

## A Model Program for Computer Engineering Master of Science Degree Embedded Systems

This program is based on the structure of the degree program provided by the University of Oulu, Oulu, Finland. The structure of the program is shown in graphical form to show the different types of studies included. Then one option of the program, Embedded Systems is described in more detail.

Basic studies	Common professional studies	Basic modules of the option	Advanced modules of the option	Elective modules	Diploma thesis
<b>75 ECTS</b>	<b>75 ECTS</b>	Automation	Automation	<b>See the descriptions in the chapter Elective modules of the degree programs</b>	<b>30 ECTS</b>
		Intelligent systems	Intelligent systems		
		<b>Embedded systems and software</b>	<b>Embedded systems and software</b>		
		Computer networks and mobile applications	Computer networks and mobile applications		
		Signal processing and technical mathematics	Signal processing and technical mathematics		

The extent of basic and basic professional studies, training period included is 150 ECTS. These studies are carried out during the first two years. After completing this program the student can choose the option in which he wants to specialize. Selection is supposed to take place during the fall term of the third year. The basic module of the chosen option is comprised of obligatory courses 30-40 ECTS combined. After having chosen the option the student has to decide if he wants to continue specialization within the chosen option or if he wants to widen his knowledge to other options as well.

Basic idea of the advanced modules is to provide thorough knowledge of the option. Its extent is 30-40 ECTS depending on student's preferences. An obligatory course package and electives are included. Elective modules are course packages with limited professional scope. Their extents are 15-25 ECTS.

If the student wants to study more natural sciences or business skills, he can plan his own personal elective module within the rules given by the faculty. The student has to choose electives enough to make the extent of the degree 270 ECTS.

### Embedded Systems Option

Demand of specialists in embedded computer systems has grown extensively due to general use of mobile phones and communications. The experts of this field need not only thorough understanding of software technology hardware expertise is needed as well due to the necessary low level programming. The goal of this option is to educate engineers who have good command of both software and hardware technologies. It gives good abilities to design e.g. embedded systems needed in the implementation of mobile phones, telephone networks, home appliances etc.

The basic module of the embedded systems option makes the student familiar to computer systems and their application to embedded systems. The module provides good basis for the design and implementation of computer-based systems by covering system architectures, computer networks and the

software included, operating systems and software design and quality control methodologies. With the advanced module the students can improve their abilities in designing e.g. intelligent systems.

### Detailed program for the Embedded Systems Option

<b>Basic Studies</b>	<b>Extent (ECTS)</b>
Studying and its planning	1
Knowledge acquisition	-
Technical English 3 or technical German	6
Second domestic language Finnish or Swedish	3
Introduction to programming	6
Basic calculus I	4
Basic calculus II	5
Analytical geometry	3
Differential equations	4
Matrix algebra	3
Physics (Electricity)	10
Electricity and magnetism	3
Complex analysis	4
Mathematical methods	5
Statistical mathematics	4
Mathematics in information engineering	5
Numerical methods	4
Literary and oral communications	3

<b>Common Professional Studies</b>	<b>Extent (ECTS)</b>
Introduction to the use of a computer work station	1
Introduction to telecommunications	3
Introduction to data and telecommunication networks	4
Circuit theory I	5
Signals and systems	4

<b>Common Professional Studies</b>	<b>Extent (ECTS)</b>
Basic electronic design	5
Digital techniques I	4
Labs of digital techniques I	3
Computer engineering I	5
Programming assignment	3
Introduction to measurements	4
Program design	4
Data structures	6
Digital filters	5
Computer engineering II	4
Control and systems engineering	5
Program design assignment	4
Operating systems	4
Training	6

<b>Basic Module of the Embedded Systems and Software Option</b>	<b>Extent (ECTS)</b>
Computer networks	4
Telecommunications software I	5
Object-Oriented real time programming	4
Digital techniques II	4
Labs of embedded systems	4
Knowledge engineering	4
Multimedia systems	5

<b>Advanced Module of Embedded Systems and Software Option</b>	<b>Extent (ECTS)</b>
<b>Obligatory</b>	
Computer architectures	5
<b>Electives</b>	

<b>Advanced Module of Embedded Systems and Software Option</b>	<b>Extent (ECTS)</b>
Telecommunications software II	4
Parallel computers	4
Software project	6
Introduction to data management	8
Signal processing systems	5
Testing and reviewing	4

**Elective Modules Available to All Degree Programs provided by the Electrical and Information Engineering Department<sup>1</sup>**

<b>Elective Module: Digital Signal Processing</b>	<b>Extent (ECTS)</b>
<b>Obligatory</b>	
Digital filters	5
Signal processing systems	4
Labs for digital signal processing	3
<b>Electives</b>	
Statistical signal processing	5
Digital picture processing	4
Mathematical signal processing	6
Mathematical methods of data transmission	4
Introduction to source coding	4
Introduction to digital transmission	3
Digital techniques II	4

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1. Students specializing in the specific option are not supposed to take the elective modules of their option.

<b>Elective Module: Digital Transmission</b>	<b>Extent (ECTS)</b>
<b>Obligatory</b>	
Signal processing systems	4
Coding methods	4
Spread spectrum and CDMA technology	5
<b>Electives</b>	
Statistical signal processing	5
Digital picture processing	4
Mathematical signal processing	6
Mathematical methods of signal transmission	4
Introduction to source coding	4
Introduction of digital transmission	3
Digital techniques II	4

<b>Elective Module: Discrete Mathematics</b>	<b>Extent (ECTS)</b>
<b>Obligatory</b>	
Graph theory	8
<b>Electives</b>	
Knowledge engineering	4
Fuzzy sets	4
Mathematical modelling	7
Automata and formal languages	7
Cryptography	7
Coding theory	7

<b>Elective Module: Electronic Testing Techniques</b>	<b>Extent (ECTS)</b>
<b>Obligatory</b>	
Electronic testing	3
Measurement systems	6
EMC-testing	3
<b>Electives</b>	
EMC-design	4
RF-measurements	3
Equipment design	4
Electronic interconnection methods	3
Identification systems	3
Microelectronics assembly techniques	5
Analogue circuits II	4
Digital techniques II	5
Digital techniques III	5

<b>Elective Module: Electronic Production Techniques</b>	<b>Extent (ECTS)</b>
<b>Obligatory</b>	
Production automation of electronics	5
Production technology of electronic products	4
Introduction to microelectronics and -mechanics	4
<b>Electives</b>	
Microelectronics assembly techniques	5
Reliability of electronic packaging	4
Electronic testing	3
Identification systems	3
Measurement systems	6
Electronic interconnection methods	3

Materials engineering	5
Plastic engineering	3

<b>Elective Module: Electronic Design</b>	<b>Extent (ECTS)</b>
<b>Obligatory</b>	
Analoque circuits II	5
Digital techniques	5
Equipment design	4
<b>Electives</b>	
Filters	4
Digital filters	5
Computer-based circuit design	4
Optpelectronics	4
EMC-design	4

Other elective modules are given below only as their titles. The structure is the same including obligatory courses and electives.

- Man, Systems, Information Security
- Information Networks and Digital Economy
- Medical Measurement Methods and Equipments
- Medical Information Technologies
- Mathematical Signal Processing
- Mechatronics
- Microelectronics
- Measurement Techniques
- Numerical Analysis
- Optoelectronics
- Radio Communication Techniques
- Embedded Systems
- Computer Engineering
- Telecommunication Systems
- Telecommunications I
- Telecommunications II
- Production Economics and Marketing
- Intelligent Systems