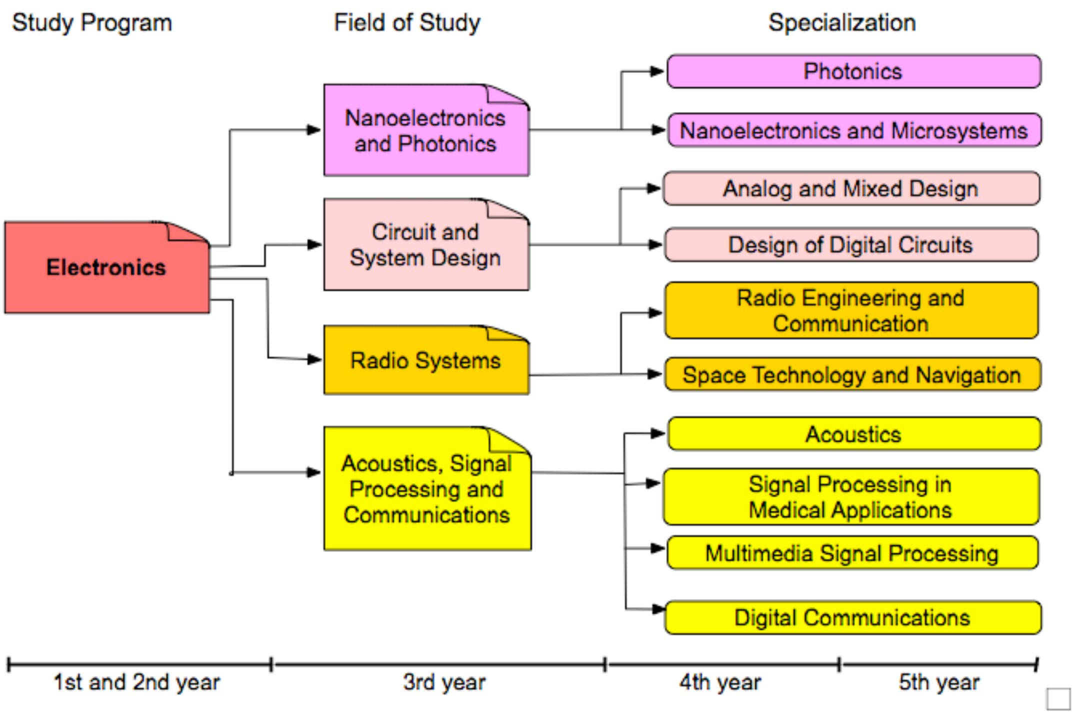
Self-Evaluation Report for the Master Program in Electronics
Januar 2007

Goals and Structure

The Master Program in Electronics gives a broad and profound theoretical and practical knowledge of analysis, construction, production and application of components and systems based on electronic, electromagnetic, acoustic and optical principles. Furthermore, it offers a thorough introduction to signal processing, information theory and communication theory. This knowledge is applied to a broad spectrum of areas, with emphasis on telecommunications, medical technology, multimedia signal processing, sensor systems, environmental surveillance, oil exploration and navigation.

The total duration of the study program is five years. Each year is devided into two semesters. The first two years are mainly devoted to general courses in mathematics, physics, computer science and circuit theory that make important basis for the rest of the studies. The program is organized in four fields of study and ten specializations as shown in the following figure. In the 9th semester students perform a larger project within the field of specialization, while the last semester is entirely devoted to a master thesis.



Nanoelectronics and Photonics
The field of study offers a broad and profound theoretical and practical knowledge of analysis, construction, production and application of components and systems based on electronic, electromagnetic, acoustic and optical principles. Important topics are MEMS/NEMS, nanoelectronics, micro/nano-optoelectronics, semiconductor manufacturing technology, thin film technology, optical fibers, and photonic crystals. Applications include electronics, sensor systems, telecommunications, medicine, and spectroscopy.

Circuit and System Design
The field of study offers broad theoretical and practical skills in design, test and implementation of digital, analog and mixed analog/digital integrated circuits according to given specifications. This involves the ability to formulate, analyze and understand complex specifications at various abstraction levels, choose appropriate system architecture, and implement and test it using state-of the-art design tools.

Radio Systems
The field of study offers broad technological knowledge and skills in construction, operation and application of components and systems for services based on radio waves. Important topics are design of antennas, microwave circuits and components, and applications in communications and navigation systems, remote sensing and space technology.

Acoustics, Signal Processing and Communications
The field of study offers a broad and profound theoretical and practical knowledge of signal processing, information and communication theory, and acoustics. This knowledge is applied to a broad spectrum of areas such as telecommunications, sound- and image processing, medicine, object detection, noise control and industrial use of acoustics.

Detailed Exit Qualifications

1. *Broad and substantial knowledge of mathematics, physics and computer science. Capability to apply this knowledge at an advanced level to the study program disciplines.*
   1.1 **Mathematics:** calculus of functions of one and several variables, differential equations, calculus of vector-valued functions, vector calculus, complex analysis, Laplace transform, Fourier series and transform, vectors and analytic geometry, linear algebra, statistics, basic numerical analysis, mathematical induction
   1.2 **Physics:** mechanics, fluid mechanics, thermodynamics, electromagnetism
   1.3 **Computer science:** HTML**,** databases (SQL), basic programming (MATLAB), procedure and object oriented programming (C/C++), computer architecture

2. *Broad and profound scientific and technical knowledge of the study program disciplines, and skills to apply this knowledge effectively. In selected areas, the knowledge reaches the forefront of scientific or industrial research and development. The knowledge level makes a good basis for innovative contributions to the disciplines.*
   2.1 **Electric circuits:** linear resistive circuits, inductor and capacitor circuits, operational amplifiers, analysis in time and frequency domain, analysis using Laplace transform, passive and active filters, semiconductor components and circuits
   2.2 **Digital design:** number systems, arithmetic operations, coding, boolean algebra, logic gates, simplification methods, combinational logic circuits, sequential circuits, synchronous and asynchronous circuits, flip flops, counters, shift registers, memory elements, memory technology, state machines, arithmetic circuits and introduction to programmable logic
   2.3 **Information, communication and signal theory:** representation of analog and time-discrete signals and systems in time and frequency domain, sampling, digital coding of signals, filtering, information contents of signals, digital baseband transmission, channel capacity, analog and digital modulation techniques
   2.4 Specific for field of study Nanoelectronics and Photonics
      2.4.1 **Common basis**
         - Physics: wave physics, wave propagation, quantum mechanics, atomic physics, material science, solid-state materials and nanostructures
         - Semiconductor physics and electronic devices
         - Semiconductor manufacturing technology

2.4.2 **Specialization in Photonics**

Focus on the electromagnetic (including optical) and acoustic energy forms and their interaction with tissues, technical materials and structures. Design and realization of lasers, optical sensors, photonic systems and components, as well as their characterization and evaluation. Applications to telecommunications, medicine, spectroscopy and sensor systems. Important topics: optical fibers, photonic crystals, optical MEMS/NEMS, micro/nano-optoelectronics and integrated systems.

