**UNIVERSITY OF PATRAS**
**SCHOOL OF ENGINEERING**

# DEPARTMENT
# OF
# ELECTRICAL AND COMPUTER ENGINEERING

# BULLETIN
# ACADEMIC YEAR

# 2019 - 2020

**PATRAS 2019**

This bulletin was edited by Prof. Michael Logothetis (ERASMUS Coordinator in the ECE Department of the University of Patras) and Prof. Nikolaos Avouris (Director of Interactive Technologies Laboratory, ECE Department, University of Patras).

URL for an electronic version of this Bulletin:
http://www.ece.upatras.gr/index.php/en/study-guide.html

# Chairman's Address

*Prof. Stavros Koubias*

Greetings!

The Department of Electrical and Computer Engineering (ECE) of the University of Patras has entered the period of maturity, as it is already in the 5th decade of its life. Currently, it is the largest Department of Polytechnic School, possessing excellent buildings and technological infrastructure. Our Department has gained a leading position in the Greece, and a distinct, valuable place at the international academic level. The development of the Department was so intense, both at the educational level and at the research level, contributing significantly to the high-level scientific potential, that led to the technological development of the country, while at the same time its graduates excel in the academic, scientific and professional field abroad.

Our Department has been evaluated both recently and in the past, by independent evaluators who acknowledged the high quality of the educational and research. The QS World Ranking / Top Universities system (www.topuniversities.com), one of the world's most reputable information providers for higher education, ranks our Department among the global academic elite, in positions 300–400, after evaluating approximately 15,000 related programs (Departments) internationally. In addition, recently, the Department's Undergraduate Curriculum has been accredited with excellent results, by an independent committee of academic certifiers (from abroad) and in accordance with the procedures foreseen by the Quality Assurance Authority (called ADIP).

Developments in the science of Electrical & Computer Engineering were rapid in recent years, while they are anticipated to be even more impressive in the coming years. Our Department considering what is happening both in science and in society, maintains close links with major academic institutions, as well as with leading productive units, in Greece and abroad, and strives to develop and continually improve the undergraduate and postgraduate curriculum, in order to respond to technological progress and to provide modern and high-level education to its students.

This bulletin contains the curriculum of the undergraduate 5-year program of studies together with a summary of the content of the courses, the regulations and the curriculum of the postgraduate studies. Information on the foundation of the University of Patras, the structure and operation of the ECE Department. The curriculum of the undergraduate studies of our ECE Department is continiously evolving and being improved according to the scientific subjects which must correspond both to basic demands and current scientific trends, as well as to current technological peaks. This is a contemporary five-year program that covers the areas of telecommunications & information technology, electrical power systems, electronics & computers, automatic control systems & industrial informatics. There are compulsory courses of basic knowledge, common to all students, as well as elective courses that students must choose according to their special interests. Study in our Department is based upon both theoretical and laboratory consolidation of knowledge.

Our new undergraduate program of studies is divided in 10 semesters. The first six semesters are comprised of compulsory courses common to all students, plus elective courses of general education (of pedagogical, cultural or economic content) and a foreign language and terminology course. At the beginning of the 7$^{th}$ semester, the students have to specialize their studies, by choosing one of the following fields of specialization (while selecting basic courses from other fields of specialization in order to expand their basic knowledge and retain a good degree of specialization):

- Communications
- Information Technology
- Smart Grid–Renewable Energy Sources–High Voltages
- Energy Conversion–Power Electronics–Electrotechnical Engineering Materials–Renewable Forms of Energy
- Computers
- Electronics and Embedded Systems
- Signal, Systems and Automatic Control
- Systems Control and Robotics
- Cyberphysical Systems

A prerequisite for obtaining the diploma in Electrical & Computer Engineering is the submission of the Diploma / Master Thesis. The 10$^{th}$ semester is devoted exclusively to the thesis in order to enhance its quality and its research character.

The Department adopted the principles and rules of the European Credit Transfer and Accumulation of Credits System (ECTS). Therefore, the transfer and accumulation of successful performance in other relevant programs at national and european level is possible; this facilitates mobility and academic recognition internationally.

The Department also offers a graduate program leading to the granting of a doctorate degree (Ph.D). To enrol in this program, students are selected twice a year basis, if they hold a degree in areas either of technology or sciences. This program initially consists in attending courses (with exams), the number of which depends on the degree held by graduate students, and, in parallel, in carrying out the Ph.D dissertation, the novelty of which is examined in accordance with the international standards.

Besides, the Department participates to several multi-disciplinary postgraduate programs: "Green Electric Power and the Advanced Network Infrastructure for its Management and Economy" (coordinator), "Biomedical Engineering" (coordinator), "Human-Computer Interaction" (coordinator), "Integrated Hardware and Software Systems", "Processing Systems of Information and Machine Learning", "Space Technologies, Applications and Services" and "Applied Optoelectronics" in cooperation with other Department/Universities.

The Department has 40 faculty members, 18 members of teaching, research and technical supportive personnel, 6 members of administrative personnel, and approximately 2600 undergraduate and postgradiuate students.

As Head of this Department, I am sending our most heartfelt wishes for a happy and creative academic year!

The Head of the Department

Patras, December, 2019

Professor Dr.-Ing. Stavros KOUBIAS

# THE DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

**(www.ece.upatras.gr)**

## History

The Department of Electrical & Computer Engineering was founded as the first department of the School of Engineering in 1967. Initially its name was Electrical Engineering Department. It included eight chairs, an institute and five laboratories (Wireless Communications, General Electrotechnics, Wire Communications, Physical Metallurgy and Nuclear Technology). In the following period up to 1982, eleven more chairs and five laboratories (Applied Electronics, Automatic Control, Computers, Electrotechnics, and Electromechanical Energy Conversion) were established, while six chairs and the laboratories of Physical Metallurgy, Nuclear Technology and Computers were transferred to other departments (Chemical, Mechanical and Computer Engineering).

In accordance with the law 1268/82, the chair system was abolished and Divisions were created within the Departments into which all personnel and the laboratories were incorporated. Three Divisions were formed in the Department of Electrical Engineering as follows:

- Division of Electrical Power Systems (Electric Power Systems Laboratory, Electromechanical Conversion Laboratory, High Voltage Laboratory).
- Division of Telecommunications and Electronics (Wireless Communications Laboratory, Wire Communication Laboratory, Laboratory of Electrotechnics, Applied Electronics Laboratory).
- Division of Systems and Automatic Control (Systems and Measurements Laboratory, Automatic Control Laboratory).

In the '80s, the VLSI-Design Laboratory (Division of Telecommunications and Electronics), the Electrotechnic Materials Laboratory (Division of Electrical Power Systems), and the Automation and Robotics Laboratory (Division of Systems and Automatic Control) were added to the Department. In addition 39 faculty positions were established: 19 for Lecturers, 6 for Assistant Professors, 7 for Associate Professors, and 7 for Professors.

In the beginning of the '90s one more laboratory, the Laboratory of Computer Systems (Division of Telecommunications & Electronics) and further faculty positions were established. In 1994, the Division of Telecommunications & Electronics was split into two: Division of Telecommunications & Information Technology and Division of Electronics & Computers. In 1995 the Department of Electrical Engineering was renamed Electrical & Computer Engineering Department (literally, Electrical Engineering & Computer Technology) honouring its strong activity in the area of computers.

In 2004, two more new laboratories were established, the CCIS – Center for Computing, Information and Communication Systems, and the Digital

Signal and Image Processing Laboratory, which do not belong to Divisions but to the whole ECE Department. In 2016 the laboratory of Interactive Technologies was established in the Division of Electronics and Computers.

The current Divisions and the associated laboratories are as follows:

- **Division of Telecommunications and Information Technology (**Wireless Communications Laboratory, Wire Communications and Information Technology Laboratory, Laboratory of Electrotechnics).
- **Division of Electric Power Systems** (Electromechanical Energy Conversion Laboratory, Electrotechnic Materials Laboratory, Power Systems, Renewable and Distributed Generation Laboratory, High Voltage Laboratory).
- **Division of Electronics and Computers** (Applied Electronics Laboratory, Computer Systems Laboratory, VLSI Design Laboratory, Interactive Technologies Laboratory).
- **Division of Systems and Control** (Advanced Control Center, Laboratory of Automation and Robotics, Systems and Measurements Laboratory, Automatic Control Laboratory).

The Department was initially housed in temporary buildings. Since 1985 it is housed in a three-story building and an adjacent wing, while, a new three-story building was added in 2007.

The Department now has 19 Professors, 10 Associate Professors, 10 Assistant Professors. It offers instruction and conducts research in the fields of Electric Power, Telecommunications, Information Technology, Computers, Electronics, Systems and Automatic Control, which are described below in detail.

## Faculty

### Professors

- **Antonios Alexandridis**
(7.12.88)*, Dipl. El. Eng., 1981, (Univ. of Patras), Ph.D. 1988 (West Virginia Univ.).

- **Theodoros Antonakopoulos**
(6.12.91)*, Dipl. El. Eng., 1985, Dr. El. Eng. 1989 (Univ. of Patras).

- **Nikolaos Avouris**
(12.1.94)*, Dipl. El. Eng. 1979 (Nat. Tech. Univ. of Athens), M.Sc. 1980, Ph.D. 1983 (UMIST).

- **Alexios Birbas**
(9.12.91)*, Dipl. El. Eng. 1985, (Univ. of Patras), M.Sc. 1986, Ph.D. 1988 (Univ. of Minnesota).

- **Efthymios Housos**
(20.9.89)*, B.Sc. 1975, M.Sc. 1976, Ph.D. 1980 (Columbia Univ., NY).

- **Grigorios Kalivas**
(2.11.93)*, Dipl. El. Eng. 1980 (Univ. of Patras), M. Eng. 1982, Ph.D. 1990 (Carlton Univ.).

- **Stavros Koubias**
(16.1.91)*, Dipl. El. Eng. 1976, Dr. El. Eng. 1982 (Univ. of Patras)

- **Stavros Kotsopoulos**
(25.2.87), Physics Degree 1975, (Aristotle Univ. of Thessaloniki), Dipl.El.Eng. 1980, (Univ. of Patras), M.Phil 1978, Ph.D 1986, (Univ. of Bradford, UK)

- **Odysseas Koufopavlou**
(13.4.94)*, Dipl. El. Eng. 1983, Dr. El. Eng. 1990 (Univ. of Patras).

* *Note:* The date in brackets refers to the first appointment at the University, not necessarily to the appointment in the present position.

- **Nikolaos Koussoulas**
(25.9.89)*, Dipl. El. Eng. 1977 (Aristotle Univ. of Thessaloniki), C.E.S. 1978 (Ecole Nat. Super. des Telecom.) M.Sc. 1980, Eng. Deg. 1983, Ph.D. 1984 (UCLA, Los Angeles).

- **Michael Logothetis**
(19.4.91)*, Dipl. El. Eng., 1981, Dr. El. Eng. 1990 (Univ. of Patras).

- **Dimitrios Lymperopoulos**
(20.9.89)*, Dipl. El. Eng., 1980, Dr. El. Eng. 1988 (Univ. of Patras).

- **John Mourjopoulos**
(14.9.89)*, B.Sc. 1978, M.Sc. 1979, Ph.D. 1985 (Univ. of Southampton).

- **George Moustakides**
(10.1.07)*, Dipl. El.Eng. 1979 (Nat. Techn. Univ. of Athens), M.Sc. 1980 (Univ. of Pennsylvania), Ph.D. 1983 (Univ. of Princeton).

- **Efstathios Perdios**
(23.5.1988)*, Degree in Math. 1980, Ph.D. in Classical Mechanics, 1985 (Univ. of Patras).

- **Dimitrios Serpanos**
(1.9.2000)*, Dipl. Comp. Eng. 1985 (Univ. of Patras), Ms.C. 1988, Ph.D. 1990 (Univ. of Princeton).

- **Athanassios Skodras**
(8.5.1981)*, Physics Degree, (Aristotle Univ. of Thessaloniki), Dipl. Comp. & Informatics Eng. 1986, Doctorate 1986 (Univ. of Patras).

- **Emmanuel Tatakis**
(20.7.93)*, Dipl. El. Eng. 1981 (Univ. of Patras), Dr. en Sc. Appl. 1989 (Univ. Libre De Bruxelles).

- **Kleanthis Thramboulidis**
(31.12.90)*, Dipl. El. Eng. 1981, Dr. El. Eng. 1989 (Univ. of Patras).

- **Ioannis Tomkos***
(26.11.19)*, Physics Degree, 1994 (Univ. of Patras), M.Sc. Telecommunication Degree, 1996, Ph.D. in Optical Communications, 1999 (Kapodistrian Univ. of Athens).

## Associate Professors

- **Spyros Denazis**
(11.10.2004)*, Degree in Math. 1987 (Univ. of Ioannina), Ph.D. in Comp. Science, 1993 (Univ. of Bradford).

- **Evangelos Dermatas**
(23.8.96)*, Dipl. El. Eng. 1984, Dr. El. Eng. 1991 (Univ. of Patras).

- **George Konstantopoulos**
(18.10.18)*, Dipl. ECE 2008, Ph.D. 2012 (Univ. of Patras).

- **Panagiotis Kounavis**
(31.12.93)*, Physics Degree 1984, Ph.D. 1991 (Univ. of Patras).

- **Konstantinos Moustakas**
(3.12.2011)*, Dipl. El. Eng. 2003, Dr. El.Eng 2007 (Aristotle Univ. of Thessaloniki).

- **Vassilios Paliouras**
(21.7.2003)*, Dipl. El. Eng. 1992, Dr. El. Eng. 1999 (Univ. of Patras).

- **Eleftheria Pyrgioti**
(7.10.99)*, Dipl. El. Eng. 1981, Dr. El.Eng. 1991 (Univ. of Patras).

- **Kyriakos Sgarbas**
(11.10.2004)*, Dipl. El. Eng. 1989, Dr. El. Eng. 1997 (Univ. of Patras).

- **Eleftherios Skouras**
(2016)*, Physics Degree (Univ. of Patras), Ph.D. (Imperial College, Univ. of London).

* *Note:* The date in brackets refers to the first appointment at the University, not necessarily to the appointment in the present position.

- **Panagiotis Svarnas**
  (7.06.10)*, Dipl. Elec. & Comp. Eng., Dr. Elec. & Comp. Eng. (Univ. of Patras); Ph.D. in Physics (Univ. de Pau et des Pays de l'Adour).

### Assistant Professors

- **Michael Birbas**
  (11.03.14)*, Dipl. El. Eng., Dr. El. Eng. (Univ. of Patras).

