on:
 - Your interests (research-oriented vs learning-/industry-oriented)
 - Your ability to work independently for a long time with progression
 - The availability of long vs short thesis topics (supervisors)
 - Most short MSc master topics can be extended into a long one, and many long ones can be reduced into a short one. Just ask the supervisor proposing the topic, if it can be adjusted.

The structure provides a lot of flexibility

- Overall Flexibility
 - In courses and thesis topics
 - Full-time vs Part-time
 - Selecting between **long vs. short master**
 - Short master: flexibility in courses. Long master: Flexibility in when to start thesis work
- Students may take single courses at IFI, MAT or FYS
- Make a plan now as soon as possible, because it is possible to change plans later
- Possible directions
 - Cybernetics
 - Autonomous systems
 - Renewable energy

The courses allows for a solid theoretical basis

- A strong ‘theoretical’ basis is instrumental to better appreciate more applied subjects
 - Fundamental courses have many “proofs”, that are a basis for other courses. Gives a solid theoretical basis useful for students with many courses (short MSc thesis).
- Basis for further learning in a future job
- No mandatory courses, however everyone is **recommended** to attend:
 - **TEK 4040 Mathematical modeling (Fall) – Lecturer: Anders Rødningby**
 - **TEK 4050 Stochastic systems (Spring) – Lecturer: Kjetil Berg Ånonsen**

The «traditional» choice (**recommendation**)

- *A baseline to start with, or if you do not have a strong idea what to choose*

- Long master example

4. semester	Master thesis	Master thesis	Master thesis
3. semester	Master thesis	Master thesis	Master course
2. semester	Master thesis	Master course	TEK 4050
1. semester	Master course	Master course	TEK 4040
	10 credits	10 credits	10 credits

<- No courses last semester. Full-time study.

<- Flexible

Stochastic systems (recommended)

Mathematical modelling (recommended)

- Short master example

4. semester	Master thesis	Master thesis	Master thesis
3. semester	Master course	Master course	Master course
2. semester	Master course	Master course	TEK 4050
1. semester	Master course	Master course	TEK 4040
	10 credits	10 credits	10 credits

<- Fixed last semester - 17 weeks (or 18 weeks in Spring term due to Easter)

<- **Note, only one spring semester for courses**

You need to plan carefully if courses are in the spring or in the fall. You need twice as many fall courses

The «traditional» choice (**recommendation** and **popularity**)

- A baseline to start with, or if you do not have a strong idea what to choose

• Long master example

4. semester	Master thesis	Master thesis	Master thesis	<- No courses last semester
3. semester	Master thesis	Master thesis	Master course	<- Flexible
2. semester	Master thesis	TEK 5030	TEK 4050	Computer vision Pattern recognition
1. semester	Master course	TEK 5020	TEK 4040	Stochastic systems (recommended) Mathematical modelling (recommended)
	10 credits	10 credits	10 credits	

• Short master example

4. semester	Master thesis	Master thesis	Master thesis	<- Fixed last semester - 17 weeks (or 18 weeks in Spring term due to Easter)
3. semester	Master course	Master course	Master course	
2. semester	Master course	TEK 5030	TEK 4050	<- Note, only one spring semester for courses
1. semester	Master course	TEK 5020	TEK 4040	
	10 credits	10 credits	10 credits	

Popular & useful choice

Example 1 - long master – of a student in recent years with interests towards machine learning:

4. semester	Master thesis	Master thesis	Master thesis	
3. semester	Master thesis	Master thesis	IFI course	
2. semester	Master thesis	TEK 5030	TEK 4050	Stochastic systems (recommended)
1. semester	TEK 5040	TEK 5020	TEK 4040	Mathematical modelling (recommended)
	10 credits	10 credits	10 credits	