2.4.3 **Specialization in Nanoelectronics and Microsystems**

Broad technological basis in solid-state and semiconductor physics and nanoelectronics. Important topics: nanoelectronics, nano-optoelectronics, MEMS/NEMS, semiconductor manufacturing technology and thin film technology, with applications in electronics and sensor systems.

2.4.4 **Supporting topics:** linear mathematical methods, mechanics, material physics, biophysics, design of integrated circuits, microwave and high-speed components, radio systems, signal- and system theory, information theory

2.5 **Specific for field of study Circuit and System Design**

2.5.1 **Common basis**

- Design and simulation of integrated circuits
- Theory of signals and systems
- Wave propagation

2.5.2 **Specialization in Design of Digital Systems**

- Design languages such as VHDL and SystemC.
- Knowledge of implementation alternatives such as ASIC, FPGA, embedded HW/SW solutions, and platform based design.

2.5.3 **Specialization in Design of Analog and Mixed Systems**

Methods and technology for design of analog and mixed integrated circuits for different applications with focus on low-effect design. Examples: ASIC for MEMS, CMOS RF, D/A and A/D converters.

2.5.4 **Supporting topics:** numerical mathematics, discrete mathematics, algorithms and data structures, computer architecture, real-time systems, embedded systems, semiconductor manufacturing technology, semiconductor physics and electronic devices, electrooptics and lasers, components and systems based on electro-optic effects, MEMS-design, nanoelectronics, communication theory, wireless communications, multimedia signal processing, cryptography

2.6 **Specific for field of study Radio Systems**

2.6.1 **Common basis**

- Introduction to radio systems
- Propagation of radio waves
- Theory of signals and systems
- Theory of radio communications

2.6.2 **Specialization in Radio Engineering and Communication**

- Radio communications
- Microwave circuits and components
- Antenna engineering

2.6.3 **Specialization in Space Technology and Navigation**

- Navigation systems
- Space technology
- Remote sensing

2.6.4 **Supporting topics:** numerical mathematics, linear mathematical methods, algorithms and data structures, design of integrated circuits, semiconductor manufacturing technology, solid state materials and nanostructures, marine acoustics, mobile communication, astrophysics, atmospheric physics, geodesy

2.7 **Specific for field of study Acoustics, Signal Processing and Communications**

2.7.1 **Common basis**

- Physics: wave physics, quantum mechanics, atomic physics, material science
- Theory of signals and systems

2.7.2 **Specialization in Acoustics**

Knowledge of the theoretical basis for sound wave propagation in open and closed spaces and measurement techniques in acoustics. Specializations in audio and music technology, marine acoustics, environmental and building acoustics and numerical acoustics.

2.7.3 **Specialization in Multimedia Signal Processing**

Theory of signals and systems, communication theory and information theory and their application to multimedia signal processing. Principles for current standards in multimedia signal processing. Specialization in image, speech and audio processing.

2.7.4 **Specialization in Digital Communications**

Signal and system theory, communication theory and information theory and their application to wired and wireless communications. Principles for current standards in digital communication.

2.7.5 **Specialization in Signal Processing in Medical Applications**

Signal and system theory, communication theory and information theory and their use in medical applications. Specialization in medical imaging and patient confined sensor networks.

2.7.6 **Supporting topics:** numerical mathematics, linear mathematical methods, optimization theory, wave propagation, algorithms and data structures, computer networks and services, design of integrated circuits, radio systems, navigation systems, remote sensing

3. *Thorough knowledge of practical methods and tools within the study program disciplines and skills to actively apply them for analyzing, modeling, simulating, implementation and testing.*

3.1 **Common to all students**

- mathematical methods
- basic programming skills (Matlab, C/C++)
- use of common measuring instruments in electrical engineering
- implementation and measurements on electronic circuits
- common signal processing methods and tools
- basic skills in implementation of digital circuits, including use of software and HW-platforms for FGPAs and microcontrollers.

3.2 **Specific for field of study Nanoelectronics and Photonics**

- semiconductor manufacturing methods and tools
- methods and equipment for optical, electrical and structural characterization and testing of thin films, micro-/nanostructures, and components
- optical spectroscopy of biological materials

3.3 **Specific for field of study Circuit and System Design**

- methods for design, implementation, validation, verification and testing of digital, analog and mixed integrated circuits
- use of state-of-the-art computer-aided design tools

3.4 **Specific for field of study Radio systems**

- computer software for design of antennas and microwave circuits
- measurements for testing antennas and microwave circuits
- design and implementation of microwave passive components and integrated circuits
- methods for detecting objects using radar
- design and analysis of navigation systems and sub-systems

3.5 **Specific for field of study Acoustics, Signal Processing and Communications**

- implementation of signal processing algorithms on computers and microcontrollers

- modeling and simulating communicational channels
- multimedia software
- speech processing development tools
- measurement techniques in acoustics
- simulation tools for sound propagation in the atmosphere, in the ocean and the sea bottom
- design, analysis and use of sonar systems for target detection and classification
- performing human perception experiments
- tools for music analysis and synthesis (MIDI)

4. *Ability and skills to independently solve complex problems in a systematic way*
   - 4.1 Define the problem and divide it into logical and manageable parts
   - 4.2 Make a project plan and, if necessary, adapt it to the changing circumstances
   - 4.3 Identify the lacking knowledge and acquire it from literature or other experts
   - 4.4 Consider alternative solutions
   - 4.5 Apply theory, methods and tools to solve the problem parts

5. *Ability to work in (multidisciplinary) teams, interacting effectively with specialists and taking initiatives where necessary.*
   - 5.1 Set up and maintain a plan, delegate and coordinate tasks, negotiate and handle conflicts, recognize own strong and weak points and those of the others
   - 5.2 Participate in discussions in a constructive way, by justifying own arguments and respecting the others point of view

6. *Good communication skills in Norwegian and English*
   - *6.1* Communicate own work in a clear and understandable way both to professionals and general public
   - *6.2* Preparing well-structured presentations and reports that hold a good language quality
   - *6.3* Mastering the tools for scientific writing and presentation
   - 6.4 Participate in discussions in a constructive way

7. *Ability to identify, assess and evaluate ethical and social impact of own work*
   - 7.1 Recognize ethical issues related to the use of new technological solution
   - 7.2 Ability to assess technical and economical feasibility of a proposed engineering solution
   - 7.3 Ability to identify and assess the safety risks related to use of current and new technology

8. *Attitude and ability to independently maintain professional competence through life-long learning*
   - 8.1 Awareness of the (historical) development of the discipline, and consequently the necessity of life-long learning to maintain the desired knowledge level
   - 8.2 Understanding the need to establish and maintain contact with other professionals in the field, both nationally and internationally
   - 8.3 Knowledge of the main literature and publication channels in the field of study
   - 8.4 Ability to grasp new ideas from the scientific literature in the field of study
   - 8.5 Knowledge of methods and tools for information search, and ability to identify reliable information sources

Courses and Their Contribution to Exit Qualifications

The courses that consist the Master Program in Electronics are given by a number of different departments at NTNU. The general rule is that each course is given by the department having research competence in the corresponding field. The following table shows the relationship between course codes and the responsible departments.