- **Sophia Daskalaki**
  (5.2.96)*, Degree Math. 1980 (Aristotle Univ. of Thessaloniki), M.Sc. 1983 (Oregon State University), Ph.D. 1988 (Univ. of Massachusetts).

- **Vassilis Kalantonis**
  (9.3.2006)*, Degree in Math 1998, M.Sc. in Decision Making and Applied Maths 2001, Ph.D. in Classical Mechanics 2004 (Univ. of Patras).

- **Demosthenes Kazakos**
  (14.9.89)*, Dipl. El.Eng. 1982 (Univ. of Patras), D.E.A. 1984 (Ecole Nat. Super. de Mechanique-Nantes), Dr. El.Eng. 1987 (Polytec. Nat. de Grenoble).

- **Stavros Koulouridis**
  (09)*, Dipl. El. Eng. 1999, Dr. El. Eng. 2003 (Nat. Techn. Univ. of Athens).

- **Michael Markakis**
  (04)*, Degree in Math. 1986 (Univ. of Athens), M.Sc 1987 (Université Paris VII), Ph.D. 1995 (Nat. Techn. Univ. of Athens).

- **Epaminondas Mitronikas**
  (5.12.03)*, Dipl. El. Eng. 1995, Dr. El.Eng. 2002 (Univ. of Patras).

- **Vasilis Stylianakis**
  (19.4.91)*, Dipl. El.Eng. 1981, Dr. El. Eng. 1990 (Univ. of Patras).

- **George Theodorides**
  (09)*, Dipl. El. Eng. 1994, Dr. El.Eng. 2001 (Univ. of Patras).

- **Panagis Vovos**
  (8.01.14)*. Dipl. El. Eng. 2002, PhD 2005 (Univ. of Edinburgh).

### Lecturers

(noone)

## Professors Emeriti

- **George Bitsoris**
  (10.5.85)*, Dipl. El. Eng. 1973 (Nat. Techn. Univ. of Athens), DEA Automatique 1974, Dr. d'Etat 1978 (Univ. Paul Sabatier de Toulouse), Dr. Habil 1982 (Univ. of Patras).

- **Nikolaos Fakotakis**
  (11.3.87)*, B.Sc. 1978 (Chelsea College, Univ. of London), M.Sc. 1979 (Univ. of Wales), Dr. El. Eng. 1986 (Univ. of Patras).

- **Christos Georgopoulos**
  (20.9.89)*, B.Sc. El.Eng. 1963 (Univ. of Lowell), M.Sc. 1967 (Northeastern Univ.), Dr.El.Eng. 1975 (Univ. of Patras).

- **Gabriel Giannakopoulos**
  (28.12.84)*, Dipl. El. Eng., 1975, Dr. El. Eng. 1978 (Univ. of Patras).

- **Constantine Goutis**
  (26.4.85)*, Physics Degree, 1966 (Univ. of Athens), M.Sc. 1974 (Herriot-Watt Univ.), Ph.D. 1978 (Univ. of Southampton).

- **Peter Groumpos**
  (9.9.88)*, M.Sc. 1976, Ph.D. 1979 (State Univ. of New York at Buffalo).

- **Robert Eric King**
  (20.9.89)*, B.Sc., M.Sc. (Victoria Univ. Of Manchester), Ph.D (Queens Univ. Of Belfast), D.Sc. (Victoria Univ. of Manchester).

* *Note:* The date in brackets refers to the first appointment at the University, not necessarily to the appointment in the present position.

- **George Kokkinakis**
(1.8.69)*, Dipl.-Ing. 1961, Dr.-Ing. 1966, Dipl.-Wirt.-Ing.1967 (Technical Univ., Munich).

- **Vasilios Makios**
(3.11.73)*, Dipl.-Ing. 1962, Dr.Ing. 1966 (Technical Univ., Munich).

- **Stamatios Manesis**
(5.3.87)*, Dipl. El.Eng. 1975, Dr. El.Eng. 1986 (Univ. of Patras).

- **George Papadopoulos**
(6.4.74)*, B.Sc. EE 1963 (City Univ., NY), M.Sc. EE 1964, Ph.D. 1970 (MIT).

- **Triantafillos Pimenides**
(30.4.84)*, Degree in Math. 1974 (Univ.of Athens), Dipl.El.Eng. 1981, Dr.El.Eng. 1984 (Univ. of Patras).

- **Athanasios Safacas**
(22.9.75)*, Dipl.-Ing. 1967, Dr.-Ing. 1971 (Technical Univ. Karlsruhe, Germany).

- **Nikolaos Spyrou**
(26.7.91)*, Mathematics Degree 1975 (Aristotle Univ. of Thessaloniki), DEA 1976, Doctorat 3eme Cycle 1979 (Univ. de Paris-Sud.)

- **Thanos Stouraitis**
(2.7.90), Physics Degree 1979, M.Sc. Elec. Autom. 1981 (Univ. of Athens), MSc. 1983 (Univ. of Cincinnati), Ph.D. 1986 (Univ. of Florida, Gainesville).

- **Dimitrios Tsanakas**
(20.9.89)*, Dipl.-Ing.1970, Dr.-Ing. 1976 (Technical Univ. Darmstad, Germany).

- **Nikolaos Vovos**
(21.12.83)*, Dipl. El.Eng. 1974, (Univ. of Patras), M.Sc. 1975, (UMIST, England), Dr. El. Eng. 1978 (Univ. of Patras).

## Honorary Doctorate/Professorship Awards

- **Bartholomew 1st** (Archbishop of Constantinople, New Rome and Ecumenical Patriarch)

- **Georgios B. Giannakis** (Professor in Signal Processing)

- **Evangelos S. Eleftheriou** (Dr Eng. in Communications)

- **Gerhard Hosemann** (Professor in Electrical Power Systems)

- **Christos H. Papadimitriou** (Professor in Algorithms and Complexity)

- **Alex Papalexopoulos** (Dr Eng. in Electrical Power and Energy Management Systems)

- **Joseph Sifakis** (Professor in Information Systems)

- **Yannis Tsividis** (Professor in Electronis)

- **Marylin Hendrix Wolf** (Professor in Embedded Systems)

## Administration

- *Head of the Department*

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- *Deputy Head of the Department*

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- *Director of the Division of Telecommunications & Information Technology*

Professor **John Mourjopoulos**
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- *Director of the Division of Electric Power Systems*

Professor **Eleftheria Pyrgioti**
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Fax: +30 2610 997 358
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- *Director* of the Division of Electronics and Computers

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+30 2610 997 305
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Email: paliuras@ece.upatras.gr

- *Director of the Division of Systems and Control*

Assist. Professor **Demosthenes Kazakos**
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- *Departmental General Assembly*
  - Head of the Department
  - Deputy Head of the Department
  - Directors of the Divisions
  - Thirty (30) faculty members representing the Faculty.
  - One Representative of the Special Educational Staff.
  - One Representative of the Laboratory Teaching Staff.
  - One Representative of the Special Technical Laboratory Staff.
  - One Representative of the Undergraduate Students.
  - One Representative of the Postgraduate Students.

- *Departmental General Assembly with Special Composition*
  - All faculty members of the General Assembly.
  - Two Representatives of the Postgraduate Students.

- ***Secretariat and the Registrar's Office***

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Electrical & Computer Engineering Building, 1st floor
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Email: secretary@ece.upatras.gr

Erasmus Secretary: **Rania Doufexi**
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- ***Departmental ERASMUS Coordinator***
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  Fax: +30 2610996471
  Email: mlogo@upatras.gr

- ***Institutional ERASMUS Coordinator***
  **Nikolaos Karamanos**
  (Vice-rector for International & Academic Affairs)
  Tel.: +30 2610996605
  Fax.: +30 2610997153
  Email: vice_rector_acaic@upatras.gr
  Email: N.K.Karamanos@upatras.gr

- ***International Affairs Department***
  **Maria Kotsari**
  Email: intern.rel@upatras.gr
  kotsari@upatras.gr
  Tel.: +30 2610969028

- ***ERASMUS Office***

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**Mariza Charalampopoulou**
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**Dimitra Stamatopoulou**
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Tel.: +30 2610996610

# CURRICULUM

The courses of the curriculum are divided into ten sections, which correspond to the ten academic semesters. These include both compulsory and elective courses. An abbreviated title is given for each course; the complete title is given in the following description of the curriculum courses. Each course may include lectures, seminars, and laboratory practice. The corresponding teaching hours per week are listed in the curriculum together with their credit units. The credit unit corresponds to one hour's lecture or seminar per week for one semester, or one hour's laboratory practice per week for twelve weeks. Specifically, the *European Credit Transfer and Accumulation System (ECTS)* is applied.

The credit units **ECTS** are based on the student workload required by the average student so as to achieve the objectives of a studying programme, according to the anticipated learning results, as well as the abilities and dexterity that should have been acquired after the successful completion of this programme.

The ECTS were instituted in order to make possible the transfer and accumulation of successful outcomes to similar studying programs in the same or another University, both on a national and European level. This fact facilitates mobility and academic recognition.

According to the ECTS, the work load required by every student during one full academic year of studies includes an average of: thirty six (36) to forty (40) full weeks of study, preparation, and examinations, which is estimated to be between one thousand five hundred (1500) and one thousand eight hundred (1800) working hours, which in turn correspond to sixty (60) ECTS.

On this basis, the five year undergraduate studies programme of our ECE Department leading to the Diploma of Electrical & Computer Engineering (equivalent to a Masters' Degree), correspond to 60 x 5 = 300 ECTS, in total. These include 40 ECTS for a diploma thesis which is compulsory for all students. The 300 ECTS are equally divided to the ten (10) semesters of study, and therefore, each semester corresponds to 30 ECTS.

Coding: The course code contains six to seven characters. The meaning of these characters is as follows:
**ECE** denotes our **ECE** department.
The following character denotes either a compulsory or elective course, or the Division offering the course:

- **Y:** Compulsory course for all students
- **K:** Elective course
- **A:** Division of Telecommunication & Information Technology
- **B:** Division of Electric Power Systems
- **C:** Division of Electronics & Computers
- **D:** Division of Systems and Control
- **F:** Foreign Language

(For a compulsory course:
$5^{th}$ / $6^{th}$ digit: Semester the course belongs to.
Last two digits: Current number of the course in the semester.)
Abbreviations used in the following tables:

- **L**: lectures (hours/week)
- **S**: seminars (hours/week)
- **LAB**: laboratory (hours/ week).

## FIRST YEAR

### 1st Semester

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_Y101 | Single Variable Functions Calculus | 4 | 2 | 0 | 6 |
| ECE_Y104 | Linear Algebra | 2 | 1 | 0 | 3 |
| ECE_Y106 | Intr. to Computers | 3 | 0 | 2 | 6 |
| ECE_Y107 | Modern Physics | 3 | 1 | 0 | 4 |
| ECE_Y108 | Applied Physics | 3 | 1 | 0 | 4 |
| ECE_Y109 | Digital Logic | 2 | 2 | 0 | 4 |
| **Select 1 of:** | | | | | |
| ECE_F210 | Foreign Lang. - Eng. | 3 | 0 | 0 | 3 |
| ECE_F220 | Foreign Lang. - Fra. | 3 | 0 | 0 | 3 |
| ECE_F230 | Foreign Lang. - Ger. | 3 | 0 | 0 | 3 |
| ECE_F240 | Foreign Lang. - Rus | 3 | 0 | 0 | 3 |
| | | **Total Credits:** | | | **30** |

### 2nd Semester

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_Y211 | Electrical Circuits I | 3 | 1 | 0 | 5 |
| ECE_Y212 | Multivar. Functions Calculus & Vector Anal. | 3 | 1 | 0 | 5 |
| ECE_Y213 | Applied Physics Lab. | 0 | 0 | 2 | 3 |
| ECE_Y214 | Differential Equations & Complex Analysis | 2 | 2 | 0 | 4 |
| ECE_Y215 | Procedural Programming | 3 | 1 | 2 | 6 |
| ECE_Y216 | Engineering Mechanics | 3 | 1 | 0 | 4 |
| ECE_Y210 | Intr. to ECE science | 2 | 1 | 0 | 3 |
| | | **Total Credits:** | | | **30** |

## SECOND YEAR

### 3rd Semester

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_Y320 | Electrical Circuits II | 3 | 1 | 2 | 7 |
| ECE_Y321 | Partial Diff. Equations & Transforms | 4 | 1 | 0 | 6 |
| ECE_Y322 | Probability & Statistics | 3 | 1 | 0 | 4 |
| ECE_Y323 | Solid State of Matter | 3 | 1 | 0 | 5 |
| ECE_Y324 | Digital Logic Circuits & Systems | 2 | 1 | 1 | 5 |
| ECE_Y325 | Object Oriented Technology | 2 | 1 | 0 | 3 |
| | | **Total Credits:** | | | **30** |

### 4th Semester

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_Y420 | Electromagnetic Fields I | 2 | 1 | 0 | 4 |
| ECE_Y421 | Microelectronic Circuits & Devices | 4 | 1 | 0 | 6 |
| ECE_Y422 | Power Circuits Analysis | 3 | 1 | 0 | 5 |
| ECE_Y423 | Computer Organization | 3 | 1 | 0 | 4 |
| ECE_Y424 | Communications Networks | 2 | 1 | 2 | 6 |
| ECE_Y425 | Signals & Systems | 4 | 1 | 0 | 5 |
| | | **Total Credits:** | | | **30** |

*L: Lectures, S: Seminars, LAB: Laboratory*

## THIRD YEAR

### 5th Semester

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_Y520 | Electromagnetic Fields II | 3 | 1 | 0 | 5 |
| ECE_Y521 | Analogue Integrated Electronics | 4 | 1 | 2 | 8 |
| ECE_Y522 | Numerical Analysis | 2 | 0 | 1 | 3 |
| ECE_Y523 | Signal Processing | 3 | 1 | 0 | 4 |
| ECE_Y524 | Communication Systems | 2 | 1 | 1 | 5 |
| ECE_Y525 | Electrical Power Systems | 3 | 1 | 0 | 5 |
| | | **Total Credits:** | | | **30** |

### 6th Semester

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_Y620 | Automatic Control Systems | 4 | 1 | 2 | 8 |
| ECE_Y621 | Elec. Measuring Devices & Techniques | 2 | 0 | 1 | 3 |
| ECE_Y622 | Microcomputers / Embedded systems | 2 | 0 | 1 | 4 |
| ECE_Y623 | Electrical Machines | 4 | 1 | 2 | 8 |
| ECE_Y624 | Engineering Drawing | 2 | 0 | 1 | 3 |
| ECE_Y625 | Algorithms & Data Structures | 2 | 2 | 0 | 4 |
| | | **Total Credits:** | | | **30** |

