Education of MST engineers
Basically engineers in MST need a combination of electrical and mechanical engineering skills with a solid knowledge in physics, mathematics, some chemistry, simulation.
In particular:
Mechanics (Newton with extra emphasis on vibrations, rotations.)
Electrodynamics
Themodynamics
Transport (fluid mechanics, diffusion, heat transport)
Construction: Mechanics of materials" elasticity"
Math: standard calculus, lin. Algebra, ordinary AND partial differential equations, Some statistics
Network theory, electronics, control
Simulation: lumped element simulation (based on network), AND FEM, Femlab like packages
Physical chemistry, some organic and anorganic chemistry
Materials science, thin films, deposition and characterization methods

Courses which are being offered for Microsystems technology at UT:
MEMS technology
MEMS design

Material science (121074)

Year of study	2004
Course language	English
Course description	In dit vak zal basiskennis van materiaalkunde voor studenten in de studierichting Elektrotechniek worden geleerd. Naast een korte introductie in de algemene materiaalkunde zal vooral op materiaalkundige aspecten, die van belang zijn voor ingenieurs in de Master's richting microsystemen en microelectronica (MM), worden ingegaan. De studenten verkrijgen hierdoor inzicht in de achtergrond van effecten en processen, die van belang zijn voor (ontwerps)keuzes die in de ontwikkeling en fabricage van microsystemen moeten worden gemaakt. Onderwerpen die aan bod zullen komen zijn o.a.: beschrijving van het atoom, atomaire bindingen, structuurtypes, relatie macroskopische grootheden en atomaire beschrijving, effecten, materiaaleigenschappe, afhangelijkheid van eigenschappen van fysische grootheden,

materiaalkundige aspecten in dunne films, thermodynamica & kinetica.
De onderwerpen zullen middels voorbeelden uit het onderzoek van de verschillende MM groepen worden verduidelijkt.

Participating progr. Electrical Engineering (EE)
Phase M **Semester** S1 5.0 **European Credits**

Teaching methods HC Lecture
Contact hours p/w 4
Assesment Written exam
Credits 5.0 EC
Inquiries dr. K. Wörhoff (tel. 3477)
Contact person dr. K. Wörhoff
Teaching staff mw. dr. K. Worhoff
Course material college sheets

Micro electro mechanical systems (MEMS) (121105)

Year of study 2004
Course language English
Course description The course Micro Electro Mechanical Systems (MEMS) explores the science of miniaturization. Miniaturization methods and materials surveyed include micromachining in or on top of single crystal silicon and other materials based on planar Integrated Circuit (IC) lithography as well as more traditional non-lithography miniaturization options and materials. All these techniques are specialically enhanced or modified for creating small three-dimensional structures with dimensions ranging from sub-centimeters to sub-micrometers, involving sensors, actuators, or other micro-components and microsystems.
Basically the course is a comprehensive incomplete overview of MEMS technology (i.e., methods and materials) and its applications (i.e., devices). Particulary, the lithography-based IC technology is treated as it covers almost the entire MEMS technology. "Silicon VLSI Technology" by James Plummer is taken as

a guide to instruct MEMS technology, whereas " Fundamentals of microfabrication" by Marc Madou should make the reader familiar with MEMS applications. In subsequent chapters the next technology issues are rubricated and discussed; MEMS-based nanotechnology (Ch.1), wafer fabrication (Ch. 2), film formation (Ch. 3), lithography (Ch. 4), film etching (Ch. 5), and micromachining (Ch. 6). After this, the reader should be able to understand the content of MEMS-related papers of least with respect to the technology involved and compare the techniques and have a look at the advantages and disadvantages of the presented methods. As a result, the reader should become familiar with the possibilities to realise the contrived devices.