Course code	**Department**
TFE, TTT	Department of Electronics and Telecommunications
TMA	Department of Mathematical Sciences
TFY, FY	Department of Physics
TDT	Department of Computer and Information Science
TTK	Department of Engineering Cybernetics
TTM	Department of Telematics
TET	Department of Power Engineering
TMT	Department of Materials Science and Engineering
TKT	Department of Structural Engineering
TIØ	Department of Industrial Economics and Technology Management
EXPH	Department of Philosophy

Each course gives 7.5 credits. The only exceptions are the project work in the 9th semester (15 credits) and the master thesis in the 10th semester (30 credits). Furthermore, the specialization courses in the 9th semester normally consist of two elective specialization topics, each counting 3.75 credits.
The normal workload per semester equals to 30 credits.

The following tables show the contribution of each course to the exit qualifications described in the previous section. Bold crosses (**x**) are used to mark strong contribution. The courses are divided into three groups:

1. Common courses for all students (includes all 1st and 2nd year courses)
2. Other ordinary courses (3rd and 4th year)
3. Specialization topics, project, and master thesis (5th year)

	Learning objectives for Master Program in Electronics											
	1. Fundamental disciplines			**2. Study program disciplines**			**3. Knowledge of practical methods and tools**	**4. Ability and skills to solve complex problems**	**5. Team work ability**	**6. Communication skills**	**7. Ethical and societal perspective**	**8. Maintaining professional competence**
Common courses	1.1 Mathematics	1.2 Physics	1.3 Computer science	2.1 Electric circuits	2.2 Digital design	2.3 Info., commun. and signal theory						
Technostart (2 week introduction program)								**x**	**x**	**x**		
EXPH0001 Philosophy and theory of science											x	
TMA4100 Calculus 1	**x**						x	x				
TMA4105 Calculus 2	**x**						x	x				
TMA4115 Calculus 3	**x**						x	x				
TMA4120 Calculus 4K	**x**						x	x				
TMA4245 Statistics	**x**						x	x				
TFY4115 Physics		**x**						x				
TFE4120 Electromagnetics		**x**						x				
TDT4105 Information technology, Introduction			**x**				x					
TDT4102 Object-oriented programming			x				x	x				
TFE4105 Digital design and computer fundamentals			**x**		**x**		**x**		x	x		
TFE4100 Electric circuits				**x**			x			x		
TFE4115 Advanced electronic systems				x			x			x	x	
TET4100 Circuit analysis				**x**								
TTT4100 Electronic circuits				**x**		x	x	x				
TTT4110 Information and signal theory			x			**x**	x	x				
Experts in team (multidisciplinary project)								**x**	**x**	**x**		
TIØ4256/7 Technology management 1											**x**	

Ordinary courses, 3rd and 4th year

Learning objectives for Master Program in Electronics

Ordinary courses, 3rd and 4th year	2. Study program disciplines: 2.4 Nanoelectronics and photonics				2.5 Circuit and system design				2.6 Radio systems				2.7 Acoustics, signal processing and communications						3. Knowledge of practical methods and tools	4. Ability and skills to solve complex problems	5. Team work ability	6. Communication skills	7. Ethical and societal perspective	8. Maintaining professional competence
	2.4.1 Common basis	2.4.2 Nanoelectronics and Microsys.	2.4.3 Photonics	2.4.4. Supporting topics	2.5.1 Common basis	2.5.2 Design of Digital Systems	2.5.3 Analog and Mixed Design	2.5.4. Supporting topics	2.6.1 Common basis	2.6.2 Space Techn. and Navigation	2.6.3 Radio Engin. and Commun.	2.6.4. Supporting topics	2.7.1 Common basis	2.7.2 Acoustics	2.7.3 Multimedia Signal Proc.	2.7.4 Digital Communications	2.7.5 Signal Pro. in Medical Appl.	2.7.6 Supporting topics						
FY2450 Astrophysics												x												
FY3020 Space technology 1										**x**	x													
FY3021 Space technology II										x														
FY3201 Atmospheric physics												x												
TDT4120 Algorithms and data structures								**x**				x						**x**	x					
TDT4260 Computer Architecture								**x**																
TFE4130 Electromagnetic and acoustic waves	**x**				x				**x**									**x**		x				
TFE4140 Modelling and analysis of digital systems						**x**													x	**x**	x	**x**		
TFE4145 Semiconductor physics and electronic devices,	**x**							x												x				x
TFE4151 Design of integrated circuits				**x**	**x**							**x**						**x**	x	**x**	x	**x**		
TFE4160 Electrooptics and lasers		x	**x**					x												x				x
TFE4165 Applied photonics		x	**x**					**x**												x				x
TFE4170 System-on-a-chip						**x**													x	**x**	x	**x**		
TFE4175 Realization and test of digital components						**x**													x	**x**	x	**x**		
TFE4180 Semiconductor manufacturing technology	**x**							**x**				**x**							**x**		x	x		
TFE4186 Analog CMOS 1		x					**x**					x												
TFE4191 Analog CMOS 2							**x**					x								**x**	x	**x**		
TFE4200 Analog integrated circuits		**x**	x				**x**					x												
TFE4210 Nanoelectronics		**x**	x					x																
TFE4215 Solid state materials and nanostructures	**x**											x								x				
TFE4225 MEMS-design		**x**	x				x												x					x
TFY4170 Physics 2	**x**							**x**				**x**	**x**							x				
TFY4195 Optics		x	**x**																	x				
TFY4200 Optics, advanced course			x																	x				
TFY4205 Quantum mechanics				**x**																x				
TFY4255 Materials physics		x																		x				
TFY4310 Molecular biophysics			x																					
TKT4116 Mechanics 1				x																				
TKT4126 Mechanics				x																				
TMA4140 Discrete mathematics								x											x					
TMA4145 Linear methods				x								x						x	x					
TMA4180 Optimization theory																		x	x					
TMA4215 Numerical mathematics								**x**				**x**						**x**	x					
TMT4245 Functional materials		x																						
TTK4105 Control systems				**x**	**x**				**x**									**x**	x					
TTK4145 Real-time programming								x											x					
TTK4147 Real-time systems								**x**																
TTK4155 Embedded systems								x																
TTK4160 Medical imaging															x		x							
TTK4165 Signal processing in medical imaging																	**x**							
TTM4100 Communication - services and networks																		**x**						
TTM4115 Engineering distributed real-time systems								x																
TTT4115 Communications								x	**x**					x	**x**	**x**	**x**							
TTT4120 Digital signal processing				**x**	x				x				**x**						x					
TTT4125 Information theory, coding and compression				x										x	**x**	**x**	**x**							
TTT4130 Digital communication								**x**			x					**x**	x							
TTT4135 Multimedia signal processing								x						x	**x**	x	x		x					
TTT4140 Fundamentals of navigations										**x**									x					
TTT4145 Radio communications								x		x	**x**					x								
TTT4150 Navigation systems										**x**				x					x					
TTT4155 Remote sensing										**x**				x		x			x					
TTT4160 Mobile communications								x				x				**x**								
TTT4170 Audio technology														**x**	x				x			**x**		
TTT4175 Marine Acoustics										x				**x**		x	**x**		x					
TTT4180 Technical acoustics														**x**					x					
TTT4185 Speech technology														x	**x**				x					
TTT4190 Music technology														**x**	x				x					
TTT4200 Introduction to radio systems				x					**x**							x	x		x					
TTT4205 Microwave and higspeed passive components		x									**x**								x					
TTT4210 Microwave integrated circuits											**x**								x	**x**	x			
TTT4215 Antenna engineering											**x**								x					
TTT4220 Satellite communications										x	**x**					x								
TTT4225 Applied signal processing												**x**	**x**						**x**	**x**				
TTT4230 Introduction to acoustics												x		**x**	x									