## FIELD OF SPECIALISATION: COMMUNICATIONS

**FOURTH YEAR**

**7th semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_AK701 | Information Theory | 4 | 0 | 0 | 5 |
| ECE_AK702 | Wireless Propagation | 3 | 0 | 0 | 5 |
| ECE_AK703 | Digital Communications I | 3 | 0 | 0 | 5 |
| ECE_AK704 | Microwaves | 3 | 0 | 0 | 5 |
| | **Group B** | | | | |
| ECE_AK705 | Artificial Intelligence | 3 | 0 | 2 | 5 |
| ECE_AK706 | Access & Switching Networks | 2 | 2 | 0 | 5 |
| ECE_CK702 | Operating Systems | 3 | 0 | 2 | 5 |
| ECE_CK705 | Digital Signal Processing | 3 | 0 | 2 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

**8th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_AK801 | Communications Lab. I | 3 | 0 | 2 | 5 |
| ECE_AK802 | Wireless & Mobile Commun. Networks | 3 | 0 | 0 | 5 |
| ECE_AK803 | Antenna Theory | 3 | 0 | 0 | 5 |
| ECE_AK804 | Teletraffic Theory & Queuing Systems | 4 | 0 | 0 | 5 |
| ECE_AK805 | Optical Communications | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_AK806 | Digital Communications II | 3 | 0 | 0 | 5 |
| ECE_CK801 | Adv. Programming Techniques | 3 | 0 | 2 | 5 |
| ECE_CK806 | Linear & Combinatorial Optimization | 3 | 0 | 0 | 5 |
| ECE_CK807 | Network Architecture | 3 | 0 | 0 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

ECE_DE100 Diploma/Master Thesis (**Optional**) 5

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: INFORMATION TECHNOLOGY

## FOURTH YEAR

### 7th semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_AK701 | Information Theory | 4 | 0 | 0 | 5 |
| ECE_AK705 | Artificial Intelligence | 3 | 0 | 2 | 5 |
| ECE_AK707 | Electroacoustics | 3 | 0 | 2 | 5 |
| ECE_AK708 | Information Retrieval | 4 | 0 | 0 | 5 |
| ECE_CK705 | Digital Signal Processing | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_AK709 | Computer Graphics & Virtual Reality | 3 | 0 | 2 | 5 |
| ECE_AK710 | Biomechanics I | 3 | 0 | 0 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

### 8th Semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_AK808 | Pattern Recognition | 4 | 0 | 2 | 5 |
| ECE_AK809 | Digital Audio Technology | 3 | 0 | 0 | 5 |
| ECE_AK812 | Digital Processing & Image Analysis | 3 | 0 | 0 | 5 |
| | **Group B** | | | | |
| ECE_AK807 | Intr. to Bioinformatics | 3 | 0 | 0 | 5 |
| ECE_AK810 | Speech & Natural Lang. Processing | 3 | 0 | 2 | 5 |
| ECE_AK811 | Computational Geometry & 3D Apps | 3 | 0 | 2 | 5 |
| ECE_CK804 | Data Mining & Learning Algorithms | 3 | 0 | 0 | 5 |
| ECE_CK811 | Cryptography | 3 | 0 | 0 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

ECE_DE100 Diploma/Master Thesis (**Optional**) 5

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: SMART GRID – RENEWABLE ENERGY SOURCES – HIGH VOLTAGES

**FOURTH YEAR**

**7th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_BK701 | Electrical Power Systems Analysis | 3 | 0 | 3 | 5 |
| ECE_BK702 | High Voltages | 3 | 0 | 3 | 5 |
| | **Group B** | | | | |
| ECE_BK704 | Electrical Installations | 4 | 0 | 0 | 5 |
| ECE_BK705 | Power Electronics I | 4 | 0 | 2 | 5 |
| ECE_AK702 | Wireless Propagation | 3 | 0 | 0 | 5 |
| ECE_AK703 | Digital Communications | 3 | 0 | 0 | 5 |
| ECE_AK705 | Artificial Intelligence | 3 | 0 | 2 | 5 |
| ECE_DK701 | State-Space Linear Systems Analysis | 3 | 0 | 0 | 5 |
| ECE_DK702 | Applied Optimization | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |

**8th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_BK801 | Power Sys. Control & Stability | 3 | 0 | 3 | 5 |
| ECE_BK802 | Renewable Energy Sources I | 3 | 0 | 0 | 5 |
| ECE_BK803 | High Voltages (Tests & Measurements) | 3 | 0 | 3 | 5 |
| | **Group B** | | | | |
| ECE_BK804 | Electrical Power Systems Protection | 3 | 0 | 0 | 5 |
| ECE_BK805 | Control Tech. in Renewable Energy Sources | 3 | 0 | 0 | 5 |
| ECE_BK806 | Dynamics & Control of E-L Systems | 3 | 0 | 0 | 5 |
| ECE_BK807 | Overvoltage/Lightning Protection | 3 | 0 | 0 | 5 |
| ECE_AK802 | Wireless & Mobile Commun. Networks | 3 | 0 | 0 | 5 |
| ECE_AK808 | Pattern Recognition | 4 | 0 | 2 | 5 |
| ECE_CK803 | Adv. Microcomputers Systems | 3 | 0 | 2 | 5 |
| ECE_CK805 | Real-time Distributed Embedded Systems | 3 | 0 | 0 | 5 |
| ECE_DK804 | Industrial Automation | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: ENERGY CONVERSION – POWER ELECTRONICS – ELECTROTECHNICAL MATERIALS – RENEWABLE FORMS OF ENERGY

## FOURTH YEAR

**7th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_BK704 | Electrical Installations | 4 | 0 | 0 | 5 |
| ECE_BK705 | Power Electronics I | 4 | 0 | 2 | 5 |
| ECE_BK706 | Electric Motor Drive Systems I | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_BK701 | Electrical Power Systems Analysis | 3 | 0 | 3 | 5 |
| ECE_BK707 | Thermal Plants | 3 | 0 | 0 | 5 |
| ECE_CK704 | Microcomputers & Microsystems | 3 | 0 | 2 | 5 |
| ECE_CK705 | Digital Signal Processing | 3 | 0 | 2 | 5 |
| ECE_CK706 | Adv. Analog/Dig. Circuits & Compon. | 3 | 0 | 0 | 5 |
| ECE_DK701 | State-Space Linear Systems Analysis | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |

**8th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_BK803 | High Voltages (Tests & Measurements) | 3 | 0 | 3 | 5 |
| ECE_BK808 | Electric Motor Drive Systems II | 3 | 0 | 2 | 5 |
| ECE_BK809 | Power Electronics II | 4 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_BK801 | Power Sys. Control & Stability | 3 | 0 | 3 | 5 |
| ECE_BK802 | Renewable Energy Sources I | 3 | 0 | 0 | 5 |
| ECE_BK807 | Overvoltage/Lightning Protection | 3 | 0 | 0 | 5 |
| ECE_BK810 | Biomechanics II | 3 | 0 | 0 | 5 |
| ECE_BK811 | Energy Design & Air Conditioning | 3 | 0 | 0 | 5 |
| ECE_AK808 | Pattern Recognition | 4 | 0 | 2 | 5 |
| ECE_CK803 | Adv. Microcomputers Systems | 3 | 0 | 2 | 5 |
| ECE_DK801 | Digital Control | 3 | 0 | 2 | 5 |
| ECE_DK804 | Industrial Automation | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: COMPUTERS

## FOURTH YEAR

### 7th Semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_CK701 | Computer Architecture | 3 | 0 | 0 | 5 |
| ECE_CK702 | Operating Systems | 3 | 0 | 2 | 5 |
| ECE_CK703 | Data Bases | 3 | 0 | 2 | 5 |
| ECE_CK704 | Microcomputers & Microsystems | 3 | 0 | 2 | 5 |
| ECE_CK709 | Object Oriented Technology | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_AK709 | Computer Graphics & Virtual Reality | 3 | 0 | 2 | 5 |
| ECE_AK705 | Artificial Intelligence | 3 | 0 | 2 | 5 |
| ECE_CK705 | Digital Signal Processing | 3 | 0 | 2 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

### 8th Semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_CK801 | Adv. Programming Techniques | 3 | 0 | 2 | 5 |
| ECE_CK802 | Internet Programming | 3 | 0 | 2 | 5 |
| ECE_CK803 | Adv. Microcomputers Systems | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_CK804 | Data Mining & Machine Learning | 3 | 0 | 0 | 5 |
| ECE_CK805 | Distributed Real-time Embedded Sys. | 3 | 0 | 0 | 5 |
| ECE_CK806 | Linear & Combinatorial Optimization | 3 | 0 | 2 | 5 |
| ECE_CK807 | Network Architecture | 3 | 0 | 0 | 5 |
| ECE_CK812 | Data Processing & Learning Algorithms | 3 | 0 | 1 | 5 |
| ECE_AK808 | Pattern Recognition | 4 | 0 | 2 | 5 |
| ECE_AK811 | Computational Geometry & 3D-Modeling Apps | 3 | 0 | 2 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

| | | |
|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | 5 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: ELECTRONICS AND EMBEDDED SYSTEMS

## FOURTH YEAR

### 7th Semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_CK704 | Microcomputers & Microsystems | 3 | 0 | 2 | 5 |
| ECE_CK706 | Adv. Analog/Dig. Circuits & Compon. | 3 | 0 | 0 | 5 |
| ECE_CK707 | Integrated Circuits Design I | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_CK701 | Computer Architecture | 3 | 0 | 0 | 5 |
| ECE_CK705 | Digital Signal Processing | 3 | 0 | 2 | 5 |
| ECE_CK708 | Photoelectronic Devices | 3 | 0 | 0 | 5 |
| ECE_AK704 | Microwaves | 3 | 0 | 0 | 5 |
| ECE_AK707 | Electroacoustics | 3 | 0 | 2 | 5 |
| ECE_BK705 | Power Electronics I | 4 | 0 | 2 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

### 8th Semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_CK803 | Adv. Microcomputers Systems | 3 | 0 | 2 | 5 |
| ECE_CK805 | Distributed Real-time Embedded Sys. | 3 | 0 | 0 | 5 |
| ECE_CK809 | Integrated Circuits Design II | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_CK807 | Network Architecture | 3 | 0 | 0 | 5 |
| ECE_CK810 | Nanoelectronics | 3 | 0 | 0 | 5 |
| ECE_CK812 | Data Processing & Learning Algorithms | 3 | 0 | 1 | 5 |
| ECE_AK805 | Optical Communications | 3 | 0 | 2 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

ECE_DE100 Diploma/Master Thesis (**Optional**)

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: SIGNALS, SYSTEMS AND AUTOMATIC CONTROL

## FOURTH YEAR

**7th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_DK701 | State-Space Linear Systems Analysis | 3 | 0 | 0 | 5 |
| ECE_AK701 | Information Theory | 4 | 0 | 0 | 5 |
| ECE_CK705 | Digital Signal Processing | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_DK702 | Applied Optimization | 3 | 0 | 0 | 5 |
| ECE_AK703 | Digital Communications I | 3 | 0 | 0 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

**8th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_DK801 | Digital Control | 3 | 0 | 2 | 5 |
| ECE_DK805 | Robotics | 3 | 0 | 1 | 5 |
| ECE_AK808 | Pattern Recognition | 4 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_DK804 | Industrial Automation | 3 | 0 | 0 | 5 |
| ECE_AK806 | Digital Communications II | 3 | 0 | 0 | 5 |
| ECE_CK801 | Adv. Programming Techniques | 3 | 0 | 2 | 5 |

*Courses from other fields of specialization, which have not already been chosen.*

ECE_DE100 Diploma/Master Thesis (**Optional**)

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: COMMUNICATIONS

**FIFTH YEAR**

**9th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_AK901 | Communications Lab. II | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_AK902 | Programmable Networks & Management | 3 | 0 | 1 | 5 |
| ECE_AK903 | Multimedia Communications | 3 | 0 | 0 | 5 |
| ECE_AK904 | Broadband Networks | 3 | 0 | 0 | 5 |
| ECE_AK905 | Personal Telemed/Biomedical Sys. | 3 | 0 | 0 | 5 |
| ECE_CK902 | Computer & Network Security | 3 | 0 | 0 | 5 |
| ECE_CK905 | Internet of Things | 3 | 0 | 0 | 5 |
| ECE_DK803 | Estimation Theory & Stochastic Control | 3 | 0 | 0 | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

**10th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 30 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: INFORMATION TECHNOLOGY

## FIFTH YEAR

### 9th Semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_AK902 | Programmable Networks & Management | 3 | 0 | 1 | 5 |
| ECE_AK906 | Parallel Programming in Machine Learning | 3 | 0 | 2 | 5 |
| ECE_CK703 | Data Bases | 3 | 0 | 2 | 5 |
| | **Group B** | | | | |
| ECE_AK905 | Personal Telemed/Biomedical Sys. | 3 | 0 | 0 | 5 |
| ECE_CK902 | Computer & Network Security | 3 | 0 | 0 | 5 |
| ECE_CK903 | Parallel Processing | 3 | 0 | 0 | 5 |
| ECE_CK904 | Interactive Technologies | 3 | 0 | 0 | 5 |
| ECE_DK902 | Non Linear & Robust Control | 3 | 0 | 0 | 5 |
| ECE_DK803 | Estimation Theory & Stochastic Control | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

### 10th Semester: 30 ECTS

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 30 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: SMART GRID – RENEWABLE ENERGY SOURCES – HIGH VOLTAGES

**FIFTH YEAR**

**9th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_BK901 | Electrical Economy | 3 | 0 | 0 | 5 |
| | **Group B** | | | | |
| ECE_BK902 | Adv. Control of Elec. Machines | 3 | 0 | 0 | 5 |
| ECE_BK903 | Renewable Energy Sources II | 3 | 0 | 0 | 5 |
| ECE_BK904 | Insulation Tech. & Nanostructured Dielectrics | 3 | 0 | 0 | 5 |
| ECE_CK902 | Computer & Network Security | 3 | 0 | 0 | 5 |
| ECE_CK905 | Internet of Things | 3 | 0 | 0 | 5 |
| ECE_DK803 | Etsimation Theory & Stochastic Control | 3 | 0 | 0 | 5 |
| ECE_DK902 | Non Linear & Robust Control | 3 | 0 | 0 | 5 |
| ECE_DK903 | Optimal Control | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

**10th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 30 |

*L: Lectures, S: Seminars, LAB: Laboratory*

## FIELD OF SPECIALISATION: ENERGY CONVERSION – POWER ELECTRONICS – ELECTROTECHNICAL MATERIALS – RENEWABLE FORMS OF ENERGY