Content	See course description
Objective	Learn most of the established MEMS tools, materials, directions, and jargon.
Participating progr.	Applied Physics (APH) **Phase** M **Semester** S1 5.0 **European Credits** Electrical Engineering (EE) **Phase** M **Semester** S1 5.0 **European Credits**
Teaching methods	HC Lecture, Lectures
Contact hours p/w	4
Assesment	essay
Credits	5.0 EC
Inquiries	Henri Jansen
Contact person	Henri Jansen
Teaching staff	dr.ir. H.V. Jansen
Course material	Dictaat MEMS-based Nanotechnology, Unionshop dictaatnummer: 199
Number of students	min. 4 - max. 20
Extra information	course has course code 143010 for TN
URL	http://teletopa.civ.utwente.nl/04121105.nsf

Technology (121073)

Year of study 2004
Course language English
Course description The course provides a general introduction in the field of manufacturing technology for microsystems. The emphasis is on fabrication steps, such as deposition, lithography, and etching. The most commonly applied fabrication steps are treated and it is shown how these steps can be combined to create a functional microsystem. The integrated process of several microsystems is treated in an introductory manner: microprocessors, integrated optics, lab-on-a-chip, MEMS and magnetic memories.
Content History of microelectronic and microsystem technology. In-depth treatment of microtechnology process steps. Introduction to the manufacturing of advanced microsystems: microprocessors, integrated optics, lab-on-a-chip, MEMS and magnetic memories.
Objective Understanding the manufacturing of microsystems
Participating progr. Electrical Engineering (EE)

Phase M **Semester** S1 5.0 **European Credits**

Teaching methods HC Lecture
Attendance obligation No
Contact hours p/w 4
Prior knowledge **Necessary:**
Materials Science (121074)
Prior knowledge for IC Technology (121099), Reliability Engineering (121098), Advanced Semiconductor Devices (121100), 122829, Integrated Optics (121088), Lab on a Chip (121112)
Credits 5.0 EC
Inquiries Schmitz, prof.dr. J.
Contact person Schmitz, prof.dr. J.
Teaching staff prof.dr. J. Schmitz
Course material Stephen A. Campbell: The Science and

Engineering of Microelectronic Fabrication, Oxford University Press; 2nd edition; ISBN 0195136055.

Magnetic recording systems (121081)

Year of study 2004

Course language English

Course description This course focusses on understanding the design of digital magnetic recording devices and investigation of the basis problems of data storage. It elaborates on fundamental magnetic principles discussed in the 1th years bachelor course 'Electromagnetic field theory', system aspects treated in the 3th years bachelor course 'Information storage' and the fysical basis of magnetic materials from the master's course 'Materials science'. Now, emphasis will be on working principles, techniques, design aspects and solutions in common magnetic-recording devices like hard disks. The focus will be on general principles, rather than a compilation of methods. Among other things, this course is introductory to SMI research on information storage systems and signal-processing aspects.

Content The course focusses on established commercial systems and also on new technological developments. Particularly the components and techniques of hard-disks and magnetic-tape memories are treated, namely basics of ferromagnetic materials, read and write pr

Objective Applying knowledge and understanding of digital magnetic-recording systems.

Participating progr. Applied Physics (APH)

Phase M **Semester** S1 5.0 **European Credits**

Computer Science (CS)

Phase M **Semester** S1 5.0 **European Credits**

Electrical Engineering (EE)

Phase M **Semester** S1 5.0 **European**

Credits

Teaching methods PJ Project
Attendance obligation Yes
Contact hours p/w 4
Assesment Written exam
Prior knowledge **Desired:**
Information storage (121051) en Material science (121074)
121051 Information Storage
121074 Material science
Credits 5.0 EC
Inquiries Dr.ir. J.P.J. Groenland
Contact person Dr.ir. J.P.J. Groenland
Teaching staff dr.ir. J.P.J. Groenland, dr.ir. L. Abelmann
Course material Photocopies of relevant bookpages (handed out)
reader (handed out)
Literature Based on a book of Wang/Taratorin 'Magnetic information storage technology'
Number of students min. 5 - max. 25

Advanced semiconductor devices (121100)

Year of study 2004
Course language English
Course description This course in "Advanced Semiconductor Devices" can be finished by an assignment or literature study on one of the topics concerning an "advanced device", for example deep-submicron device, silicon-on-insulator devices or molecular electronics. This class is intended mainly, but not exclusively, for students who also take the class in "Reliability Engineering". The assignment can be done all year around.
Content Practical study into one or more topics in advanced semiconductor devices. Precise topics determined later. Examples are device characterisation, device or circuit simulations or literature study.
Objective hands on experience with "advanced semiconductor devices"