	Learning objectives for Master Program in Electronics																							
	2. Study program disciplines																							
	2.4 Nanoelectronics and photonics				2.5 Circuit and system design				2.6 Radio systems				2.7 Acoustics, signal processing and communications											
Specialization topics (3.75 credits), 5th year	2.4.1 Common basis	2.4.2 Nanoelectronics and Microsys.	2.4.3 Photonics	2.4.4. Supporting topics	2.5.1 Common basis	2.5.2 Design of Digital Systems	2.5.3 Analog and Mixed Design	2.5.4. Supporting topics	2.6.1 Common basis	2.6.2 Space Techn. and Navigation	2.6.3 Radio Engin. and Commun.	2.6.4. Supporting topics	2.7.1 Common basis	2.7.2 Acoustics	2.7.3 Multimedia Signal Proc.	2.7.4 Digital Communications	2.7.5 Signal Pro. in Medical Appl.	2.7.6 Supporting topics	**3. Knowledge of practical methods and tools**	**4. Ability and skills to solve complex problems**	**5. Team work ability**	**6. Communication skills**	**7. Ethical and societal perspective**	**8. Maintaining professional competence**
TFE01 Low-power digital design						x																		x
TFE02 HW/SW codesign of embedded systems						x																		x
TFE03 Self-test of digital systems						x																		x
TFE04 Dynamicly reconfigurable systems						x																		x
TFE05 High-level syntesis and verification						x																		x
TFE06 ASIC for MEMS		x					x																	x
TFE08 Data converters							x																	x
TFE09 Low-voltage/low-power analog integrated circuits							x																	x
TFE11 MEMS and MOEMS processing and components		x	x																					x
TFE12 Medical sensors		x	x																x					x
TFE13 Fiber components		x	x																x					x
TTT01 3D-sound and sound in multimedia applications														x	x									x
TTT02 Adaptive filters																x			x	x		x		x
TTT03 Acoustic remote sensing														x										x
TTT04 Antenna engineering											x													x
TTT05 Digital image communication															x	x								x
TTT07 Fusion of sensor data and advanced radar concepts										x														x
TTT09 Communication and coding theory																x								x
TTT11 Music and sensing														x										x
TTT12 Numerical acustics														x										x
TTT13 RF/microwave integrated circuits											x													x
TTT14 Passive microwave components											x													x
TTT15 Satellite communication										x	x													x
TTT16 Speech technology - selected topics															x									x
TTT17 Impact of sound														x										x
TTT23 Biomedical signal and image processing and communication																	x							x
TTT26 Radar										x														x
TTT29 Satellite navigation										x														x
TTK10 Signal processing methods in ultrasound image composition																	x							x
TTK11 Statistical signal processing in ultrasound image composition																	x							x
TTK12 Ultrasound transducers and front-end technology in ultrasound image composition																	x							x
TTK13 Medical instrumentation																	x							x
Project work (15 credits)		x	x			x	x			x	x			x	x	x	x		x	x		x		x
Master thesis (30 credits)		x	x			x	x			x	x			x	x	x	x		x	x		x		x

Academic Staff and Research

Most of the core courses in the Master Program in Electronics are given by the Department of Electronics and Telecommunications. The academic staff of the department consists of 25 full professors, 13 associate professors and 9 adjunct professors. In addition there are 10 postdoctoral fellows and close to 100 PhD candidates. A large number of the PhD candidates serve as teaching assistants.

The academic staff is organized into six research groups. The tables on the following two pages show an overview of the academic staff with their research areas, as well as the teaching staff for the courses offered by the department in 2006/07.

Department of Electronics and Telecommunications is distinguished by the amount of externally financed research activities and the number of PhD candidates. It also takes part in one of the Norwegian Centers of Excellence. This provides a firm bases for the research-based education, and offers an opportunity for the master candidates to work on the ongoing research projects.

The quality of the academic staff is further emphasized by several recent national and international awards. Two professors have been appointed as Young Outstanding Researchers by Research Council of Norway, a post doctoral fellow has been rewarded with Young Innovation Prize, while two other staff members have won prestigious international awards. Furthermore, the department staff members are frequently nominated as Lecturer of the Year at the Faculty of Information Technology, Mathematics and Electrical Engineering.

Several companies have been started by the former students and academic staff of the department. Some of them have gained international reputation for their products. Examples are Atmel Norway, Nordic Semiconductor, ARM Norge (Phalanx), Optoplan, Nacre, 3D Radar, New Index and Fast Search and Transfer.

Laboratory Facilities

The Department of Electronics and Telecommunications owns a large number of advanced laboratories that are used both for research and educational purposes. The existence of the laboratories is one of the main advantages of the electronics education offered by NTNU compared to other educational institution in Norway.

The laboratory facilities cover all research and educational areas. This includes:

- laboratories for film deposition of semiconductors and other materials (MBE, PLD, PECVD, Sputter deposition, e-beam evaporation) and for characterization (e.g. AFM, XRD, Hall, SEM, FTIR-PL, Auger, XPS)
- clean room with processing equipment and a microassembly laboratory
- laboratories for biomedical optics and fiber optics with a number of lasers and various equipment for spectroscopy
- acoustic hall with a number of special rooms for performing acoustical experiments as well as an echo-free room
- laboratories for multimedia processing (piano lab, MIDI lab, auralization and multimedia lab)
- indoor and outdoor facilities for antenna measurements
- circuit design laboratories