**FIFTH YEAR**

**9th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_BK903 | Renewable Energy Sources II | 3 | 0 | 0 | 5 |
| ECE_BK904 | Insulation Tech. & Nanostructured Dielectrics | 3 | 0 | 0 | 5 |
| | **Group B** | | | | |
| ECE_BK902 | Adv. Control of Elec. Machines | 3 | 0 | 0 | 5 |
| ECE_DK702 | Applied Optimization | 3 | 0 | 0 | 5 |
| ECE_DK902 | Non Linear & Robust Control | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

**10th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 30 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: COMPUTERS

**FIFTH YEAR**

**9th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_CK901 | Software Sys. /Analysis & Design | 3 | 0 | 0 | 5 |
| ECE_CK902 | Computer & Network Security | 3 | 0 | 0 | 5 |
| | **Group B** | | | | |
| ECE_CK903 | Parallel Processing | 3 | 0 | 0 | 5 |
| ECE_CK904 | Interactive Technologies | 3 | 0 | 0 | 5 |
| ECE_CK905 | Internet of Things | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

**10th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 30 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: ELECTRONICS AND EMBEDDED SYSTEMS

**FIFTH YEAR**

**9th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_CK906 | Integrated Systems Design | 3 | 0 | 2 | 5 |
| ECE_CK907 | High Speed Electronics | 3 | 0 | 0 | 5 |
| | **Group B** | | | | |
| ECE_CK901 | Analysis & Design of Software Sys. | 3 | 0 | 2 | 5 |
| ECE_CK902 | Computer & Network Security | 3 | 0 | 0 | 5 |
| ECE_CK905 | Internet of Things | 3 | 0 | 0 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

**10th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 30 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# FIELD OF SPECIALISATION: SIGNALS, SYSTEMS AND AUTOMATIC CONTROL

**FIFTH YEAR**

**9th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| | **Group A** | | | | |
| ECE_DK803 | Estimation Theory & Stochastic Control | 3 | 0 | 0 | 5 |
| ECE_DK901 | Adaptive Control | 3 | 0 | 0 | 5 |
| ECE_DK902 | Non-Linear and Robust Control | 3 | 0 | 0 | 5 |
| | **Group B** | | | | |
| ECE_DK903 | Optimal Control | 3 | 0 | 0 | 5 |
| ECE_AK705 | Artificial Intelligence | 3 | 0 | 2 | 5 |
| *Courses from other fields of specialization, which have not already been chosen.* | | | | | |
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 5 |
| ECE_DE100 | Diploma/Master Thesis (**Optional**) | | | | 5 |

**10th Semester: 30 ECTS**

| Code | Course | L | S | LAB | ECTS |
|---|---|---|---|---|---|
| ECE_DE100 | Diploma/Master Thesis (**Compulsory selection**) | | | | 30 |

*L: Lectures, S: Seminars, LAB: Laboratory*

# DESCRIPTION OF COURSE UNITS

## FIRST YEAR

### 1st semester

| | |
|---|---|
| **Code** | **ECE_Y101** |
| **Title** | Single Variable Functions Calculus |
| Instructor | Kalantonis<br>Perdios |
| Credits | 6 ECTS |

**Content:**
Derivative and differential of a function. Inverse trigonometric and hyperbolic functions. Polar coordinates. Implicit functions, Parametric equations. Taylor expansion and Series. Indefinite integrals, Definite integral and its applications, Improper integrals. Basic concepts of Ordinary Differential Equations (ODEs), First order linear ODEs, Separation of variables, Bernoulli and Riccati ODEs. Series of numbers, Series of functions, Power series and Binomial series. Laplace transform.

| | |
|---|---|
| **Code** | **ECE_Y104** |
| **Title** | **Linear Algebra** |
| Instructor | Daskalaki<br>Markakis |
| Credits | 3 ECTS |

**Content:**
Matrices and linear systems. Definitions and basic operations. Transpose. Sub-matrices. Determinant. Inverse. Gauss elimination. Rank. Non-unique solution of systems. Linear dependence of vectors. Eigen values and applications. Definitions and properties. The coefficients of the characteristic polynomial. Similarity and diagonalisation. Iterative methods. Instability of solutions. Quadratic forms. Functions of matrices. Vector spaces.

| | |
|---|---|
| **Code** | **ECE_Y106** |
| **Title** | **Introduction to Computers** |
| Instructor | Avouris<br>Paliouras<br>Sgarbas<br>Valouxis<br>Karavatselou<br>Dilios<br>Sintoris |
| Credits | 6 ECTS |

**Content:**
1. Digital representation, digital arithmetic. Information digitization and Character encoding.
2. Procedural programming with Python: Arithmetic expressions and commands, input/output and selection commands.
3. Loops, library functions (modules), functions defined by the user
4. Sequences, strings, lists, dictionaries and tuples.
5. Files, interface to the operating system
6. Sorting and searching algorithms, complexity.
7. Object Oriented Programming in Python, Definition of classes, objects, methods, inheritance.

8. Graphical user interfaces, programming with tkinter.
9. Computer architecture, Memory, Memory hierarchy, Central Processing Unit.
10. Operating systems: process management, scheduling, virtual memory.
11. Introduction to computer networks and the Internet. web programming
12. Data retrieval from the Internet.
13. Social aspects of computing, free and opensource software.

**Lab.:** The course includes laboratory exercises involving algorithmic and programming and group work project.

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|---|---|
| **Code** | **ECE_Y107** |
| | **ECE_Y108** |
| **Title** | **Modern Physics** |
| | **Applied Physics** |
| Instructor | Kounavis |
| Credits | 4 + 4 ECTS |

**Content:**

**INTRODUCTION**. What is Physics, physical quantities, measurements, standards and the International System of units (SI), space, time and mass measurements. The Big Bang, the expansion of the universe, gravitation theories, the fundamendal forces, interstellar matter collapse and star generation, the fundamental components of the universe, galaxies, the Milky Way galaxy, Hubble's law, the cosmological redshift, the lives and deaths of stars, star collapse, red giants and white dwarfs, neutron stars, black holes, the Hertzsprung-Russel star diagram. Comets, meteorites, asteroids, Kepler's laws of planetary motion, escape velocity, the Sun and the solar system.

**ELASTICITY**. The solid state of matter, the crystalline structure of matter, defects in matter and elastic properties of solid materials, strain and deformation, Hook's law, the modulus of elasticity, bulk modulus, shear modulus, the Poisson constant and relations among elastic constants. Elastic limit and ultimate strength of materials.

**WAVE MOTION**. Phenomena in wave motion, types of waves, superposition, interference, diffraction, wave propagation through an elastic medium, sinusoidal waves, standing waves, water waves, tidal and seismic waves, the Richter scale, sound effects, shock waves, the Doppler effect, the human ear, intensity of sound waves, pressure of sound waves, response of the ear to sound waves, the dB scale, sound pollution.

**FLUID MECHANICS.** Density, pressure and lift in a fluid, the Archimedes' principle, characteristics of flux, fluid dynamics, Bernoulli's law, surface tension, viscosity, friction in solids and fluids.

**THERMODYNAMICS.** The kinetic theory of gases, the molecular interpretation of temperature, the mean free path, the Maxwellian distribution, thermodynamic laws and thermodynamic processes, state equations, the ideal gas and real gases, thermal capacity, thermal expansion in solids and fluids, phase diagramms, phase transformations, phase equillibrium diagramms, work and thermodynamic cycles, heat flow. The Carnot cycle, heat engines, refrigerators and heat pumps, the liquefaction of gases, critical phenomena, superfluidicity. The thermal conductivity coefficient, reversible and non-reversible processes, entropy, latent heat.

**KINETICS**. Motion, speed, acceleration. Translational, rotational and cyclic motion. Vector derivatives. Velocity and accelaration in polar coordinates. The relativity of motion. The special theory of relativity. Scalar and vector product of vectors.

**DYNAMICS**. Force, mass, Newton's laws. Inertial and non-inertial reference systems.

Equations of motion of the particles in one, two and three dimensions. Circular motion. Solution of the equations of motion. Applications. Forces of inertia. Dynamics of solid bodies. The centre of mass and moment of inertia. Examples. Equations of motion in rotational motion and solutions. Angular momentum and conservation. Static equillibrium in a solid body.

**WORK-ENERGY**. Work and kinetic energy. Conservative and non-conservative forces. Potential energy. Momentum and impulse. Conservation of momentum. Elastic and inelastic collisions, shock loading and impact phenomena.

**QUANTUM PHYSICS**. The limits of visible light. The blackbody spectrum. Wien's shift law. Stefan-Boltzmann's law. Efficiency of light sources. Planck's theory-quantization of energy. Quantization of the electric charge. The photoelectric effect. Photons, Einstein's photoelectric equation. Frank-Hertz' experiment. The dual aspect of matter. The principle of complementarity. Davison-Germer's experiment. Scattering of radiation-quantum interpretation of the Compton effect. The Bragg relationship. Heisenberg's principle of uncertainty.

**ATOMIC PHYSICS**. The spectrum of the electromagnetic radiation. Linear spectra. The Hydrogen spectrum. The Rydberg constant. The scattering of α-particles. The quantum model of the atom. The main axioms of Bohr's theory. Standing energy levels. The structure of an atom. The principle of correlation. The fine texture constant. Stern-Gerlach's experiment. Pauli's prohibitive principle and the periodic table of the elements. Lasers and masers, principle and applications. Optical pumping, ruby laser, He-Ne laser and Ar laser. Fluorescence and phosphorescence.

**NUCLEAR PHYSICS**. Characteristics of an atom. Magnitude and shape of a nucleus-nuclear structure. Classification of nuclei. The line of stability and the prohibitive principle. The mass spectrograph. Nuclear binding energy. Nuclear transitions. Radioactive decay, the disintegration constant, the half-life and the mean life. Nuclear fission. The model of the drop for a nucleus. The quantum mechanics' tunnel effect-the Strutinski model. Separation of isotopes, enrichment methods. Nuclear energy, nuclear reactors. Energy production in stars, thermonuclear fusion, nuclear and thermonuclear weapons. Protection from radioactivity. Physics of elementary particles, accelerators, exotic matter and quarks. Cosmology.

**ELECTRICITY-MAGNETISM**. Electric charge, Coulomb's law, electric field, Gauss' law, electrostatic potential. Electric energy. Dielectrics and condensers. Electric conductivity. Direct current circuit, Kirchhoff's rules. Dangers from electric currents. Electric discharges. Magnetic field, magnetic flux. Biot-Savart's law. Magnetic materials. The motion of a charged particle in a magnetic field. The Hall effect and the quantum Hall effect. Ampere's law. Electromagnetic induction. The super-conducting state, the Meissner effect, electron-phonon interaction and the Cooper pairs. Superconductors in magnetic fields, superconducting elements, alloys and compounds, applications of super-conductivity.

**OPTICS**. Nature and propagation of light, interaction of electromagnetic radiation with matter, reflection and refraction. Dispersion and scattering. Geometric optics. Mirrors and lenses, the human eye and optical instruments. Interference, diffraction, scattering and polarization. Electron and X-ray diffraction in crystals.

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|---|---|
| **Code** | **ECE_Y109** |
| **Title** | **Digital Logic** |
| Instructor | Antonakopoulos |
| Credits | 4 ECTS |

**Content:**
Introduction to digital systems. Number systems. Base Conversion. Binary arithmetic. Coding. Complement Arithmetic. Boolean Algebra. The Huntington Postulator De Morgan's theorem. Switching Function. Karnaugh maps. Quine-McClusky Algorithm. Combinational Logic. Design of Switching Circuits. Adders. Comparators. Multiplexers. Demultiplexers. Encoders/Decoders. Programmable Logic Arrays. Sequential Circuits. Flip-flops, counters. Asynchronous and synchronous sequential circuits. State Machines.

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|---|---|
| **Code** | **ECE_F210** |
| **Title** | **Foreign Language – English** |
| Instructor | Rizomilioti |
| Credits | 3 ECTS |

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|---|---|
| **Code** | **ECE_F220** |
| **Title** | **Foreign Language - French** |
| Instructor | Velissarios |
| Credits | 3 ECTS |

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|---|---|
| **Code** | **ECEF230** |
| **Title** | **Foreign Language – German** |
| Instructor | Savva |
| Credits | 3 ECTS |

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|---|---|
| **Code** | **ECEF240** |
| **Title** | **Foreign Language - Russian** |
| Instructor | Ioannidou |
| Credits | 3 ECTS |

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|---|---|
| **Code** | **ECEE133** |
| **Title** | **Marketing & Sales** |
| Instructor | Karagianni |
| Credits | 3 ECTS |

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|---|---|
| **Code** | **ECEE138** |
| **Title** | **History of the European Literature** |
| Instructor | Gotsi |
| Credits | 3 ECTS |

**2nd semester**

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|---|---|
| **Code** | **ECE_Y211** |
| **Title** | **Electrical Circuits I** |
| Instructor | Koussoulas |
| Credits | 5 ECTS |

**Content:**

Circuits of lumped elements. Kirchhoff's Laws. Circuits elements: Resistor, Capacitors, Inductors, Coupled Inductors. The response of simple RC, and RLC circuits state variables. The response of constant linear circuits: Convolution state equations. Sinusoidal steady state: Phasors, impedance, admittance, network functions, resonance.

General principles. The concept of measurement. Accuracy and precision of measurements. Errors in measurements. Systematic and random errors. Combined errors. Statistical analysis of measurement data. Analogue, digital and comparison methods of measurement. Display methods. Basic analogue instruments for resistance, current and voltage measurement. Recording instruments. Magnetic tape recorders of analogue data. Cathode ray oscilloscopes. Analogue electronic instruments. Q-meter.

DC-AC bridges and their application. Measurements of resistance, inductance, capacitance, mutual inductance and frequency. Single and double ratio transformer bridges. Digital instruments-D/A and A/D conversion.

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|---|---|
| **Code** | **ECE_Y212** |
| **Title** | **Calculus of Multivariable Functions and Vector Analysis** |
| Instructor | Kalantonis Perdios |
| Credits | 5 ECTS |

**Content:**

Continuity at a point and in a region of multivariable functions. Partial derivative and differentiability of functions of several variables. Functional determinant and implicit functions. Taylor expansion. Extremum points and conditional extremum points. Vector Analysis. Dot, cross and mixed product of vectors. Curves in space, Frenet formulas, Surfaces, Hamilton operator, Directional derivative, Vector operators. Multiple integrals, curve and surface integrals, Green's, Gauss' and Stokes' theorems.