Computer vision

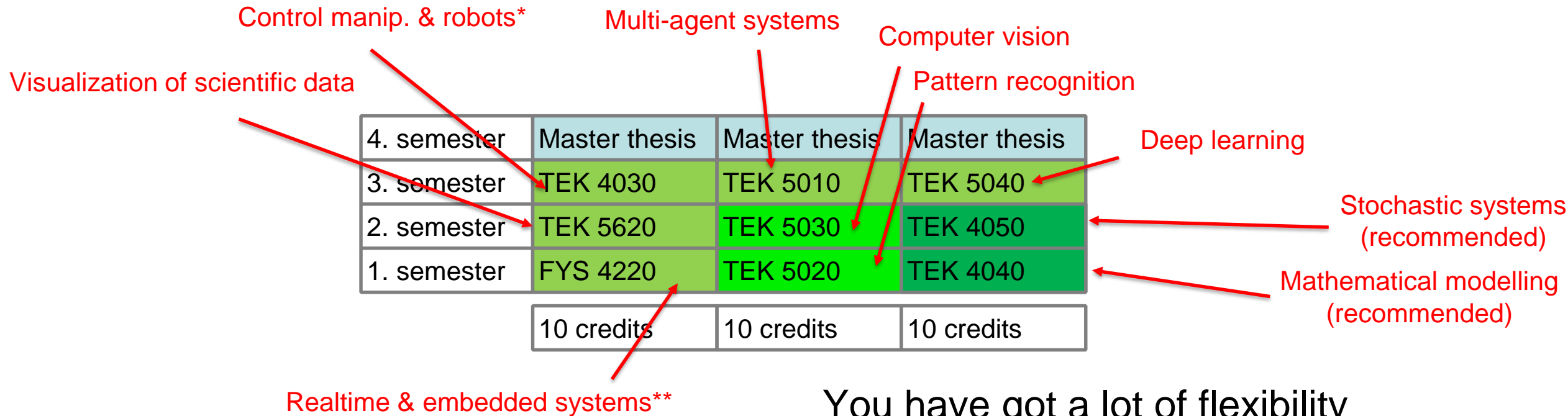
Pattern recognition

Deep learning

Stochastic systems (recommended)

Mathematical modelling (recommended)

Example 2 – short master – of another student in recent years



You have got a lot of flexibility

- Many "TEK"-courses here at ITS
- Many other courses at other departments

*) Ideally, TEK 4030 Styring av manipulatorer og mobile roboter would be taken in 3. semester.

***) FYS4220 Sanntids og embedded datasystemer is very useful course, because usually many of you will spend a lot of time with realtime programming. Furthermore, this course is very useful to do in first semester, but it is challenging to enlist to the course within the **deadline of 19 august !!!**.

Example 2 – short master – of another student in recent years

4. semester	Master thesis	Master thesis	Master thesis
3. semester	TEK 4030	TEK 5010	TEK 5040
2. semester	TEK 5620	TEK 5030	TEK 4050
1. semester	FYS 4220	TEK 5020	TEK 4040
	10 credits	10 credits	10 credits

Control manip. & robots* Multi-agent systems Computer vision

Visualization of scientific data Pattern recognition Deep learning

Stochastic systems (recommended)

Mathematical modelling (recommended)

Realtime & embedded systems**
Note deadline!
Register today!

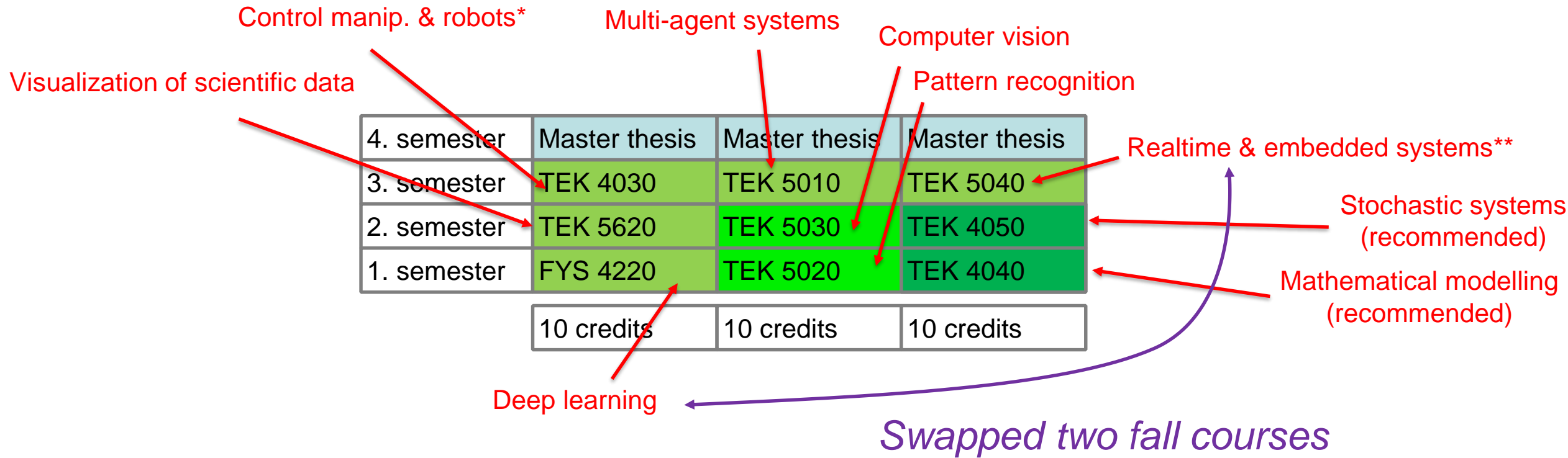
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Example 3 – short master