Academic staff at the Department of Electronics and Telecommunications	
Electrooptics Group	
Professor Helge Engan	Ultrasound and electrooptics
Professor Lars O. Svaasand	Electrooptics, biomedical technology
Professor Johannes Skaar	Electrooptics and photonics
Assoc. Professor Astrid A. Dyrseth	Photonics
Adjunct Professor Dag Roar Hjelme	Optical communication and sensor technology
Electronic Devices and Materials Group	
Professor Bjørn-Ove Fimland	Electronic materials technology
Professor Jostein Grepstad	Electronic material technology
Professor Arne Rønnekleiv	Analog signal processing, ultrasonic waves
Professor Thomas Tybell	Micro and nanotechnology
Professor Helge Weman	Nanoelectronics, nanophotonics and nanomagnetism
Adjunct Professor Ralph Bernstein	Silicon-based MEMS
Adjunct Professor Kjell Arne Ingebrigtsen	Medical technology
Circuit and System Design Group	
Professor Einar J. Aas	Electronic Circuit Design
Professor Trond Ytterdal	Microelectronics, Analog and Mixed Circuit Design
Professor Trond Sæther	Analog and Digital Circuits Design
Professor Tor A. Fjeldly	Semiconductor Technology
Professor Kjetil Svarstad	Sistem-Level Design of Embedded Systems
Assoc. Professor Per Gunnar Kjeldsberg	Design and Analysis of Embedded HW
Assoc. Professor Bjørn B. Larsen	Design of High-Performance Digital Systems
Assoc. Professor Ragnar Hergum	Analog Circuit Technology
Acustics Group	
Professor Peter Svensson	Audio Technology
Professor Ulf Kristiansen	Numerical Acoustics
Professor Hefeng Dong	Acoustical Remote Sensing
Professor Jens M. Hovem	Marine Acoustics
Associate Professor Jan Tro	Music Technology
Adjunct Professor Odd Kr. Pettersen	Environmental Acoustics
Adjunct Professor Åge Kristensen	Seismoacoustics
Adjunct Professor Arild Brekke	Building Acoustics
Radio Systems Group	
Professor Börje Forssell	Navigation
Professor Odd Gutteberg	Radio Systems/Satellite Communications
Professor Guennadi Kouzaev	High-Frequency Circuit Techn. and Microwave Techn.
Assoc. Professor Torbjörn Ekman	Radio Communications
Assoc. Professor Morten Olavsbråten	Microwave Integrated Circuits
Assoc. Professor Kjell Aamo	Radio Engineering/Radio Systems
Assoc. Professor Jon Anders Aas	Radio Engineering/Antennas
Adjunct Professor Jens Hjelmstad	Remote Sensing
Signal Processing Group	
Professor Tor A. Ramstad	Signal Processing
Professor Nils Holte	Digital Communications, Transmission Engineering
Professor Torbjørn Svendsen	Speech Processing
Professor Geir Øien	Information and Coding Theory
Professor Ralf Müller	Wireless Networks
Professor Andrew Perkis	Multimedia Signal Processing
Assoc. Professor Magne Hallstein Johnsen	Speech Processing
Assoc. Professor Lars Lundheim	Signal Processing in Radio Communications
Assoc. Professor Bojana Gajic	Speech Processing
Adjunct Professor Terje Røste	Mobile Communications
Adjunct Professor Ilangko Balasingham	Medical Signal Processing

Teaching Staff for Courses Offered by Department of Electronics and Telecommunications in 2006/07

Course	Name/Title	Function
TFE4100	Morten Olavsbråten, Assoc. Professor	Lecturer
	Bojana Gajic, Assoc. Professor	Lecturer
	Lars Løge, PhD student	Teaching Assistant
	Øystein Dahl, PhD student	Teaching Assistant
	23 MSc students	Student Assistants
TFE4105	Per Gunnar Kjeldsberg, Assoc. Professor	Lecturer
	Lasse Natvig, Professor	Lecturer
	Asghar Havashki, PhD student	Teaching Assistant
	4 MSc students	Student Assistants
TFE4110	Ragnar Hergum, Assoc. Profesor	Lecturer
	Bjørn B. Larsen, Assoc. Professor	Lecturer
	Hallvard Kringstad, MSc	Teaching Assistant
	12 MSc students	Student Assistants
TFE4115	Morten Olavsbråten, Assoc. Professor	Lecturer
	Bojana Gajic, Assoc. Professor	Lecturer
	Kjell Arne Ingebrigtsen, Professor	Lecturer
	Andrew Perkis, Professor	Lecturer
	Gunnar Stette, Professor	Lecturer
	Thomas Tybell, Professor	Lecturer
	Eivind Larsen, PhD student	Teaching Assistant
	Bertil Nistad, PhD student	Teaching Assistant
TFE4120	Johannes Skaar, Professor	Lecturer
	Lars Lydersen, PhD student	Teaching Assistant
	2 MSc students	Student Assistants
TFE4125	Lars O. Svaasand, Professor	Lecturer
	Andreas M. Winnem, PhD student	Teaching Assistant
	1 MSc students	Student Assistants
TFE4130	Helge E. Engan, Professor	Lecturer
	Ørnulf Nordseth, PhD student	Teaching Assistant
	2 MSc students	Student Assistants
TFE4140	Einar J. Aas, Professor	Lecturer
	Per Gunnar Kjeldsberg, Assoc. Professor	Lecturer
	1 MSc students	Student Assistants
TFE4145	Jostein Grepstad, Professor	Lecturer
	Chang Chuan You, PhD student	Teaching Assistant
TFE4151	Bjørn B. Larsen	Lecturer
	Jukka Tapio Typpö, Post doc.	Lecturer
	Qubo Hu, PhD Student	Teaching Assistant
	Linga Reddy Cenkeramaddi, PhD student	Teaching Assistant
	2 MSc students	Student Assistants
TFE4160	Astrid Aksnes, Assoc. Professor	Lecturer
	Hanne Martinussen, PhD student	Teaching Assistant
	Bertil Nistad, PhD student	Teaching Assistant
	1 MSc students	Student Assistants
TFE4165	Dag Roar Hjelme, Adjunct Professor	Lecturer
	Vegard Larsen Tuft	Teaching Assistant
	2 MSc students	Student Assistants
TFE4170	Kjetil Svarstad, Professor	Lecturer
	Saeeid Tamashbi Oskuii, PhD student	Teaching Assistant
TFE4175	Einar J. Aas, Professor	Lecturer
	Bjørn B. Larsen, Assoc. Professor	Lecturer
	2 MSc students	Student Assistants
TFE4180	Bjørn-Ove Fimland, Professor	Lecturer
	Tron Arne Nilsen	Teaching Assistant
TFE4186	Trond Ytterdal, Professor	Coordinator
	Tajeshwar Singh, PhD student	Lecturer
TFE4191	Trond Sæther, Professor	Lecturer
TFE4200	Regnar Hergum, Assoc. Professor	Coordinator
	Tajeshwar Singh, PhD student	Lecturer
TFE4210	Tomas Thybell, Professor	Lecturer
	Ørnulf Nordseth, PhD student	Teaching Assistant
TFE4215	Helge Weman, Professor	Lecturer
	Espen Eberg	Teaching Assistant
TFE4220	Thomas Tybell, Professor	Lecturer
	2 MSc students	Student Assistants