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|---|---|
| **Code** | **ECE_Y213** |
| **Title** | **Apllied Physics Laboratory** |
| Instructor | Kounavis |
| Credits | 3 ECTS |

**Content:**

Laboratory Exercises:

**Lab.1** MEASUREMENTS, PRECISION OF MEASUREMENT-ERROR

**Lab.2** DETERMINATION OF ERROR TRANSMISSION THROUGH CALCULATIONS

**Lab.3** DETERMINATION OF DENSITY OF SOLID MATERIALS

**Lab.4** PENDULUM OSCILLATION: MEASUREMENT OF ACCELERATION OF GRAVITY

**Lab.5** A STUDY OF MOVEMENT IN A FLUID, VISCOSITY MEASUREMENT

**Lab.6** STUDY OF WAVE PROPAGATING IN A CORD-STADING WAVES

**Lab.7** MEASURING SPEED OF SOUND

**Lab.8** DETERMINATION AND MAPPING OF ELECTROSTATIC FIELDS

**Lab.9** DETERMINATION AND MAPPING OF ELECTROSTATIC FIELDS

**Lab.10** MEASURING SPEED OF LIGHT A LED
**Lab.11** MEASURING ELECTRICAL RESISTANCE AND SPECIFIC CONDUCTIVITY
**Lab.12** A STUDY OF CHARGING AND DESCHARGING OF A CAPACITOR: RC CIRCUIT
**Lab.6** STUDY AND MEASUREMENT OF MAGNETIC FIELD

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|---|---|
| **Code** | **ECE_Y214** |
| **Title** | **Differential Equations and Complex Analysis** |
| Instructor | Markakis |
| Credits | 4 ECTS |

**Content:**
Definitions and basic concepts. Ordinary DE. Linearity and linearisation. First order linear equations. Existence and behaviour of solutions. Equations reducible to linear. Non-linear DE. Existence and behaviour of solutions. Approximation methods. Direction field. Envelopes. Variables separable and homogeneous equations. Riccati equations. Exact equations. Integrating factors. Existence and uniqueness theorem for first-order equations. 2nd-order equations. Non-linear 2nd-order equations reducible to first-order. 2nd-order linear equations. The homogeneous equation. Fundamental solutions. Linear independence. Reduction of order. The homogeneous equation with constant coefficients. The non-homogeneous equation. Undetermined coefficients method. Variation of parameters method. Applications. Mechanical and electrical oscillations. Higher-order linear equations. Linear nth-order equation general. nth-order homogeneous equation. Non-homogeneous nth-order. Numerical methods. Euler, Taylor, Runge-Kutta methods.

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|---|---|
| **Code** | **ECEY_215** |
| **Title** | **Procedural Programming** |
| Instructor | Dermatas<br>Paliouras<br>Valouxis<br>Kouretas<br>Karavatselou<br>Dilios<br>Sintoris |
| Credits | 6 ECTS |

**Content:**
Introduction. Program development process. Language alphabet. Imperative-Procedural programming paradigm (C language): variables, data types, operators, expressions, statements, control statements. Arrays, type conversion, functions, recursion, scope, duration, program structure, pointers, complicated declarations, structures, input/output, file handling. Object-Oriented programming paradigm (Java language): Introduction to Object-Oriented concepts, class & object, attribute, operation, encapsulation. Java as an Object-Oriented language. Inheritance, polymorphism, constructors, garbage collection, overloading, shadowing, visibility modifiers, exception handling.

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|---|---|
| **Code** | **ECE_Y216** |
| **Title** | **Engineering Mechanics** |
| Instructor | Papanikolaou |
| Credits | 4 ECTS |

**Content:**
Introduction to Mechanics. The Basic Units of Mechanics. Elementary vector analysis. Static of Particles. Equilibrium of rigid bodies. Method of virtual work. Analysis of structures. Forces in beams and cables. Friction. Centroids and centres of gravity.

Introduction to Dynamics. Kinematics of particles and systems of particles. Dynamics of rigid bodies. Mechanical vibrations with one degree of freedom.

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|---|---|
| **Code** | **ECE_Y210** |
| **Title** | **Intoduction to the Science of Electrical Engineer** |
| Instructor | ECE Faculty Members (Coordinator : Mourjopoulos) Hatziantoniou Stavroulopoulos |
| Credits | 3 ECTS |

**Content:**
The course offers a global overview of the topics attained by the students during their future studies and prepares them for the necessary skills required for their subsequent academic and professional development. The course is structured around 8 lectures from different professors, covering basic, tutorial and research topics from all the 4 Divisions of the Department. The students are then preparing and submit a report on a selected topic related to these lectures. Furthermore, the professors of the Department propose additional topics for group projects, carried out throughout the semester. The course is successfully completed when both the submitted report and the presentation of the group project has received passing grade.

**SECOND YEAR**

**3rd semester**

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|---|---|
| **Code** | **ECE_Y320** |
| **Title** | **Electrical Circuits II** |
| Instructor | Koussoulas |
| Credits | 7 ECTS |

**Content:**
Independent network equations: Topological network. The methods of node voltages, loop currents and state variables. Frequency response: Laplace transforms, natural modes, network functions, network theorems. Two ports. Distributed parameter networks: The homogenous transmission line. Introduction to linear systems analysis.

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|---|---|
| **Code** | **ECE_Y321** |
| **Title** | **Partial Differential Equations and Transforms** |
| Instructor | Markakis |
| Credits | 4 ECTS |

**Content:**
Algebraic equations. Root finding. Iterative methods. Solution of non-linear simultaneous equations. Newton's iteration method and parameter perturbation. Solution of linear simultaneous equations. Gaussian elimination with pivoting. Iterative methods Gauss-Seidel and over-relaxation. Algebraic eigenvalue problems. Convergence acceleration. Richardson extrapolation. Numerical integration. Numerical optimisation. One-dimensional search techniques. Interpolation. Approximation. Curve fitting. Numerical solution of ordinary differential equations. Taylor, Euler, Runge-Kutta methods. Midpoint rule. Multistep and predictor-corrector methods. Numerical instability.

Two-point boundary value problems. Finite differences methods for partial differential equations. Numerical methods laboratory.

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|---|---|
| **Code** | **ECE_Y322** |
| **Title** | **Probability & Statistics** |
| Instructor | Daskalaki Moustakides |
| Credits | 4 ECTS |

**Content:**

**I.** Introduction to probability. Counting techniques and applications. Conditional probability. Univariate and multivariate random variables. Cumulative distribution functions, probability functions and probability density functions. Functions of random variables. Independence of random variables. Conditional distributions. Moments, moment generating functions and characteristic functions. Covariance and correlation. Conditional expectation and variance. Applications of useful distributions: Bernoulli, binomial, multinomial, hypergeometric, geometric, negative binomial, Poisson, uniform, exponential, Gamma, Beta, Weibull, normal, lognormal, $\chi 2$, t, F and the multivariate normal. The Poisson stochastic process. Inequalities and limit theorems. Reliability and hazard rate. The exponential and Weibull distributions in reliability. **II.** Random sampling. Descriptive statistics. Sampling distributions and normal distribution. Basic principles of point estimation. Interval estimation. Statistical Intervals on the mean, proportion and variance of one population. Statistical Intervals on a difference in means, on a difference in proportions and on the ratio of two variables. Simple linear regression.

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|---|---|
| **Code** | **ECEY323** |
| **Title** | **Solid State of Matter** |
| Instructor | Svarnas |
| Credits | 5 ECTS |

**Content:**

**Bonds between atoms**: Bohr's model of the atom, Pauli's exclusion principle and the shell model of the atom, atoms in solids, ionic bonding, the repulsive force, metallic bond, the covalent bond, bonds between molecules, the relationship between the type of bond and the physical properties of a solid.

**Crystals and crystalline solids**: close-packed structures, non-close-packed structures, the crystal lattice, labelling crystal planes, X-ray diffraction, electron microscopes, allotropic phase transitions (changing the crystal structure).

**Electrical properties of metals**: Drude's classical theory of electrical conduction, failures of the classical model, Bloch's quantum theory of electrical conduction, band theory of solids, distribution of the electrons between the energy states (the Fermi-Dirac distribution), the density of states, the free electron model, the density of occupied states, band theory of electrical conduction.

**Semiconductors**: band theory of solids, the difference between insulators and semiconductors, holes, optical properties of semiconductors, the effective mass, n-type semiconductors, p-type semiconductors, majority and minority carriers, the Hall effect, the free electron model applied to semiconductors.

**Semiconductor devices**: junctions between two metals (the contact potential), the p-n junction (a qualitative description), the p-n junction (a quantitative analysis), the p-n junction with an applied voltage (qualitatively), the p-n junction with an applied voltage (quantitatively), transistors

(an introduction), bipolar transistors, the field-effect transistor, the integrated circuit, heterojunctions, optoelectronic devices.
**Magnetic properties**: macroscopic magnetic quantities, atomic magnets, materials with magnetic moment, Pauli paramagnetism, Curie paramagnetism, ordered magnetic materials, temperature dependence of permanent magnets, band theory of ferromagnetism, ferromagnetic domains, soft and hard magnets, applications of magnetic materials for information storage.
**Superconductivity**: the discovery of superconductivity, the resistivity of a superconductor, the Meissner effect, type II superconductors, superconductivity of superconductors, type I and type II, high-temperature superconductors, superconducting magnets, SQUID magnetometers.
**Dielectrics**: induced polarization, other polarization mechanisms, the frequency dependence of the dielectric constant, resonant absorption and dipole relaxation, impurities in dielectrics, piezoelectricity, ferroelectrics, dielectric breakdown.
**Crystallization and amorphous solids**: the melting point, crystallization, amorphous solids, optical properties of amorphous solids, amorphous semiconductors, amorphous magnets.
**Polymers**: elastic properties of rubber, the rubbery and glassy states, amorphous and crystalline polymers, oriented crystalline polymers, conducting polymers.

| **Code** | **ECE_Y324** |
|---|---|
| **Title** | **Digital Circuits and Systems** |
| Instructor | Theodoridis<br>Paliouras<br>Fakotakis |
| Credits | 5 ECTS |

**Content:**
*Single-bit memory elements*: The T flip-flop, the SR flip-flop, the JK flip-flop, the D flip-flop, the latching action of a flip-flop.
*Counters*: series and parallel connection of counters, synchronous up/down-counters, decade binary up-down-counter, decade grey code counter, asynchronous binary counters, scale-of-ten asynchronous counter, asynchronous resettable counters, integrated-circuit counters.
*Shift register counters and generators*: shift register with parallel loading, shift registers as counters, the universal state diagram for shift registers, the design of a decade counter, shift register sequence generators, the ring counter.
*Clock-driven sequential circuits*: analysis of a clocked sequential circuit, the design procedure for clocked sequential circuits, the design of a sequence generator, moore and mealy state machines, pulsed synchronous circuits, state reduction, state assignment.
*Event-driven circuits*: races and cycles, race-free assignment for a three-state machine, race-free assignment for a four-state machine, a sequence detector.
*Hazards*: gate delays, the generation of spikes, the production of static hazards in combinational networks, the elimination of static hazards, design of hazard-free combinational hazards, detection of hazards in an existing network, dynamic hazards.

| **Code** | **ECE_Y325** |
|---|---|
| **Title** | **Object Oriented Technology** |
| Instructor | Thramboulidis<br>Valouxis<br>Sintoris |
| Credits | 3 ECTS |

**Content:**
1. Introduction. Embedded Systems, Mechatronics, Cyber Physical Systems,

IoT. From the Procedural to the Object Oriented Programming. The paradigm shift. Abstraction (data - procedural - HAL)

2. Introduction to the object Technology. Object, class, instance. The program as an aggregation of objects. Class diagram. Object interaction diagram.
3. Introduction to the Object-Oriented Programming. The conceptual model of the object-oriented programming. Introduction to Java. The Java as an extension of C. The basic library of Java.
4. Inheritance, simple and multiple. The interface construct.
5. Polymorphism, early vs. late binding.
6. Abstraction in user interface. GUIs. The Abstract Window Toolkit (awt).
7. Exception handling. Garbage collection.
8. Event Handling.
9. Multithreading.
10. Network programming constructs for distributed applications. Servlets. Socket Programming. Java support for SOA.

**Lab.1** The restrictions of C and the need for stronger language constructs. The reverse Polish notation calculator case study. Data abstraction. The Logic Gate simulator.

**Lab.2** Hardware abstraction layer. Using ARM® Cortex™-M0+ processor (ARM University Program).

**Lab.3** Using the BlueJ environment in the development of object-oriented applications. Exploiting the basic Java library. Simple example applications. The Reverse Polish Notation calculator.

**Lab.4** The Eclipse environment for the development of object-oriented applications. Development of Reverse Polish Notation calculator with graphical user interface (3 exercises).

**Lab.5** Development of a Logic Gate Simulator.

**Lab.6** Network programming. Sockets, Client-Server model. Robot remote controller.

**Lab.7** Multi-threading in Java. Development of Producer Consumer application.

**4th semester**

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|---|---|
| **Code** | **ECE_Y420** |
| **Title** | **Electromagnetic Fields I** |
| Instructor | Skouras |
| Credits | 4 ECTS |

**Content:**

**Introduction**. Relationship between electromagnetic and circuit theory. Vector Analysis Elements, Coordinate Systems. Gradient, Divergence, Rotation, Gauss, Stokes, Helmholtz Theorems.

**Electrostatic field**. Coulomb law. Electrical charge distributions. Electric field of point charge and continuous charge distributions. Flat and solid angles. Gauss law in Integral and differential form. Electric flux. Electric displacement. Electric potential. Circulation of electric field intensity. Potential and electric field strength ratio.

**Conductors**. Conditions in the interior and the surface of the conductors. Optical representation of electrostatic fields. Theorem of the reciprocity of Green. Electrostatic induction.

**Calculation Methods**. Poisson and Laplace equations, boundary conditions problems. Image Theory, Non-Static Charges' Images. Multipolar method, multipolar potential expansion, electric dipole. Method of variables' Separation. Introduction to numerical methods, finite difference method.

**Dielectric materials**. Polarization, polarization charges, polarized dielectric fields, Gauss law in dielectrics, dielectric materials types, dielectric constant, dielectric strength, boundary conditions in the interface of two media, Poisson - Laplace equations in dielectric, microscopic theory of dielectrics. Electrostatic shielding. Electrostatic energy. Conductor systems, Potential, capacitance and induction factors. Capacitance of isolated conductor, capacitors, partial capacitance.