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How to go ahead if you have not yet a clear plan?

- First, select between long and short master
 - Long:
 - Need to start finding supervisor and topic early
 - MSc topic usually chosen at end of 1st semester (term)
 - Choice of courses is much easier (only 6 courses to chose)
 - Short:
 - Need to focus mainly on the courses now (9 courses to chose from)
 - MSc topic usually chosen at end of 3rd semester, but good to know topic earlier, so that the courses can be selected in a way that supports the planned topic
- Start course selection process ... (next slide)

Advice for selection of courses

- What are your personal interests and preferences?
 - Heart: Which topics/directions attract your interests? Theory vs Practical? Etc.
 - Head: Where would you like to work after MSc study and later?
- You may start with some of the examples provided (e.g. Example 2 in a previous slide)
 - Which courses in the examples would you like to replace?
 - Be aware of whether the course is given in Fall or Spring!
 - Only one spring-semester! Spring courses must be selected carefully.
- Check the prerequisites of a course and possible overlap with other you want to attend.
- Discuss your plan with contact person / supervisor
- Later you should discuss your course choices with MSc supervisor, in case you need to apply to make changes to your plan
 - I.e. Your course choices for the first term (semester) are most important right now!

After having a first draft of courses selected.

- Discuss your plan with contact person / supervisor
- The course plan should be approved by 1. desember by supervisor / faculty contact person at ITS.
- Later you should discuss your course choices with MSc supervisor, when the topic of the MSc thesis is decided
 - You may want to apply to make changes to your course plan later to fit it better with the MSc topic. The application needs support/approval by supervisor/contact person.
 - Thus, your course choices for the first term (semester) are most important right now!
 - And also getting a clearer idea of your preferred MSc thesis topic /direction

Example 2 – short master – of another student in recent years

4. semester	Master thesis	Master thesis	Master thesis
3. semester	TEK 4030	TEK 5010	TEK 5040
2. semester	TEK 5030	TEK 5620	TEK 4050
1. semester	TEK 5020	FYS 4220	TEK 4040
	10 credits	10 credits	10 credits

Visualization of scientific data

Multi-agent systems

Deep learning

Control manip. & robots*

Computer vision

Pattern recognition

Realtime & embedded systems**

You have got a lot of flexibility

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- Many other courses at other departments

*) Ideally, TEK 4030 Styring av manipulatorer og mobile roboter would be taken in 3. semester.

***) FYS4220 Sanntids og embedded datasystemer is very useful course, because usually many of you will spend a lot of time with realtime programming. Furthermore, this course is very useful to do in first semester, but it is challenging to enlist to the course within the **deadline of 15 august !!!**.

Autonomous systems

Relevant for robot applications, navigation, autonomous systems, machine learning and research

- Kontroll
 - TEK4030 – Styling av manipulatorer og mobile roboter, (Fall)
 - TEK5010 – Multiagent-systemer, (Fall)
- Mønster og billedbehandling
 - TEK5020 – Mønstergjenkjenning, (Fall)
 - TEK5150 – Radar - systemer og signalbehandling, (Fall)
 - TEK5030 – Maskinsyn **(Spring)**
- Dyp Læring
 - TEK5040 – Dyp læring for autonome systemer, (Fall)
- Annet
 - TEK5600 – Visualisering av vitenskapelige data **(Spring)**
- Some complimentary and useful courses from other departments:
 - IN5490 – Advanced Topics in Artificial Intelligence for Intelligent Systems (Fall)
 - IN5520 – Digital bildeanalyse, (Fall)
 - IN4050 – Introduksjon til kunstig intelligens og maskinlæring, (Spring)
 - IN4140 – Introduksjon til robotikk, (Spring)