Course	Name/Title	Function
TTT4100	Morten Olavsbråten, Assoc. Professor	Lecturer
	Marius Ubostad, PhD student	Teaching Assistant
	Lars Løge, PhD student	Teaching Assistant
	8 MSc students	Student Assistants
TTT4110	Tor Ramstad, Professor	Lecturer
	Line Adde, PhD student	Teaching Assistant
	Alfonso Canterla, PhD student	Teaching Assistant
	8 MSc students	Student Assistants
TTT4115	Torbjørn Ekman, Assoc. Professor	Lecturer
	Pål Anders Flo, PhD student	Teaching Assistant
	Terje Nymoen, PhD student	Teaching Assistant
	4 MSc students	Students Assistants
TTT4120	Bojana Gajic, Assoc. Professor	Lecturer
	Trond Skogstad, PhD student	Teaching Assistant
	Andreas Egeberg, PhD student	Teaching Assistant
	6 MSc students	Student Assistants
TTT4125	Ralph Müller, Professor	Lecturer
	Vesna Gardasevic, PhD student	Teaching Assistant
	Chiangman Wang, PhD student	Teaching Assistant
TTT4130	Nils Holte, Professor	Lecturer
	Robert Bains, PhD student	Teaching Assistant
TTT4135	Andrew Perkis, Professor	Lecturer
	Pham Min Long, PhD student	Teaching Assistant
TTT4140	Børje Forssell, Professor	Lecturer
TTT4145	Torbjørn Ekman, Assoc. Professor	Lecturer
	Marius Ubostad, PhD student	Teaching Assistant
TTT4150	Børje Forssell, Professor	Lecturer
TTT4155	Jens Hjelmstad, Adjunct Professor	Lecturer
	Marius Ubostad, PhD student	Teaching Assistant
TTT4160	Geir Øien, Professor	Lecturer
	Sebastien de la Kethulle, PhD student	Teaching Assistant
	Chiangman Wang, PhD. student	Teaching Assistant
TTT4170	Peter Svensson, Professor	Lecturer
	Erik Hellerud, PhD student	Teaching Assistant
TTT4175	Hefeng Dong, Professor	Lecturer
	Joachim Hammer, 5th year MSc student	Teaching Assistant
TTT4180	Ulf R. Kristiansen, Professor	Lecturer
TTT4185	Torbjørn Svendsen, Professor	Lecturer
	Trond Skogstad, PhD. student	Teaching Assistant
	Andreas Egeberg, PhD. student	Teaching Assistant
TTT4190	Jan Tro, Assoc. Professor	Lecturer
	Audun Solvang, PhD student	Teaching Assistant
TTT4195	Jens Martin Hovem, Professor	Lecturer
TTT4200	Kjell Olav Aamo, Assoc. Professor	Lecturer
	Marius Ubostad, PhD student	Teaching Assistant
	2 MSc students	Student Assistamts
TTT4205	Guennadi Kouzaev, Professor	Lecturer
	Sergey Kapranov, PhD student	Teaching Assistant
TTT4210	Kjell Olav Aamo, Assoc. Professor	Lecturer
TTT4215	Jon Anders Aas, Assoc. Professor	Lecturer
TTT4220	Odd Gutteberg, Professor	Lecturer
TTT4225	Magne H. Johnsen, Assoc. Professor	Lecturer
	Pål Anders Flo, PhD student	Teaching Assistant
	Terje Nymoen, PhD student	Teaching Assistant
	Ingmund Bjørkan, PhD student	Teaching Assistant
	Dyre Meen, PhD student	Teaching Assistant
TTT4230	Ulf Kristiansen, Professor	Lecturer
	Børge Nygård, PhD student	Teaching Assistant

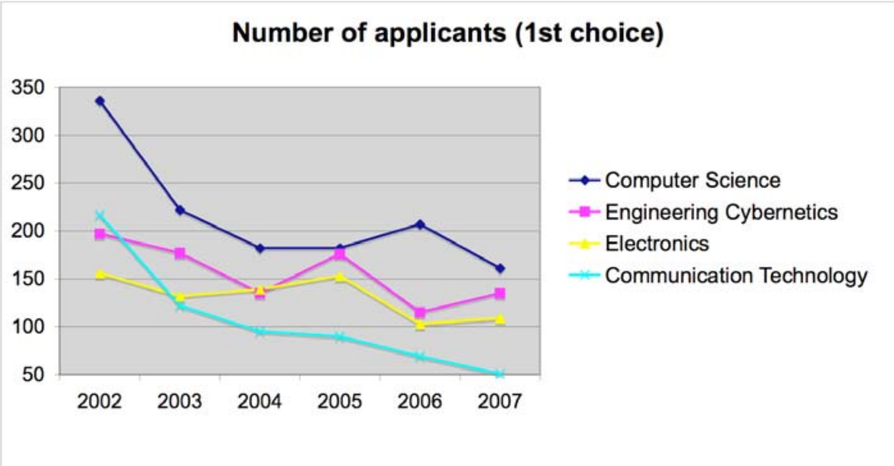
Statistics - Admission, Dropout Rate, Labor Market and Student Exchange

Admission quota

The admission quota for the Master Program in Electronics has varied between 80 and 85 for some years, but has been reduced to 70 and 75 in the last two years. In addition, there have been 15-25 study places available at the 2-year Master Program in Electronics. The statistics in this section is restricted to the 5-year master program.

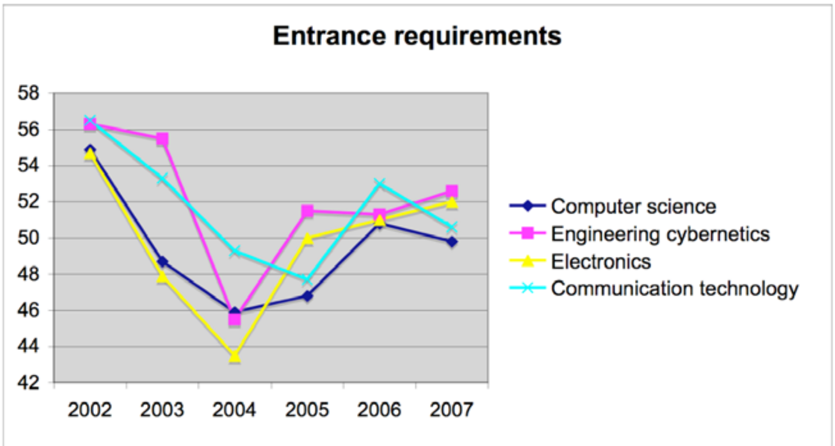
Number of applicants

The total number of applicants has been relatively stable, while the number of applicants that have electronics as their first choice has been strongly reduced in 2006 with only a slight increase in 2007 (see figure). On the other side, the total number of female applicants has increased by over 50% in 2007 compared to previous years. This increase is probably related to the Electronics and Cybernetic Day organized in March 2007, where female students from all Norwegian high schools were invited. (This also resulted in a 70% increase of female applicants at the Master Program in Engineering Cybernetics.)



Entrance requirements

In 2001 and 2002, the entrance requirements for the Master Program in Electronics have been higher than the average for all master programs in technology at NTNU. However, starting from 2003, the entrance requirements have been among the lowest, although there has been a slight increase for the last three years. The low entrance requirements has been a general trend for all ICT-related master programs at NTNU for the last three years.



Number of students admitted
The actual number of students admitted to the study program has varied between 68 in 2006 and 98 in 2004, without any clear tendency. However, the number of female students has had a clear increasing tendency from the bottom level in 2004, when only 2 female students were admitted. In 2007 the number has reached 8. This is important, since the study program has been among those with lowest percentage of female students at NTNU.

Dropout rate
The statistics over the dropout rate for the master programs in technology at NTNU is available starting from 2004. It shows that the dropout rate at the Master Program in Electronics has been 29%, 45% and 25% for the students commencing their studies in 2004, 2005 and 2006, respectively. Corresponding average rates for all master programs in technology at NTNU are 26%, 24% and 16%, respectively. This is a severe problem, and actions have already been taken to increase the motivation for studies in order to reverse the trend (e.g. motivation lectures by earlier students working in the industry, excursions, information meetings, separate study room for female students).

Labor market
The Department of Electronics and Telecommunications has performed two yearly surveys among the graduating students since 2005 in order to get an overview of the labor market for the candidates. The first yearly survey is performed in May/June, closely before the graduation, while the second one is performed in October/November, 4-5 months after the graduation.