Participating progr. Electrical Engineering (EE)

Phase M **Semester** - 5.0 **European Credits**

Teaching methods OPD Assignments, Assignment

Contact hours p/w 2

Assesment Assignment with final report

Prior knowledge **Obligatory:**

Introduction to semiconductor devices (121706)

121706 Introduction to semiconductor devices

Credits 5.0 EC

Inquiries dr.ir. C. Salm

Contact person dr.ir. C. Salm

Teaching staff mw. dr.ir. C. Salm

http://teletopb.civ.utwente.nl/04121100.nsf

Materials for information storage (121082)

Year of study 2004

Course language English

Course description Magnetism in materials: exchange, reversal, magnetic anistropy.
Magnetic Analysis: Magnetometry (VSM, Squid, Torque), Microscopy (Kerr, MFM, Lorentz)
Design of magnetic materials for information storage: in-plane and perpendicular anisotropy, remanent magnetisation, grain size distribution, medium noise, thermal stability, heat assisted recording
Preparation techniques: granular materials, multilayers, patterned media, self assembled arrays of particles
Future materials for ulta-high density information storage.

Participating progr. Electrical Engineering (EE)

Phase M **Semester** S2 5.0 **European Credits**

Teaching methods HC Lecture, OPD Assignments

Attendance obligation Yes

Contact hours p/w 4

Assesment Oral in combination with case study
Prior knowledge **Obligatory:**
121051 Information Storage
121074 Material science
Desired:
121073 Technology
Credits 5.0 EC
Inquiries Dr.ir. L. Abelmann
Contact person Prof.dr. J.C. Lodder
Teaching staff prof.dr. J.C. Lodder, dr.ir. L. Abelmann
Course material Reader (in preparation)
Number of students min. 1
URL http://www.el.utwente.nl/smi/mis

Integrated circuit technology (121099)

Year of study 2004
Course language English
Course description In this course an overview is given of the technology that is used in state-of-the-art Integrated Circuit fabrication.
The focus is on silicon CMOS technology. The course consists of several blocks; the evolution of semiconductor technology, technical (scaling limits, Moore's law) and economical trends, basic process steps (oxidation, diffusion, lithography, deposition, etching, ...), process integration (the fabrication of a high performance IC), circuit yield and process simulation. The course ends with a practical assignment, where modern simulation software is used to study process steps and MOSFET fabrication. The course is of a multidisciplinary nature (electrical engineering, physics,chemistry). Besides for students in semiconductor processing the course is relevant for students of related disciplines such as micro-system fabrication, nano-technology, physics, process chemistry and IC design. Lecture attendance is recommended.
Content Treatment of the IC production process
Objective Acquire knowledge about the IC fabrication

Participating progr.	Applied Physics (APH) **Phase** M **Semester** S2 5.0 **European Credits** Electrical Engineering (EE) **Phase** M **Semester** S2 5.0 **European Credits**
Teaching methods	HC Lecture, Lectures
Contact hours p/w	2
Assesment	Oral exam
Prior knowledge	**Desired:** Introduction to Semiconductor devices (121706) 121706 Introduction to semiconductor devices
Credits	5.0 EC
Teaching staff	dr. J. Holleman, A.Y. Kovalgin
Course material	Silicon VLSI Technology Fundamentals, Practices and modelling Auteurs: J.D. Plummer, M.D. Deal and P.B. Griffin, ISBN: 0-13-085037-3
URL	http://sc.el.utwente.nl/education/ic-technologie/

Integrated optics (121088)

Year of study	2004
Course language	English
Course description	This course is an introduction into the field of integrated optics. It thus presents, in lecture format, the basic principles, covering the theory of planar waveguides, basic structures, non-linear optics, materials and technology, and an introduction into numerical methods and software tools. That theoretical knowledge forms the basis for the practical solution of a number of problems. The final assignment will consist of the design and optimisation of a basic device. Extensive use will be made, both in the problem-solving and the design assignment, of software tools that are specifically developed for integrated optics, such as mode solvers and beam propagation methods. The course evaluation is based on the student's written report. Fields of application include telecommunication

and optical sensors.