Be aware of the distinction between Deterministic- and Stochastic- related topics/courses:

- *Stochastic: Pattern recognition (Bayes Theorem), radar and signal processing (noise), machine vision (noise in images), deep learning (statistics)*
- *Deterministic: Matematisal modellering of dynamic systems*

To increasing your industrial focus, you may consider also

- From ITS
 - TEK5510 – Sikkerhet i operativsystemer og programvare, (Fall)
 - TEK5520 – Cybersikkerhet i industrielle systemer, (Fall)
 - TEK5530 – Målbar sikkerhet for tingenes internett, (Spring)
- From other departments
 - FYS4220 – Sanntids og embedded datasystemer, (Fall)
 - INF4411 – Analog mikroelektronikk, (Fall)
 - INF4470 – Digital signalbehandling, (Fall)
 - INF4480 – Digital signalbehandling II, (Spring)
 - FYS4240 – Datainnsamling og kontroll, (Spring)
 - FYS4260 – Mikrosystemer og elektronikk byggemetoder, (Spring)

Also relevant for robot applications, navigation, autonomous systems, machine learning and research

Renewable energy systems and environmental surveillance

- Renewable energy
 - TEK5300 – Renewable Energy: science and technology, (Fall)
 - TEK5340 – Energisystemanalyse: Modellering, metoder og scenarioer **(Spring)**
 - TEK5330 – Solenergisystemer (videreført), **(Spring)**
 - TEK5350 – Energy Markets and Regulation, (Fall)
 - TEK5370 – Grid, Smartgrid and IoT, (Fall)
- Sensors
 - TEK5050 – Avbildning og deteksjon av optisk og infrarød stråling **(Spring)**
 - TEK5160 – Fjernmåling med radar **(Spring)**
- Some complimentary and useful courses from other departments:
 - MENA3200 - Energimaterialer, (Fall)

Possible MSc thesis topics

- Talk to ITS people to discover their research directions
- Note difference between internal and external supervisor
- Be aware of the ongoing research at FFI and IFE
 - Many researchers there are very eager to supervise MSc topics
 - ITS have many adjunct/parttime employees affiliated with FFI and IFE. Just ask!
- Plan ahead
- Some possible directions
 - Optimal motion planning for autonomous systems (robots/drones/vehicles)
 - Control of renewable energy systems: wind turbines, storage, PV plants
 - Cyber-physical security
 - Communication and control in cyber physical systems
 - Optimization of sensor networks
 - Deep learning for situation awareness (e.g. image analysis)

Some thesis titles in previous years

- **Master students 2017-2019**
 - Modelling and Control of a Vertical Take-Of and Landing Fixed-Wing Unmanned Aerial Vehicle
 - Plastic Bottle Cap Detection – Utilizing Artificial Intelligence
 - Image-based terrain characterization for autonomous vehicles, based on Deep Learning
 - Mikrofonmatrise integrert med treghetsnavigasjonssystem
 - Acoustic Recognition with Deep Learning – Experimenting with Data Augmentation and Neural Networks
 - Cybersecurity in cyber-physical systems – Digital Substations
 - Energy Efficient Determinisme in WSN through Reverse Packet Elimination
 - Idle Listening Reduction Mechanism for Overprovisioned Cells in 6TiSCH Tracks
 - Active Queue Management for window based applications in Named Data Networking

Typical deadlines (double-check for this year)

- 19 August:
 - Registration for taking courses in Student Web, i.e. not for the TEK-xxxx courses, but for all your other courses given this fall at FYS, IFI, MAT, etc., (Possible to sign off later.
 - **E.g. if you would like to attend FYS 4220 in the first term, you need to register by 15 August!**
- 1. September:
 - Registration to attend course and exam
 - i.e. your TEK-courses for the fall should be decided
 - Payment of student fee
 - Exceptions for exam
 - Tentative plan
- 1. Desember
 - Final plan for the entire study – 4 terms (can be changed later upon application and support by supervisor/contact person)
 - Signing of Master agreement