The surveys show a clear improvement in the labor market for the last 3 years. While only 31% of the job applicants got a job by May/June 2005, the corresponding numbers were 60% and 80% for 2006 and 2007, respectively.

International Student Exchange
The number of students taking a part of their studies at universities abroad is varying strongly from year to year, with an average of 10 students per year. Most of the students take their 4th year of study abroad, but some also travel during their 3rd and 5th year. During the last 6 years the students have studied in 16 different countries, most commonly in Australia, USA and Spain.

Financial Issues

The reduced budget for NTNU generally, and particularly for the Department of Electronics and Telecommunications, several years in row represents a large threat for the quality of education. Furthermore, the income distribution model used at NTNU does not compensate for the expenses for managing the large number of advanced laboratories. These expenses are to a great extent independent of the fluctuations in the number of students. Long-term, predictable and sufficient financing is the only way to retain the good quality of education.

The Department of Electronics and Telecommunications has started a reduction of the workforce in order to adjust the expenses to the reduced funding. This will in turn lead to a reduction of the number of research areas covered, and thus a reduction in the quality and broadness of the education.

A large number of external projects has been an important source of financing for the department. However, this means that the academic staff uses a larger amount of time on managing the research projects and supervising PhD students, and often do not have time to do lecturing themselves. This in turn reduces the quality of the master education.

Summary of the Student Survey

A web-based student survey has been performed in October 2007 in order to gain an insight in the student satisfaction with the Master Program in Electronics. The survey was answered by 83 students, equally distributed from 2nd to 5th study year (in 2006/07) and over the four fields of study. Detailed results of the survey (in Norwegian) can be obtained on request from the Department of Electronics and Telecommunications. The results are summarized in the following.

General satisfaction with the study program

- 76% of students are (very) satisfied with the study program, while 3% are (very) unsatisfied.
- 72% say that their expectations are fulfilled, while 6% say that they are not.
- 20% would choose another study program if they were to choose again, while 18% have considered to change some time during their studies. The alternative study programs are mostly those closely related.

Course quality

The students were asked to point out the courses that are best organized as well as those that need greatest improvement. The survey shows that the following aspects contribute positively to the experienced course quality:

- Lecturers with good pedagogical abilities that show that they like to teach. Good quality of teaching and motivation of students is especially important during the first study year. Student dropout rate could be largely reduced by focusing on this.
- Good relationship between theory and exercises.
- Laboratory exercises in addition to lectures and computational exercises.
- Mid-term exams that cannot contribute negatively to the final grade.
- Existence of exercises.
- Courses with good follow-up routines.
- Practical examples from teachers' research areas.
- Slides that are handed out prior to lectures.

Aspects that influence negatively the experienced course quality:

- Poor lecturers that do not manage to motivate students and make the matter interesting. The learning aims should be pointed out and their relevance explained.
- Too large focus on mathematical derivations compared to understanding. Lack of practical explanation of relatively difficult mathematics.
- Too large syllabus, such that there is no time to absorb each topic.
- Course organization and slides that have not been revised for years.
- Laboratory exercises should to much greater extent build upon students' curiosity and their interest in the subject. They are often organized in a too formal way and require students to follow a given recipe. This kills the motivation.

The survey shows also that 36% of the students would prefer more laboratory work in the studies, while only 5% would prefer less.

Workload

The survey shows that there are three major reasons that the students experience the workload as too high:

1. Too many topics in the course, so that it is not possible to absorb them all.
2. A large, time-consuming project in the course.
3. Combination of several demanding courses in one semester. 3rd semester is pointed out as the one with the greatest workload due to the two courses with laboratory exercises in addition to two other demanding courses.
4. The non-technical subjects are among those that are least time consuming, but that is not necessarily because the workload is small, but rather because those courses are usually not prioritized.

Lacking prerequests
The following two problems are clearly pointed out:

1. Lacking programming skills, especially C/C++/Matlab.
2. The introductory course in physics seems to require the highest level of physics from the high-school (3FY), while the formal prerequestes for entering the study program is 2FY.

The first problem is already addressed in the changes of programming courses that were implemented in the study plan from 2007/08. According to these changes the students will be introduced to Matlab and C/C++ during the first study year rather than to JSP and Java. However, it might be necessary to follow up those introductory courses by greater use of programming in the 2nd and 3rd year courses in order to further develope the programming skills.

Overlap
Generally there is not a large overlap in courses, and the existing overlap is mainly experienced as positive and needed. The only exception is perhaps the overlap in signal processing and communication courses that might be too large. Those courses should therefore be revised to get an overview of the amount of overlap, and find a better organization of topics into courses.

Non-technical courses
Students are largely satisfied with the amount of non-technical courses in the study program. However, it should be noted that some of the students also think of mathematics and physics as non-technical courses. Still there are 19% of the students who would prefer less non-technical courses during the first two years of study, and 25% who would prefer less non-technical courses in the 3rd-5th study years, while only 6-7% would prefer more in both cases.

As most relevant non-technical topics, the students point out technological management and related topics, experts in team and teamwork, and mathematics (since some students regard it as a non-technical subject). The least relevant non-technical courses are Ex. Phil and Medicine for non-medical students.

Although the topics related to management and economics are among the most desired non-technical topics, several students pointed out that the course Technological management involves too many topics, and is thus not as useful as it could be, as there is no time to absorb the matter.

Other non-technical topics that were suggested by students are: an introduction to the way we learn (cognitive psychology), more on general use of computers, presentation technique, communication at the work place, cooperation, technical ethics, scientific English writing, cultural understanding, Japanese language and topics related to health, environment and security (HMS).

Experts in team
30% of the students were (very) satisfied with the organization of the course Experts in team, while 12% were not satisfied. In order for Experts in team to be experienced as a good and relevant course, it was emphasized that the groups should be put together on the basis of the competence needed to solve the problem at hand, not randomly.

Evaluation methods
Most of the students appreciate the use of exercises for continuous evaluation of student work. 95% of the students agree that exercises contribute positively to the leaning outcome, while only 3% disagree. Furthermore, 72% agree that compulsory exercises give a better learning outcome than optional exercises, while 11% disagree in this.

63% agree that it is positive that the final grade is set on the base of several evaluation parts, while 15% disagree. However, 58% disagree that exercises should make a part of the final grade, while only 20% agree in this. 70% agree that mid-term exams have positive influence on the learning outcome, while 15% disagree. 55% prefer mid-term exams that cannot contribute negatively to the final grade, while 19% disagree in this.

Organization of semester and activity weeks
Most of the students regard the activity weeks as positive and desired. They wish that the two activity weeks during the school year remain, but point out that there should be one in each semester instead of two in the spring semester. Furthermore, the students desire more time for exam preparations. However, they are strongly against moving parts of the exam period after Christmas holidays.

Motivation and recruitment
The survey shows that the students regard information meetings in connection with the choice of study direction as extremely valuable. The help offered by study advisors is regarded to be of varying quality, but predominantly good.

The students are very positive both to the guided tour to the research laboratories at the department in the start of the first semester, and the excursions to the industry in the first and second study years. They largely agree that those activities contribute to the increased motivation for studies. The contact with the potential employers seems to be relatively well accomplished through company presentations organized by Contactor, a branch of the student association Omega.