Participating progr. Applied Physics (APH)

Phase M **Semester** S2 5.0 **European Credits**

Electrical Engineering (EE)

Phase M **Semester** S2 5.0 **European Credits**

Teaching methods HC Lecture, Lectures (see extra information)

Contact hours p/w 2

Assesment Evaluation takes place based on written reports on the assignments adn design assignments

Credits 5.0 EC

Teaching staff dr. H.J.W.M. Hoekstra, prof.dr. A. Driessen, dr.ir. R.M. de Ridder

Course material Verkrijgbaar via TeleTOP. Het bevat kopieën van alle sheets, kopieën van de aanbevolen literatuur en oefeningen

Extra information Lectures, feed-back to bonus assignments, practical training on the use of computational tools, interaction during performance of exercises/assignments

URL Verdere informatie op TeleTOP

Advanced Analog IC Electronics (121085)

Year of study 2004

Course language English

Course description Analog circuits play a crucial role in modern systems for telecommunication and multi-media applications, which combine digital signal processing with mixed analog-digital interfaces (e.g. to communication channels and sensors & actuators). For reasons of cost and size, these systems are preferably implemented using mainstream IC technologies (CMOS, BiCMOS,Bipolar). This course deals with the design of important analog circuit building blocks, mainly concentrating on two aspects:

* Ways to implement analog circuit building blocks using components available in mainstream IC technologies. Examples of such blocks are

single and differential amplifiers, current mirrors, V-I and I-V converters, reference sources, switches, comparators, mixers. The focus is mainly on circuits using MOS transistors, but most of the principles are also applicable to bipolar transistor circuits.
* The analysis of the main performance limitations of such circuits due to physical limitations in accuracy, non-linearity, speed, noise and power consumption. First order behavioural models are crucial for insight in circuit
operation and design trade-offs. Such models are developed and verified using circuit simulations.
For a further hands-on training in IC design skills, see 121086.

Content Analog Integrated Circuits

Objective Gain insight in the operation and analysis of analog Integrated Circuits

Participating progr. Electrical Engineering (EE)
Phase M **Semester** S2 5.0 **European Credits**

Teaching methods HC Lecture

Contact hours p/w 4

Assesment Written test & oral examm

Prior knowledge **Desired:**
Network Theory (121005)

Credits 5.0 EC

Teaching staff dr.ing. E.A.M. Klumperink, prof.dr.ir. B. Nauta

Course material B. Razavi: "Design of Analog CMOS Integrated Circuits" ISBN 0-07-2373771-0
Library-EL has 20 loan books.

URL TeleTOP

Micro electro mechanical systems design (121130)

Year of study 2004

Course language English

Course Introduction in microfabrication, resonators, elastic

description mechanics of beams and membranes, design of elastic constructions, actuator theory, electrostatic micromotors (rotatiion, linear), thermal and piezoelectric microactuators, sensor principles, acceleration -, angular velocity -, force -, and pressure sensors, flow sensors, fluid mechanics, micropumps, mixers and valves, capillary action, contact angle and wetting, nanofluidics.

Content

Objective

Participating progr. Applied Physics (APH)
Phase M **Semester** S2 5.0 **European Credits**
Chemical Engineering (CHE)
Phase M **Semester** S2 5.0 **European Credits**
Electrical Engineering (EE)
Phase M **Semester** S2 5.0 **European Credits**
Mechanical Engineering (ME)
Phase M **Semester** S2 5.0 **European Credits**

Teaching methods HC Lecture

Attendance obligation But following the lectures is very recommendable

Contact hours p/w 4

Prior knowledge **Obligatory:**
Bachelor in one of the Technical Sciences

Credits 5.0 EC

Inquiries Dr. ir. N.R.Tas (HO-7242)

Contact person Dr. ir. N.R.Tas (HO-7242)

Teaching staff dr.ir. N.R. Tas, dr.ir. H.V. Jansen, prof.dr. M.C. Elwenspoek, dr.ir. G.J.M. Krijnen, dr.ir. R.J. Wiegerink, dr.ir. T.S.J. Lammerink