**Electrostatic forces and torques**. Coulomb method, electrostatic pressure, Maxwell's pressure tensor method.

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|---|---|
| **Code** | **ECE_Y421** |
| **Title** | **Microelectronic Circuits and Devices** |
| Instructor | Kalivas<br>Birbas A. |
| Credits | 6 ECTS |

**Content:**

Microelectronic Systems. Linear Circuits, p-n junctions. diodes. Non Linear Circuit Applications, Junction Field Effect Transistors (JFETs). MOSFETs. Bipolar Transistors (BJT). Biasing. Transistors Models. One Stage Amplifiers. The Transistor as a Switch. SPICE. Integrated Circuits. Basic Technology of Integrates Circuits Manufacture. State of the Art Microelectronic Devices (METFETs. HEMTs. BiCMOS. SENSORS).

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|---|---|
| **Code** | **ECE_Y422** |
| **Title** | **Power Circuits Analysis** |
| Instructor | Alexandridis<br>Vovos P.<br>Vovos N. |
| Credits | 5 ECTS |

**Content:**

Sinusoidal steady-state analysis of single phase circuits: The sinusoidal source, the sinusoidal response, the concept of phasors, the passive circuit elements in the frequency domain, laws and methods for circuit analysis in the frequency domain, series and parallel resonance. Power in circuits with sinusoidal excitation: Instantaneous, real and

reactive power, the concept of complex power, apparent power, the power triangle, power factor correction, equivalent circuits of loads. Circuits with periodic non sinusoidal excitation: Harmonics, power with periodic non sinusoidal voltages and currents. Multiphase circuits: Two-phase system. Symmetrical three- phase system under symmetrical load. One phase equivalent circuit. Symmetrical three- phase system under unsymmetrical load. Shift of the neutral point of the load in relation to neutral point of the source. Active, reactive and apparent power of the three- phase circuits with symmetrical and unsymmetrical load. Measurement of active and reactive power in symmetrical and unsymmetrical three- phase circuits. The two Wattmeter method (ARON). Phase sequence. Symmetrical components: Definition of symmetrical component transformation. Loads sequence impedances. Unsymmetrical three- phase voltages with symmetrical loads. Sequence circuits. Symmetrical component powers.

| **Code** | **ECE_Y423** |
|---|---|
| **Title** | **Computer Organization** |
| Instructor | Theodoridis |
| Credits | 4 ECTS |

**Content:**

**Basic principles:** History of computer systems, Abstractions and technology. Performance and power consumption issues. Metric for evaluating the processor's performance. Single- and multi-core computing systems.

**Language of the computer**: Operations of the computer hardware. Instruction set of the MIPS processor. Instructions for arithmetic, logic, and conditional operations. Functions and procedures. Addressing modes. Compilation and execution of the software. .

**Arithmetic for computers:** Algorithms for addition, subtraction, multiplication, and division in fixed- and floating-point arithmetic and their hardware implementations.

**Central Processing Unit**: Datapath, control, and memory units and their organization. Single-cycle implementation of the MIPS' CPU. Pipeline and performance. Pipelined datapath and control units. Hazards (structural, data, control) in pipelined implementations and their addressing. Five-stage implementation of the MIPS' CPU.

**Memory:** Memory technologies. Memory hierarchy and performance issues. Cache memory (organization, operation, and implementation). Virtual memory.

| **Code** | **ECE_Y424** |
|---|---|
| **Title** | **Communications Networks** |
| Instructor | Logothetis<br>Lymperopoulos<br>Denazis<br>Karavatselou<br>Mandelos |
| Credits | 6 ECTS |

**Content:**

- **Introduction:** Computer Networks and the INTERNET. Communication Protocol. Open Systems Interconnection. The protocol layers stack of the Internet. The Network Edge. The Network Core. Networks with Virtual Circuits and Datagrams. Delay and Loss in Packet-Switched Networks. Delay and Loss in Circuit-Switched Networks
- **Elementary teletraffic/queuing theory.**
- **Application Layer (AL):** Principles of AL Protocols. WEB – HTTP, FTP, SMTP, DNS.
- **Transport Layer (TL):** The goal. The TL of the Internet. Basic multiplexing/de-

multiplexing functions in TL. The User Datagram Protocol (UDP) (Segment structure, Checksum). Principles of Reliable Data Transfer. Stop and Wait protocol. Pipelining. The Transport Control Protocol (TCP). The TCP connection. Round-Trip time. Determination of the length of the "Sequence Numbers" field**.** Flow control. Congestion Control. Best Transmission Window Size.

- **Network Layer:** The goal. The Service Model (Virtual Circuits – Datagrams). Routing. Centralized and distributed routing algorithms. Hierarchical Routing. The Internet Protocol (IP). IPv4 addresses. Subnets definition through subnet mask. Moving a Datagram from Source to Destination: Addressing, Routing and Forwarding. The ICMP Protocol. Routing in the Internet. Intra-Autonomous System Routing: RIP, OSPF. Inter-Autonomous System Routing: BGP. IPv6. Transition from IPv4 to IPv6. Inside a Router. Head of the Line Blocking. Virtual Output Queues.
- **Data Link Layer (DLL):** The goal. The services. Broadcast channels and PPP. Adapters Communicating. Error Detection and Error Corrections Techniques. MAC – Channel Partitioning Protocols: TDM, FDM,CDMA. – Random Access Protocols: CSMA, CSMA/CD (Ethernet), IEEE 803.11 (WiFi). – Taking-Turns Protocols: Polling – Token Pass. Hubs, Bridges and Switches (comparison with routers). The LAN as a DLL protocol.
- **LABARATORY EXCERCISES (Based on OPNET, WIRESHARK and LINUX).**

| **Code** | **ECE_Y425** |
|---|---|
| **Title** | **Signals and Systems** |
| Instructor | Skodras |
| Credits | 5 ECTS |

**Content:**

This course offers the basic knowledge in continuous-time and discrete-time signals and systems. This is the prerequisite knowledge for the forthcoming courses as for example communications, signal and image processing, pattern recognition, etc. More specifically, the material covered in this course includes:

Continuous-time Signals and Systems: Linear time invariant systems; Time-domain analysis (convolution); Frequency-domain analysis (Fourier transform – Fourier series); Frequency response; Fourier transform in 2 and 3 dimensions; Hartley transform; Hilbert transformation; Signal correlation.

Discrete-time Signals and Systems: Linear time invariant systems; Time-domain analysis (convolution); Frequency-domain analysis; Discrete-Time Fourier transform (DTFT); Discrete Fourier transform (DFT); Fast Fourier Transform (FFT); Frequency response; Z-transform; Sampling.

**THIRD YEAR**

**5th semester**

| | |
|---|---|
| **Code** | **ECE_Y520** |
| **Title** | **Electromagnetic Fields II** |
| Instructor | Koulouridis |
| Credits | 5 ECTS |

**Content:**

**Continuous Currents Electric Field.** Definition, Electric Current Density, Electric Current distribution, Continuity equation, Boundary conditions. Relaxation time of electric Charge, Power Consumption, Joule's law. Resistance and conductivity, Methods of calculating the resistance, Modeling the sources of electric energy, The laws of Kirchhoff

**Nature of the Electromagnetic Field**. Base Theory. Basic energy relations. The Maxwell equations

**Magnetostatic Field**. Ampere's Law. Biot-Savart Law. Vector Dynamics. Induction. magnetic flux linkage. Magnetic forces. Magnetic Materials and Circuits Magnetostatic Field in Materials, Microscopic Approach. Macroscopic Approach. Boundary conditions. Magnetization.

**Electromagnetic Induction**. Faraday's Law. Moving Conductive rod. Time Constant magnetic field. Movement in a time-varying field. Dynamic magnetic field energy, definition of mutual inductance. Electromagnets.

**Time-varying fields**. Differential and integral form of Maxwell equations. Displacement current. Wave Equation. Diffusion Equation. Energy and Power Flow - The Poynting Theorem. Harmonic time dependence. Representation in time and in complex space. Helmholtz equations.

**Waves and propagation**. Planar waves Wave propagation in insulating and conducting media. Planar wave polarization. Skin effect. Group Speed. Propagation to arbitrary direction. Theorem of reciprocity

**Reflection and refraction of wave fields**. Fresnel equations. Parallel and vertical polarization. Reflection Law. Snell's Law. Critical angle. Total reflection, Brewster angle. Vertical and tangential strike on conductive and dielectric media. Propagation constants. Types of waves.

**Introduction to Propagation Issues.** Transmission Lines, Waveguides, Antennas.

**Introduction to electromagnetic compatibility and safety issues.**

| | |
|---|---|
| **Code** | **ECE_Y521** |
| **Title** | **Analogue Integrated Electronics and Systems** |
| Instructor | Kalivas<br>Gialelis |
| Credits | 8 ECTS |

**Content:**

Review of one stage amplifiers-Linear and non Linear Circuits- Differential Amplifiers-Operational Amplifiers-Frequency Response-Feedback-Stability of Feedback Amplifiers-Output stages and Power amplifiers-Analogue integrated Circuits. Filters. Tuned Amplifiers-Oscillators-Switched capacitors Wave Generators.

| | |
|---|---|
| **Code** | **ECE_Y522** |
| **Title** | **Numerical Analysis** |
| Instructor | Kalantonis<br>Markakis<br>Moustakas<br>Perdios |
| Credits | 3 ECTS |

**Content:**
Root finding of a non-linear algebraic equation, Iterative solution methods for non-linear simultaneous algebraic equations. Gaussian elimination, Partial pivoting, Iterative methods Gauss-Seidel and over-relaxation, Algebraic eigenvalue problems. Numerical integration. Interpolation and curve fitting. Numerical solution of ordinary differential equations, Taylor - Euler - Runge-Kutta methods - Midpoint rule - multistep and predictor-corrector methods. Numerical instability. Two-point boundary value problems, Finite differences and shooting methods.

| **Code** | **ECE_Y523** |
|---|---|
| **Title** | **Signal Processing** |
| Instructor | Skodras |
| Credits | 4 ECTS |

**Content:**
The whole course consists of the following three parts:
**Digital Signal Processing**: design of digital filters of finite impulse response (FIR) and infinite impulse response (IIR); realisation of digital filters via the fast convolution; implementation of digital filters on finite wordlength processors.
**Information Theory**: introduction to information theory (communication model, the measure of information by Shannon); discrete sources of information with or without memory; discrete and continuous communication channels.
**Stochastic Signals**: first and second moments; stationarity and ergodicity; LTI filtering of stochastic signals; spectal estimation.

| **Code** | **ECE_Y524** |
|---|---|
| **Title** | **Communications Systems** |
| Instructor | Logothetis<br>Mourjopoulos<br>Stylianakis<br>Karavatselou<br>Mandellos<br>Hatziantoniou<br>Christogianni |
| Credits | 5 ECTS |

**Content:**
**Introduction:** Communication concept and model. Basic components and resources of communications systems. Analog and digital systems (Transmitter - Transmission Channel - Receiver - Distortion - Interference). Examples. Brief review of the evolution of communications systems.
**Analog Transmission:** Need of Modulation. Amplitude Modulation Systems. Demodulation. Angle modulation: Frequency and Phase Modulation. Demodulation of FM signals.
**Effect of noise on Analog Transmission**. The noise as a Stochastic Signal. Power Spectral Density. White Noise. Bandpass noise. Efficiency of the Amplitute Modulation Systems in the presence of noise. Efficiency of the Frequency Modulation Systems in the presence of noise. Pre-emphasis, De-emphasis. Comparison of FM - AM systems.
**Digitazation of analog signals:** Sampling theorem. Quantization of analog signals. Quantization noise.
**Pulse Modulation:** Pulse Amplitute Modulation (PAM), Pulse Duration Modulation (PDM / PWM), Pulse Position Modulation (PPM), Pulse-Coded Modulation (PCM). Efficiency of PCM in the presence of noise. PCM system of 1st and higher order.

**Signal multiplexing:** Orthogonal, Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM).
**Digital Transmission:** General: Symbol coding, Line coding, Transmission Rate, Error rate, Shannon-Hartley Theorem (Shannon's capacity). Spectral (bandwidth) efficiency.
**Baseband digital transmission:** Pulse transmission. Inter-Symbol Interference (ISI). Eye Pattern. 1st and 2nd Nyquist criteria. Filters of Rise Cosine. Transmission channel with Additive White Gaussian Noise. Equalizer and Matched Filter. Baseband transmission using M-ary PAM. Probability of error in the presence of Gaussian noise (use of Q-function).
**Digital transmission with modulated carrier:** Amplitute Shift Keying (ASK, On-Off Keying, OOK), Frequency Shitf Keying (FSK), Phase Shift Keying (PSK), Combined Phase and Amplitute Modulation (QAM), M-ary Phase Modulation (QPSK, 8PSK, 16PSK) and other M-ary modulations. Constellations.
**Examples of communications systems.**

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|---|---|
| **Code** | **ECE_Y525** |
| **Title** | **Electrical Power Systems** |
| Instructor | Alexandridis Giannakopoulos |
| Credits | 5 ECTS |

**Content:**
History of Electric Power Systems. Present and future trends. Computers in power systems Engineering. Introduction to electrical energy transmission and distribution systems. Resistance, inductance and capacitance of transmission lines. Inductive interference with neighbouring communi-cation circuits. Overhead line insulators and corona. Mechanical design of overhead transmission lines. Underground cables. Distribution systems. Determination of size of conductors for distribution system. Voltage drop compensation and power loss minimisation in a distribution system. Current and voltage relation on a short transmission line medium length line and longs transmission line. Reactive compensation of transmission lines. Wave propagation on transmission lines. System modelling per-unit impedances. Power flow analysis of transmission networks.

**6th semester**

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|---|---|
| **Code** | **ECE_Y620** |
| **Title** | **Automatic Control Systems** |
| Instructor | Kazakos |
| Credits | 8 ECTS |

**Content:**
Introduction to Control System (ACS), open and closed loop systems. Laplace transform. System representation (block diagrams, signal flow graphs). Transfer function for a class of servo-mechanisms. Electromechanical ACS. Hydraulic and pneumatic ACS. Stability analysis. Stability criteria. Analysis of ACS in time (root locus) and frequency domain (Nyquist, Bode, Nichols). Direct and inverse polar plots. Stability of ACS in frequency domain (gain margin, phase margin, Nyquist criteria). Constant M and N contours for a closed system on complex plain. Second order systems. Steady state and transient specifications (accuracy, sensitivity, rise time, settling time, overshoot etc.)

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|---|---|
| **Code** | **ECE_Y621** |
| **Title** | **Electric Measuring Devices and Techniques** |
| Instructor | Antonakopoulos<br>Birbas A.<br>Pyrgioti<br>Skodras |
| Credits | 3 ECTS |

**Content:**
General concepts of metering sensors (characteristics, precision classes, sensitivity, classification, selection, etc.), transducers and measurement methodology and methodology, units and standards of measurement, measurement system construction.

