Cybernetics courses and Msc thesis

Paal Engelstad
Professor, Section leader
According to the agenda...

• Welcome and overview of ITS
  By Stian Løvold, Department leader

• Cybernetics courses and MSc thesis
  By Paal Engelstad, Prof., Section leader Autonomous Systems and Sensor Techn.

• Practical info (later)
  By Ida Elisabeth Rydning, Study advicer
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

<table>
<thead>
<tr>
<th>Semester</th>
<th>Master thesis</th>
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</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>10</td>
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</tr>
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</table>

Overwhelmingly the most popular choice among students
- Especially those from «Ingeniørhøyskole» (about 90%). They have also experience with «projektoppgave». Recommended.
- Learning-oriented and industry-oriented

### Long master example

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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)

<table>
<thead>
<tr>
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<tr>
<td></td>
<td>10 credits</td>
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<- No courses last semester
<- Flexible

• Then you 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 scaled down 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
  - 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**

- **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 Rødningsby
  - 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**

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</tr>
<tr>
<td>1.</td>
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<td>Master course</td>
<td>TEK 4040</td>
</tr>
</tbody>
</table>

10 credits 10 credits 10 credits

<- No courses last semester
<- Flexible

Stochastic systems (recommended)
Mathematical modelling (recommended)

**Short master example**

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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
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

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course 1</th>
<th>Course 2</th>
<th>Course 3</th>
</tr>
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</tr>
<tr>
<td>2. semester</td>
<td>Master thesis</td>
<td><strong>TEK 5030</strong></td>
<td><strong>TEK 4050</strong></td>
</tr>
<tr>
<td>1. semester</td>
<td>Master course</td>
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- No courses last semester
- Flexible

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

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- 10 credits

**Computer vision**

**Deep learning**

**Pattern recognition**

**Stochastic systems (recommended)**

**Mathematical modelling (recommended)**
Example 2 – short master – of another student in recent years

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</tr>
<tr>
<td>2. semester</td>
<td>TEK 5620</td>
<td>TEK 5030</td>
<td>TEK 4050</td>
</tr>
<tr>
<td>1. semester</td>
<td>FYS 4220</td>
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<td>TEK 4040</td>
</tr>
<tr>
<td></td>
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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 15 august !!!.
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?
  – 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. december 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

<table>
<thead>
<tr>
<th>1. semester</th>
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<th>3. semester</th>
<th>4. semester</th>
</tr>
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Visualization of scientific data
Multi-agent systems
Deep learning
Control manip. & robots*
Computer vision
Pattern recognition
Realtime & embedded systems**

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Realtime & embedded systems**
Relevant for robot applications, navigation, autonomous systems, machine learning and research

- **Kontroll**
  - TEK4030 – Styring 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: Mathematical modelling 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 Markeds 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)

• 15 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. December
  – 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
LIDAR
AutonoWeather

Svein-Erik Hamran
Professor 100%
Radar and related
applications
CENSSS

Øivind Kure
Professor 100%
Education Leader
(20% FFI)
Communion and security

Torbjørn Skauli
Professor 80%
Electrooptical
sensors, physics
and electronics
CENSSS

N.N.
Professor 100%
Cybernetics

General direction: Focus on technology, high TRL-level, system and application

Refert to introductory presentation by Dept leader Stian Løvold
Overview of parttime/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 Hafse (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. Helgelund Anders (Visualisering, FFI, 20%)
13. Bruvoll Solveig (Sikkerhet, FFI, 15%)
14. Johnsen Frank Trehan (Tj.Ark, FFI, 10%)
15. Torvik Børge (Radar, FFI, 10%)
16. Hannay Jo Erskine (Data Science/AR, NR, 10%)
17. Rossebo Judith Ellen Y (Sikkerhet, ABB, 10%)
18. Chowdhury Mohammad M. R. (Sikkerhet, 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