Course material Collegedictaat

Number of students min. 10

Extra information During the lectures there are tests (one every week) that have to be made satisfactory in order to complete the course

URL http://www.el.utwente.nl/tt/education/memsdesign/

NanoElectronics (121083)

Year of study	2004
Course language	English
Course description	The course starts with a broad overview of the fascinating novel approaches for nanoscale electronics that are emerging, and then focuses on NanoElectronics based on magnetism and magnetic nanostructures, and their applications (such as in magnetic memory (MRAM), logic and sensors). It covers basic magnetic properties of magnetic materials (the origin of magnetic ordering, types of ordering, magnetization, hysteresis, coercivity, Curie temperature, anisotropy, magnetic domains). It discusses the magnetic behavior of materials when nano-structured into ultrathin films and multilayers (interface effects), into nanowires, and in the form of nanodots and nanoparticles (single domain particles, thermal stability). It provides a basic introduction to electronic transport in magnetic systems (spin polarization, magnetoresistance, magnetic tunnel junctions, spin-dependent transport in semiconductors) illustrated with apllications such as sensors, MRAM and magnetic FETs. It also covers novel materials (ferromagnetic semiconductors) and their use in electronic nanostructures (electrical field control of magnetization, electrical switching of nanomagnets). In a case study the student has the choice to either develop a more in depth knowledge of a particular aspect of magneto-electronic nanostructures, or dive into one of the alternative emerging approaches for NanoElectronics.

Participating progr. Applied Physics (APH)

Phase M **Semester** S2 5.0 **European Credits**

Electrical Engineering (EE)

Phase M **Semester** S2 5.0 **European Credits**

Nanotechnology (NAN)

Phase M **Semester** S2 5.0 **European Credits**

Teaching methods HC Lecture

Attendance obligation Yes

Contact hours p/w 4

Assesment Case study / Assignment

Prior knowledge **Desired:**

Materials Science (121074), Technology (121073)
121073 Technology
121074 Material science

Credits 5.0 EC

Inquiries Dr. R. Jansen (tel. 3355)

Contact person Dr. R. Jansen (tel. 3355)

Teaching staff dr. R. Jansen

Number of students min. 5 - max. 25

URL http://www.el.utwente.nl/smi/nanoelectronics

Lab on a Chip (121112)

Year of study 2004

Course language English

Course description A "lab-on-a-chip" consists of electrical, fluidic, and optical functions integrated in a microsystem, and has applications in (bio)chemical and medical fields. The core of the lab-on-a-chip system is a microfluidic channel structure, through which fluid sample plugs with less than a nanoliter volume are propelled by hydraulic or electrokinetic forces. The fluidic structures are machined in materials like fused silica, borofloat glass, or plastics. The course will discuss all aspects of such microsystems. Topics will be: microfabrication, fluidic behaviour in dimensions ranging from the micrometer to the nanometer scale, fluidic control by electronic or other means, microreactors, analysis and manipulation of (living) cells and biomolecules, detection principles (optical, electrical), chemical analysis on a chip (electrophoresis, chromatography). "The course will be given in combination with the "Biochip Diagnostics" course (354202).

Content Principles of fluidics at the micro and nanoscale; Microfabrication; Microfluidic systems; Medical diagnostics on a chip; Detection on a chip; Spectroscopy on a chip; Microreactors; Bioanalytical applications of microsystems; Nanofluidics

Objective To gain knowledge of the possibilities of micro/nanotechnology.

Participating progr. Electrical Engineering (EE)

Phase M **Semester** S2 5.0 **European Credits**

Teaching methods HC Lecture, Lectures

Attendance obligation Yes YES

Contact hours p/w 2

Assesment literature research + presentation

Conditions for enrollment Bachelor degree

Prior knowledge **Obligatory:**
General physics at bachelor level
Desired:
Microtechnology of transducers (122821) or Micro Electro Mechanical Systems (122830)

Credits 5.0 EC

Inquiries j.g.e.gardeniers@utwente.nl

Contact person Dr. J.G.E. Gardeniers

Teaching staff dr. J.G.E. Gardeniers

Course material Syllabus

Number of students min. 5