1. Measurement errors:
   a. absolute and relative error
   b. accuracy, correctness and discernment
   c. observation errors
   d. systematic errors
   e. accidental errors
2. Sensors and measuring instruments of various electrical, mechanical and other physical sizes:
   a. electrical quantities (voltage, current, resistance, induction, capacitance, power etc.)
   b. power and torque
   c. temperature
   d. position, distance, displacement, speed, acceleration, tilt, level.
   e. telecommunication measuring instruments (frequency and waveform generator, spectrum analyzer, vector signal analyzer, pedometer, etc.)
   f. other sensors and measuring instruments
3. Sensor signal conditioners (measuring bridges, power sources, multipliers, peak detectors, etc.), Non-linearity of sensors and measuring devices.
3. Sensor signal conditioners (metering bridges, power sources, multipliers, peak detectors, etc.), Sensor nonlinear offset and measuring devices.
4. Amplifiers for weak signals (instrument amplifiers, isolation amplifiers, etc.), reference voltage generating circuits
5. Comparison of analogue and digital measuring instruments

| | |
|---|---|
| **Code** | **ECE_Y622** |
| **Title** | Microcomputers / Embedded systems |
| Instructor | Koubias<br>Birbas M.<br>Paliouras<br>Gialelis<br>Konstantinidis<br>Mitropoulos |
| Credits | 4 ECTS |

**Content:**

- Embedded systems models
- Embedded system specifications, low-power design and high-integration architectures
- Hardware for embedded systems, micro-computers family architectures, memory and peripherals
- Microprocessor command sets and programming models.
- Process control: Interfacing with analogue and digital environment, sample-and-hold, analog-to-digital, digital-to-analog converters, sensors, actuators
- Basic principles of real-time operating systems and real / critical system response time, real-time communication
- Parallel and serial communication principles, interruptions
- Intel 8085 and Arduino 8-bit architectures, applications

Laboratory exercises in the programming and interfacing of the above processors

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|---|---|
| **Code** | **ECE_Y623** |
| **Title** | **Electrical Machines I** |
| Instructor | Mitronikas<br>Tatakis |
| Credits | 8 ECTS |

**Content:**

The basic principles of the electric and magnetic field, iron losses, leakage. Transformers: Basic construction (core, windings). Cooling, voltage equations and equivalent circuit of single-phase transformer, operation behaviour, efficiency, short-circuit operation, parallel operation of transformers, calculation of the leakage. Three-phase transformers, winding connections, unbalanced duty. Transformers for measurements. Advanced equivalent circuit, heating of transformers. Direct current machines: Basic construction, windings, induced voltage, electromagnetic torque, magnetic field and armature reaction, compole winding and compensating winding, armature current, current commutation, armature reaction, connections of DC machines, operation as generators and as motors, starting, braking, voltage and speed control.

Induction Machines: Basic construction, windings, magnetic field, equations and equivalent circuit, power, currents, electromagnetic torque, starting, heating, Ossana's circle, speed control, theory of the squirrel-cage-rotor machines, higher harmonics. Synchronous machines: Basic construction, cooling, excitation, non salient-pole machines, magnetic field equations, electromagnetic torque, parallel operation, current circle diagram, armature reaction, behaviour under load, short-circuits, salient pole machine, inductive reactances, steady state equations, current circle diagram, vibrations, stability, starting, synchronism, power control. Single phase machines: Synchronous, asynchronous.

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|---|---|
| **Code** | **ECE_Y624** |
| **Title** | **Engineering Drawing** |
| Instructor | Vovos P.<br>Tsemperlidou |
| Credits | 4 ECTS |

**Content:**

– Introduction to Computer Aided Design (CAD). – Practice on orthogonal projection. – Full section: definition and design. – Complex sections. – Introduction to electrical design. – Lighting circuits. – Simple electrical installations. – One line diagrams for domestic electrical installation. – Design of electrical service panels. – Basic principles and design of automation circuits.

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|---|---|
| **Code** | **ECE_Y625** |
| **Title** | **Algorithms and Data Structures** |
| Instructor | Housos<br>Valouxis<br>Dilios |
| Credits | 4 ECTS |

**Content:**

Introduction, performance analysis, array and structures, stacks and queues. Lists. Trees. Graphs. Sorting. Searching. Recursive algorithms, hashing.

## FOURTH YEAR

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|---|---|
| **Code** | **ECE_AK701** |
| **Title** | **Information Theory** |
| Instructor | Denazis<br>Moustakides<br>Birbas M. |
| Credits | 5 ECTS |

**Content:**

- Introduction to Information Theory. What is information, how is it measured?
- Probability, Entropy, and Inference
- The Source Coding Theorem, Discrete and memoryless sources of symbols
- Symbol Codes (Fixed and Variable Length)
- Stream Codes
- Communication over a Noisy Channel
- The Noisy-Channel Coding Theorem
- Coding and Error Correction Theory.
- Introduction to Coding Theory. Error Detection. Error Correction.
- Linear Codes: Generator and Parity Check Matrix. Decoding with Cosets. Decoding with Syndromes. Hamming codes. Dual Codes. Perfect Codes.
- Cyclic Codes: Basic Theory, Encoding and Decoding of Cyclic Codes.
- Finite Fields (Galouis Fields). BCH Codes: Basic Theory, Encoding and Decoding of BCH Codes with error correction capability of 2 errors or more.
- Reference to Convolutional Codes: Basic Theory, Encoding and Decoding (Viterbi) of Convolutional Codes

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|---|---|
| **Code** | **ECE_AK702** |
| **Title** | **Wireless Propagation** |
| Instructor | Kotsopoulos |
| Credits | 5 ECTS |

**Content:**
Electromagnetic propagation mechanisms, multipath phenomenon, diffraction by edges and corners, geometrical theory of diffraction, uniform theory of diffraction, fresnel zones, Fresnel zone clearance, path gai for wireless applications, diffraction by multiple edges, propagation in the presence of building in various terrain, shadow fading and the effects of terrain and trees, site specific propagation prediction, path loss models (indoor areas, outdoor areas and open air areas), Empirical RF models, stochastic RF models, applications in the design and optimization of wireless networks.

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|---|---|
| **Code** | **ECE_AK703** |
| **Title** | **Digital Communications I** |
| Instructor | Stylianakis |
| Credits | 5 ECTS |

**Content:**
**Introduction, Signal Spectra and Noise**
Noise in communication systems.
Signal transmission through linear systems.
**Digital Communications Model**
Elements of a Digital Communications System.
Communication Channels.
A Historical Perspective in the Development of Digital Communications.
**Source Coding**
Sampling.
Quantization and encoding.
Baseband transmission.
Elements of Information Theory.
Information Measures.
Coding for Discrete and Analog Sources.
**Optimum Receivers for the Additive White Gaussian Noise Channel**
Correlation Modulation.
Matched Filter Modulation.
Maximum-Likelihood Sequence Detector.
Performance of the Optimum Receiver.

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|---|---|
| **Code** | **ECE_AK704** |
| **Title** | **Microwaves** |
| Instructor | Koulouridis |
| Credits | 5 ECTS |

**Content:**
**Transmission Lines Theory:.** Circuit analysis of transmission line. Electromagnetic analysis and distributed elements. Telegrapher's equations. Lossless transmission line termination. Smith Chart. $\lambda/4$ transformer. Source and load matching. Lossy transmission lines.
**Transmission lines and Waveguides.** General solutions for TEM, TE και TM modes. Parallel plates waveguide. Rectangular and circular waveguide. Coaxial line. Striplines. Microstrips
**Microwave Network Analysis.** Impedance and equivalent voltages and currents. Impedance and Admittance matrices. Scattering Matrix. Transmission (ABCD) matrix. Signal Flow graphs.

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|---|---|
| **Code** | **ECE_AK705** |
| **Title** | **Artificial Intelligence** |
| Instructor | Moustakas<br>Sgarbas<br>Peppas<br>Christogianni |
| Credits | 5 ECTS |

**Content:**
Problem-solving methods, search techniques, propositional and categorical logic, decision-making, game theory, machine learning. The

laboratory addresses problem solving with search algorithms and cnstraint satisfaction problems in Prolog programming language, game theory and machine learning.

The curriculum per week is as follows:

1. Introduction-Intelligent Agents: Definition, historical review, link to other disciplines. Rationality, performance measures, operational environment, agent structure.
2. Problem solving with search: State spaces, search trees, uninformed search methods (depth-first, breadth-first), partial-information search.
3. Informed search and exploration: Best First and A* algorithms.
4. Local search algorithms I: Hill climbing, simulated annealing.
5. Local Search Algorithms II: Genetic Algorithms.
6. Constraint Satisfaction Problems: Constraint propagation, early check, arc consistency.
7. Adversarial Search: Optimal strategies in two person games, minimax algorithm, alpha-beta pruning, extension to multiplayer games, extension to games of chance, expectiminimax algorithm.
8. Game Theory I: Games of simultaneous moves, Nash equilibrium.
9. Game Theory II: Theory of Usability and Decision Making.
10. Logic I: Propositional logic, reasoning patterns, resolution, logic circuits.
11. Logic II: First-order logic (categorical logic), inference rules for quantifiers, unification, inference chains, theorem proving.
12. Machine learning I: Introduction, modeling, decision trees.
13. Machine learning II: Bayes Networks, naive Bayes models, probabilistic reasoning, inference with Markov chains, hidden Markov models.

| **Code** | **ECE_AK706** |
|---|---|
| **Title** | **Access and Switching Networks** |
| Instructor | Lymperopoulos Stylianakis |
| Credits | 5 ECTS |

**Content:**

Basic principles of network architecture of TCP/IP technology, with reference to the most important functional components found in network systems and their devices, and participate in packet routing and layer communication among the layers of Link (L2), Network (L3), Transport (L4) and Application (L5) . Operations and functions of Link layer, address structure and assignment, and frame transmission in the context of local networks, the ARP protocol and its use. Operations and functions of Network layer and its protocol IPv4, structure and address assignment in IPv4 (classfull and classless addresses), IP packet routing principles across various subnetworks in order to support end-to-end ubiquitous connectivity. Design of and functionality of L4 protocols TCP and UDP, explain the corresponding protocol state diagrams. Explain the difference between connection oriented and connectionless connections. Socket programming. Basic operations in applications layer, namely, NAT, DNS and DHCP. Introduction to IPv6 and its differences to IPv4.

**1.** *Introduction to Access Networks:* Telecommunications Networks. Introduction to Access Networks

**2.** *Access Technologies:* Wired - Wireless - Optical - BPL - Satellite - Hybrid

**3.** *Access Techniques:* Channel Models - Modulation - OFDM - Spread Spectrum - Standards.

**4.** *Techno-economic Elements:* Diffusion predictions - Genetic algorithms -

Dimensionalization - Cost analysis and comparisons.

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|---|---|
| **Code** | **ECE_AK707** |
| **Title** | **Electroacoustics** |
| Instructor | Mourjopoulos |
| Credits | 5 ECTS |

**Content:**

*Introduction* Electroacoustics (specialization areas, applications, history). General features and structure of sound systems, types of distortions in such systems, principles of sound perception and audio system reproduction

*Sound sources, waves and quantities* Acoustic waves and equations. Frequency analysis of signals, relevant acoustic quantities, sound sources, directivity. Sound pressure level, loudness and noise measurement

*Electromechanical and electrocoustical analogies, transduces and circuits* The relationships of the elements and the transduction in electro-mechanical-acoustical systems. Equivalent (analogous) circuits, transducer sensitivity and frequency response

*Microphones* Principles of operation, types, electrical and acoustical characteristics. Use of microphones in recording

*Loudspeakers* Principles of operation, types and technology evolution. Electromechanical system response and acoustic radiation. Electromagnetic loudspeaker drivers, analysis and equivalent circuits. Loudspeaker cabinets, cross-over circuits. Measuring loudspeaker systems and principles of design and construction

*Room Acoustics* Significance, history and theoretical approaches. Principles of wave theory, sound field in an enclosed space, Reverberation Time, Geometric approach, use of Signal theory and processing. Speech intelligibility and acoustic reverberation. Systems for simulating, predicting and analysing room acoustics, computer software methods, Acoustics and Virtual Reality applications

*Sound systems: general principles and acoustic coverage* Acoustic principles of electroacoustic and sound installations / systems. Aspects of source / receiver distance, acoustic gain, delay, directivity. Loudspeaker properties, arrays, directivity, installation and acoustic system equalisation

*Sound systems: electrical properties* Input/ output relationships. Preamplifier characteristics, operation and circuit analysis. Power amplifiers (stages, types, design, properties), digital amplifiers. Interconnections principles and practice in sound systems. Typical examples of sound systems and installations

*Laboratory Exercises*

**Lab.1** *Introductory concepts - signal processing and its application in Electroacoustics*

Frequency Response Measurements in Electroacoustic Systems. Signal to Noise and Harmonic Distortion Measurements in Electroacoustic Systems.

**Lab.2** *Measurement of Environmental Noise and of Noise Insulation*

The students familiarize with the use and the functions of sound level meter and learns to measure noise levels, equivalent level and noise in 1/3 octaves, as well as the measurement of Sound Reduction Index and Sound Insulation in a building arrangement.

**Lab.3** *Measurement of Microphone and Loudspeaker characteristics.*

The exercise covers measurement of sensitivity and directivity for different microphones as well as measurement of sensitivity, response and impedance of loudspeaker systems.

**Lab.4** *Measurement, Analysis and Computational simulation of Acoustics in Enclosed Spaces*

The exercise combines prediction and measurement of the acoustic parameters for a given enclosed space. The students must compare the results between the predictions and the measurements and discuss any differences. Another aim of the exercise is to optimize the acoustics of a simple "show-box" shaped space by choosing appropriate absorption materials for the various surfaces. This optimization will be based on dedicated acoustic prediction software. The results will be assessed with respect to the optimal choice for Reverberation Time and speech intelligibility.

**Lab.5** *Measurement of the specifications for a power amplifier*

The exercise covers the measurement procedure for assessment of a power amplifier total harmonic distortion with respect to the variation of its output load (via combinations of different number of loudspeakers).