Overview of the section for Autonomous Systems and Sensor Technologies

- Full-time faculty staff («faglige ansatte»):



Paal Engelstad
Professor 100%
Section Leader
(10% FFI, 10% OsloMet)

Communication,
security and applied
machine learning



Svein-Erik Hamran
Professor 100%
(20% FFI)

Radar and related
applications



Øivind Kure
Professor 100%
Education Leader
(20% FFI)

Communication
and security



Torbjørn Skauli
Professor 80%
(40% FFI)

Electrooptical
sensors, physics
and electronics



Jonas Moen
Ass. Prof. xx%

Cybernetics,
Multi-agent systems



Kim Mathiassen
Ass. Prof. 20%

Robotics, Auton.
Systems, AI, ...

Overview of part-time/adjunct staff (Most of these are eager to supervise)

Four Prof II (mostly 20%)

1. Nilsen Leif (Sikkerhet, Thales – erstattes)
2. Orten Pål (Kommunik., Kongsberg Maritim)
3. Bråten Lars Erling (Kommunikasjon, FFI)
4. Lie-Svendsen Øystein (Radar, FFI, 15%)

Eight Univ.lecturers (most 10%)

1. Dyrdal Idar (Autonomi/m.syn, FFI, 20%)
2. Sørby Trond Arne (sikkerhet, FFI, 15%)
3. Lehne Per Hjalmar (Kommunik., Telenor)
4. Kaosher Abul (Kommunikasjon, Nokia S.)
5. Solberg Eilif (Autonomi, FFI)
6. Bloebaum Trude Hafsøe (Tj.Ark, FFI)
7. Opsahl Thomas Olsvik (Auton./m.syn, FFI)
8. Haavardsholm Trym V. (Auton/m.syn, FFI)

+ many PhD candidates

20 stk Ass./Acc. Prof II (10-20%)

1. Nordbotten Nils Agne (Sikkerhet, Thales, 20%)
2. Mathiassen Kim (Kybernetikk, FFI, 20%)
3. Landmark Lars (Kommunikasjon., FFI, 20%)
4. Ulversøy Tore (Kommunikasjon, FFI, 20%)
5. Moen Hans Jonas Fossum (Autonomi, FFI, 20%)
6. Ånonsen Kjetil Bergh (Kybernetikk, FFI, 20%)
7. Rødningsby Anders (Autonomi nav/gps FFI; 20%)
8. Kálmán György Tamas (Sikkerhet DnB, 20%)
9. Larsen Erlend (Kommunikasjon, FFI, 20%)
10. Tjelta Terje (Kommunikasjon, Tidl. Telenor, 20%)
11. Gregersen Thomas (Sikkerhet, NSM, 20%)
12. Helgeland Anders (Visualisering, FFI, 20%)
13. Bruvoll Solveig (Sikkerhet, FFI, 15%)
14. Johnsen Frank Trethan (Tj.Ark, FFI, 10%)
15. Torvik Børge (Radar, FFI, 10%)
16. Hannay Jo Erskine (Data Science/AR, NR, 10%)
17. Rossebø Judith Ellen Y (Sikkerhet, ABB, 10%)
18. Chowdhury Mohammad M. R. (Sikkerh., ABB, 10%)
19. Warakagoda Narada Dilp (Autonomi, FFI, 10%)
20. Audun Stolpe (Data Science, FFI, 10%?)

Full-time affiliation:

- FFI : 21 employees
- Thales : 2 employees
- Telenor : 2 employees
- ABB : 2 employees
- Kongsberg Maritime : 1 employees
- NSM : 1 employees
- DnB : 1 employees
- NR : 1 employees
- Nokia Siemens : 1 employees
- IFE : 0 employees

Work % at ITS

- 20% : 16 employees
- 15% : 3 employees
- 10% : 13 employees

Areas of interests

- Sikkerhet : 8 employees
- Kommunikasjon : 8 employees
- Autonomy : 7 employees
- Data Science (DS) : 1 employees
- Radar : 2 employees
- Tjenestearkitektur : 2 employees
- Kybernetikk : 2 employees
- Visualisering : 1 employees
- Sim. og modellering : 1 employees