One of the students suggests that a guided tour to the laboratories also be organized in connection with the choice of field of study in the 4th semester. Another suggestion is to introduce motivation lectures where the researchers are invited to talk about fascinating topic in the field of study. Furthermore, one student suggests replacing all introductory courses by a single course in 4th semester where each specialization is presented in 1-2 weeks.

70% of students agree that the name of the study program reflects well its content, while 20% disagree. 37% agree that the information material about the study program aimed to high-school students gives a credible impression of the studies, while 15% disagree.

Lecturing language
More lecturing in English is generally not desired by the students, and it does not seem to be more acceptable in 4th than in 3rd year of study. 17% of the students who answered to those questions agree that more lecturing during the 3rd year could be given in English, while 39% disagree. 18% of the students agree that more lecturing during the 4th year could be given in English, while 49% disagree. However, 43% do not desire more textbooks/compendia in Norwegian, while only 29% desire this.

Summary of the Industry Survey

A web-based industry survey has been performed in October 2007 in order to get an insight in the quality and relevance of the Master Program in Electronics seen from the point of view of the earlier students, now working in the industry, and their employers. Detailed results of the survey (in Norwegian) can be obtained on request from the Department of Electronics and Telecommunications. The main findings are summarized in the following.

The survey was answered by 101 employees from 44 different companies. Most of them have graduated from the Master Program in Electronics at NTNU (approx. 20% hold also a PhD). All fields of study were well represented. 38% have graduated 2-9 years ago, 40% have graduated 10-14 years ago, while the rest have graduated more then 15 years ago.

The survey shows that a great majority of the candidates consider their master education to be relevant to their work. However, there is less accordance between the particular specialization and the current work position.

The candidates regard the following aspects as most valuable in their education at the master level:

1. Broad and firm technological basis in the study discipline that can be extended by more specific elements during working practice
2. The ability to learn, and rapidly acquire new fields of study
3. The ability to think analytically and develop structured problem-solving techniques
4. The ability to understand technical problems
5. Specialization acquired trough the project and master thesis
6. A good mathematical foundation

As the least valuable in the master's studies, the candidates mention the non-technical courses, in addition to some of the basic science courses that are farthest away from their field of study or specialization (chemistry, mechanics, semiconductor physics, etc.).

Other negative aspects of the education is the lack of problem-based learning and relating the theory to practical problems from industry, as well as putting too much focus on details.

The majority think that it is important that the education provides broad and thorough knowledge within the basis disciplines (mathematics, statistics, and physics). The survey shows clearly that it is more important that the education provides a broad basis in engineering which gives the opportunity to adapt to a wide range of jobs and the future technological developments, rather than specializing within the needs of today's industry (although this is also important).

Over 50% of candidates think that there should be more focus on oral presentations and programming skills in the education. Over 30% think that the education should contain more implementation technology, electronics design, circuit analysis and fundamental electronics, project management, writing skills, innovation and entrepreneurship, signal processing, and laboratory work. On the other hand, few suggest more physics, mathematics, and business economics.

All in all, the survey shows that the candidates are satisfied with the theoretical fundament provided by the education, but that it is necessary to have more focus on practical skills and relating the knowledge to practical problems.

SWOT analysis

This section summarizes major strengths, weaknesses, opportunities and threats related to the Master Program in Electronics, based on the data presented in the preceding sections.

Strengths

- Research-based education by highly qualified academic staff, including many good lecturers.
- Large number of well equipped research laboratories available for educational purposes.
- Project and master thesis related to ongoing research projects give a unique insight in the latest development and challenges in the field of study.
- Comprehensive education offering firm theoretical foundation and a large scope of specializations that is unique of its kind in Norway.
- High level of student satisfaction, and good reputation in industry.
- The free education system in Norway represents an advantage with respect to recruitment of both Norwegian and foreign students compared to many foreign universities.

Weaknesses

- Rigid system with equal course sizes limits the flexibility in the course design.
- Limited flexibility with respect to choice and placement of non-technological courses.
- Too small focus on project-based learning.
- Use of evaluation forms that do not have sufficient focus on understanding.
- Lacking resources for maintenance of laboratories cause errors and delays in the student projects.
- Teaching in very large groups, mainly in the first two study years, limits the possibility to develop class-belonging feelings and to adapt the courses to the different study programs.

Opportunities

- Allowing course size of 3.75 credits and multiples of it would increase the flexibility in the course design. This would for example make it possible to re-introduce small laboratory courses, or to extend the existing courses with more laboratory and project-based work.
- Introduction of project-based learning in larger number of courses, in order to increase the focus on understanding and application of theory to open problems.
- Greater extent of laboratory work in education is desired both from students and industry. This will improve the practical skills of the candidates.
- Relatively large number of academic staff is currently approaching retirement age. This creates an opportunity to recruit new members having the expertise in emerging research fields. In the same time, it is important to put more focus on pedagogical skills in the future employments.
- Increase the quality of education by letting the academic staff with good pedagogical skills take a greater part of teaching, especially in 1st-3rd study years. This can be achieved by introducing proper incentives for teaching.
- Focus on the importance of mathematics and natural sciences in pre-university stages of the educational system in Norway has contributed to an increased interest for those subjects. More students are currently taking the higher level of these subjects that qualify for admission to the engineering study program.

Threats

- The lack of good, long-term, predictable financing is the major threat that limits most of the opportunities listed above.
- Reducing the academic staff, as a consequence of reduced financing, as well as a greater focus on obtaining and managing externally financed projects, will necessarily lead to reduced quality of lecturing
- The expenses for managing laboratories, and other expenses related to use of laboratories in education are not compensated in the income model. Those expenses are largely independent of the number of students and long-term financing is essential. Reduced amount of laboratory work in education is in contrast with the requests from both industry and students.
- Large dropout rate during the first two years. The youth have much greater opportunities now than earlier, and larger resources have to be put into motivating them for demanding studies.

- The recruitment of students is sensitive to the fluctuations in the job market
- Competition from other universities and engineering colleges in Norway and abroad.

Symmary

The master program in electronics at NTNU offers a comprehensive education with firm theoretical foundation and a large scope of specializations. High quality of the academic staff and a large number of well-equiped laboratories make this education unique of its kind in Norway. It enjoys a high level of student satisfaction, and good reputation in the industry. The academic staff is involved in a large number of research projects, which makes a firm base for research-based teaching that follows the development in the field.

However, lack of sufficient and predictable financing presents the major threat for maintaining the high quality of the education. The financing model is largly based on the number of students, while the expences are to the great extent independent of it. Declining interest for engineering among high-school students is a general trend in the highly developed countries. In addition to a large student dropout rate this presents both a financial problem and the problem to meet future industry needs. Therefore it is important to maintain the large effort put into student recruitment and motivating current students to complete the education. This will require closer cooperation with the industry.

The quality of the study program is maintained through yearly revision of the study plans. Measures have already been taken to improve the programming skills of the students. In the future study plan revisions, we will look at the possibilities to improve the practical skills of the students through greater use of project-based learning. Furthermore, we will look for the ways to improve both oral and written presentation skills.