**Lab.6** *Electroacoustic installation: connections, measurement and sound engineering*

The exercise familiarizes the students with the practices involving setting up a realistic sound system and the use of the individual system components and devices. After connecting the individual components, the students must measure the response of the installation using computer software.

| **Code** | **ECE_AK708** |
|---|---|
| **Title** | **Information Retrieval** |
| Instructor | Makris |
| Credits | 5 ECTS |

**Content:**

Introduction (user modeling, logical text representation, retrieval process)

1. Performance evaluation metrics ((recall, precision, average precision, R-precision, precision histograms, NDCG metric, harmonic median, user oriented metrics).
2. Modeling in Information Retrieval
3. Boolean models, fuzzy set model, extended boolean model, algebraic models (probabilistic models, latent semantic indexing model, topic models), probabilistic models (classical and linguistic models)
4. Information Retrieval on the World Wide Web and Its Specifics
5. Web Search Engines (crawler, indexer), HITS algorithm (Hyperlink-induced topic search), Google search engine (PageRank metric), SALSA algorithm, web search variants.
6. Indexing structures (inverted files, signature files, bitmaps).
7. Full indexing structures in main memory (suffix trees, suffix arrays, acyclic directed graphs (DAWG) for strings), and in secondary memory (supra-suffix array, prefix B-tree, string B-tree).
8. Compressing Texts and Indexing Structures
9. Applications of Machine Learning Algorithms to Corpora/Texts.

| **Code** | **ECE_AK709** |
|---|---|
| **Title** | **Computer Graphics and Virtual Reality** |
| Instructor | Moustakas |
| Credits | 5 ECTS |

**Content:**

1. *Basic Concepts*

Introduction in computer graphics and virtual reality, graphics pipeline, I/O graphics devices, drawing algorithms, polygon drawing, anti-aliasing. Affine transformations, 2D and 3D transformations, homogenous coordinates, viewport transformations.

2. *Common procedures*

Line and polygon culling algorithms in 2D and 3D. Projections. Stereoscopic vision. Z-

buffering. Shadows, texture. Basic shading principles. Color.

3. *Advanced topics*

Ray tracing, global illumination, motion, articulated motion, virtual reality simulations, physics based simulations. Virtual, augmented and mixed reality.

*Laboratory Exercises*

**Lab.1** *Introduction in OpenGL*

OpenGL application interface (Initialization/ Event handling/Representation). Orthogonal Projection. Colors RGBA. Basic shapes.

This Lab aims to present to the students, the structure and functionality of OpenGL through glut library. Also after the first exercise students will learn to draw, color on RGBA mode and project to the screen basic geometric shapes.

**Lab.2** *Motion*

Basic 3D objects. Transformations. Perspective projection. Objects Motion.

In this Lab students learn to apply motion in basic 3D objects and shapes using several transformations. Moreover perspective projection helps to better perceive motion in 3D space.

**Lab.3** *Lights*

Lighting and light sources. Colors and materials. Polygonal models.

Lights are very important for the nice and correct rendering of a 3D scene in an virtual reality environment. Different types of light sources in combination with different material types can give the feeling of real in this environment. Students will learn not only how to apply and manage lights sources, but also how to load and manage polygonal models in a more format.

**Lab.4** *VRML*

Virtual Reality Markup Language. Basic shapes. Lights.

VRML is a markup language that easily can describe objects in 3D environment. Students will use this language to describe the 3D objects that hey use in previous labs. Moreover they will apply RGB and CKY lights in a scene.

**Lab.5** *Interaction Part 1*

Fonts in OpenGL. Menu creation. Event handling from IO devices (keyboard/ mouse)

Interaction with the user is a very important aspect of virtual reality. In this exercise students will learn how to create menus and manage select events using glut library.

**Lab.6** *Interaction Part 2*

Interaction (apply transformation based on keyboard and mouse events). Camera.

Following the previous Lab students will learn how to manipulate the orientation and the position of the camera in 3D scene, using keyboard and mouse events.

**Lab.7** *Texture*

Texture mapping on basic geometric objects.

Applying textures is an important element in all virtual reality applications. Students by completing this Lab exercise will learn how to map a texture in a simple geometric object and how to load and apply an already mapped texture on a more complex mesh model.

**Lab.8** *Physics Engine*

Newton laws. Collision detection. Spring simulation.

Behavior of the objects in a virtual reality 3D scene and the interaction between them should be in a way that seems real to the human eye. Physics law have to be applied. Collision detection, the calculation of the forces that will produced after the collision and the accurate calculation of the position of all objects in each time frame is a difficult problem to solve.

| **Code** | **ECE_AK710** |
|---|---|
| **Title** | Biomechanics I |
| Instructor | Deligiani<br>Mavrilas<br>Mahinetzis |
| Credits | 5 ECTS |

**Content:**
Introduction to biomechanics principles, Structural elements of the human body. Biomechanics of the musculoskeletal system - bones, muscle: Basic anatomy and physiology, Mechanical functions, Physiological functions, Composition, Microscopic- macroscopic structure, Tissue mechanical characteristics. Bone fracture and remodeling. Mechanical adaptation. Muscle contraction and its modeling. Kinematics elements. Musculoskeletal modeling.
Biomechanics of soft connective tissues (SCT): Anatomy - histology of SCT. Biopolymers composing SCT. Mechanics of SCT, static and dynamic, correlation with its components and structure. Mathematical modeling of SCT mechanics. Biomechanics of blood circulation: Anatomy and physiology. The heart as a pump. Circulation fluid dynamics. Systemic circulation in arteries, veins, bifurcations. Blood-Vessel interaction. Mechanical characteristics of cardiovascular implants (heart valves, vessels). Blood flow equations, blood flow dynamics.
Respiratory system. Artificicial oxygenation, extracorporeal blood circulation. Kidneys, artificial kidney, hemodialysis systems. Measurement techniques for pressure, strain, velocities in the human body and in artificial organs.

| **Code** | **ECE_AK801** |
|---|---|
| **Title** | **Communications Laboratory I** |
| Instructor | Antonakopoulos<br>Denazis<br>Koulouridis<br>Kotsopoulos |
| Credits | 5 ECTS |

**Content:**

- Electromagnetic Wave Propagation Topics. Microwave power sources. Measurement of transport lines. Study of antenna characteristics. Electromagnetic wave parameters measurement.
- Information Transmission Topics. Analog and digital modulation. Modulation techniques. Spectrum analysis and characterization. Spread spectrum systems.
- Networking of telecommunication systems. Monitoring and analysis of packets and protocols in telecommunication systems. Design and implementation of telecommunication network topologies. Telecommunication network programming.

| **Code** | **ECE_AK802** |
|---|---|
| **Title** | **Wireless and Mobile Communications Networks** |
| Instructor | Kotsopoulos<br>Lymperopoulos |
| Credits | 5 ECTS |

**Content:**
Basic concept of cellular wireless networks, the hierarchical structure of an organized wireless network (the radionetwork level, the switching level and the management level), the architectures of cellular systems of various technologies and various generations (e.g. GSM, GPRS, EDGE, LTE, UMTS, Wi-Fi, etc), Satellite Networks and the effect of the wireless satellite channel, QoS issues, SNR, BER and G/Ts, Blocking Probability, Design issues of terrestrial wireless networks and design issues of satellite networks, involved protocols in terrestrial and satellite networks.

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|---|---|
| **Code** | **ECE_AK804** |
| **Title** | **Antennae Theory** |
| Instructor | Koulouridis Kotsopoulos |
| Credits | 5 ECTS |

**Content:**

Basic antenna concepts, point sources, arrays of point sources, the electric dipole and thin linear antennas, the loop antenna, the helical antenna, the biconical antenna, the cylindrical antenna and the moment method, self and mutual impendences, arrays of dipoles and its apertures, reflector antennas and their feed systems, slot, horn and complementary antennas, lens antennas, antennas measurements, antennae applications

Principles of radio propagation in homogeneous media, Principles of radio propagation in turbulent media, Fundamental technical parameters of the antennae, Linear Wire Antennae. Aperture Antennae, Antennae Arrays, Design of special type of antennae (Planar Antennae, Reflector Antennae, Broadband Antennae), Antennae Measurements and Matching Techniques, Applications: Analysis of the Line–of– Sight (LOS) Radiolink Systems (ERP, 1st Fresnel Zone Clearance, Excess Path Loss due to the K factor, Free Space Loss, Hydrometeor Attenuation, Link Budget, Radiolink System Availability, Performance Parameters of Radiolink systems * Analysis of the Troposcatter Communications Systems (Scattering Effects and Link Budget) * Radar Equation and analysis of the involved electromagnetic parameters * Antennae Co-location techniques and Analysis of the involved Technical Parameters of an Antennae Park (Notch Filters, Combiners, Patch Panels and Power Dividers, Antennae Feeders), The practical experience of the fourth year students, include laboratory work in the investigation of the Antennae Technical Parameters (VSWR measurements, Gain Measurements, Radiation Pattern Measurements, Radiolink Measurements).

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|---|---|
| **Code** | **ECE_AK804** |
| **Title** | **Teletraffic Theory and Queueing Systems** |
| Instructor | Logothetis |
| Credits | 4 ECTS |

**Content:**

- Introduction - The objectives of Teletraffic Engineering - The Nature of Teletraffic. Features and Modelling of Teletraffic Systems.
- Traffic load - Properties. Markov Property. Little's Law. Traffic from Terminals and Aggregated Traffic.
- Markovian Loss Systems: M/M/s – M(n)/m/s
- Markovian Delay (Queueing) Systems.
- Birth-Death Process.
- Open and Close Queueing Networks.
- Mean Value Analysis.
- Multi-Dimensional Traffic Models – Trunk Reservation System. The Erlang Multirate Loss Model (EMLM).
- Restricted availability.
- Overflow System – Equivalent Random Theory. Design of Alternative Routing.
- Traffic Simulation.
- Computer Implementation of Basic Teletraffic Formulas.

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|---|---|
| **Code** | **ECE_AK805** |
| **Title** | **Optical Communications** |
| Instructor | Tomkos |
| Credits | 5 ECTS |

**Content:**

Historical overview, optical fibers (geometrical optics description, solution of Maxwell equations for step-index fiber, loss, chromatic dispersion, polarization –mode dispersion, nonlinear effects), optical transmitters (with directly modulated single-frequency semiconductor lasers and with external modulators), optical receivers (with p-i-n and avalanche photodiodes, using direct or coherent detection), erbium-doped fiber amplifiers, single-wavelength and multiwavelength optical communications systems design and performance evaluation, introduction to transparent optical networks.

| **Code** | **ECE_AK806** |
|---|---|
| **Title** | **Digital Communications II** |
| Instructor | Stylianakis |
| Credits | 5 ECTS |

**Content:**

*Channel Capacity and Coding*
Channel Models.
Channel Capacity.
Channel Capacity with Orthogonal Signals.
Channel Reliability Functions.
*Signal Design and Communication for Band-Limited Channels*
Signal Design for Band-Limited Channels.
Probability of Error.
Modulation Codes for Spectrum Shaping.
Optimum Receiver for Channels with ISI and AWGN.
Equalization.
*Multichannel and Multicarrier Systems and Multiuser Communications*
Introduction to Multiple Access Techniques
OFDM
Spread Spectrum
CDMA

| **Code** | **ECE_AK807** |
|---|---|
| **Title** | **Introduction to Bioinformatics** |
| Instructor | Makris |
| Credits | 5 ECTS |

**Content:**

*Part One:* Introduction to the use of algorithms for the efficient management and storage of strings and biological data sequences. Accurate template matching algorithms (Boyer-Moore, Knuth-Morris-Pratt, Shift-Or, Multi-Template). Introduction to suffix tree and its applications. Sequence Alignment Algorithms for Alignment and Sequence Alignment. Search Algorithms in Sequence Databases (FASTA, BLAST, PROSITE).
*Part Two:* The Theoretical Basis of Molecular Design. Molecular Models and Biochemical Information. Structure-Based Drug Design. Open Problems.
*Part Three:* Clustering Techniques for predicting the behavior of biological molecules.

| **Code** | **ECE_AK808** |
|---|---|
| **Title** | **Pattern Recognition** |
| Instructor | Dermatas<br>Sgarbas<br>Christogianni<br>Mandellos |
| Credits | 5 ECTS |

**Content:**

Basic concepts of pattern recognition. Supervised and unsupervised training. Estimation of the probability of classification error-Error bounds. Distance functions. Minimum distance pattern classification. k-nearest neighbour classification. Single and multiply prototypes. Decision functions. Linear decision functions. Perceptron and k-

means algorithm. Bayes classifier. Bayes decision rule for minimum risk. Estimation of probability density function: Maximum entropy criterion, Parzen estimate, ortho-normal functions approximation. Stochastic approximation of the probability density function: Robbins-Monro and LMS algorithm. Neural networks structure. Error correction, competitive and hebbian learning. Multilayer perceptron. Back-propagation of error. Radial-Basis function networks. Hopfield machine. Syntactic pattern recognition. Formal languages. Type-0,1,2,3. CYK algorithm. Stochastic languages. Grammatical inference. Error correction.

Training pattern recognition systems: Line search, gradient descent, Conjugate gradients, Newton, the Levenberg-Marquart algorithm, Bayes learning, Monte Carlo methods, simulated annealing, Genetic algorithms. Minimum description length principle. Pre-processing and feature selection. Karhunen-Leone expansion. Syntactic pattern recognition and error correction. Markov and hidden Markov models, recurrent neural networks and non-linear temporal processing. Image recognition applications.

| | |
|---|---|
| **Code** | **ECE_AK809** |
| **Title** | **Digital Audio Technology** |
| Instructor | Mourjopoulos |
| Credits | 5 ECTS |

**Content:**

*Introduction*

Analysis of technology history, evolution and market trends. Current developments and future predictions.

*Theory of digital audio*

Principles of digital audio conversion (samling, quantisation), Oversampling, Noise Shaping, signal arithmetic representation and coding, ADC and DAC subsystems

*Coding and compression*

Coding formats, data representation, PCM, Σ/Δ, PWM and other relevant audio signal representations. Perceptual audio data reduction, MPEG-1 (MP3), MPEG-2, Dolby, MPEG-4 coding standards. Standards and technologies for audio data transmission and storage, optical disc formats (CD, DVD, BD)

*Systems and methods*

Structure and general properties of digital audio systems, digital interconnection standards (S/PDIF, AES/EBU, MADI, etc), MIDI, implementation of DSP methods for audio, DSP processor based systems, implementation in software. DSP applications (digital equalization, compression, reverb / delay, moise reduction, etc.). Analysis of systems for typical case studies.

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|---|---|
| **Code** | **ECE_AK810** |
| **Title** | **Speech and Natural Language Processing** |
| Instructor | Sgarbas |
| Credits | 5 ECTS |

**Content:**

The syllabus includes: Stages of Language Processing, Coding, Levenshtein Distance, Optimal Paths on the Levelshtein Matrix, Multiple Paths at the Levenshtein Matrix, Regular Expressions, Finite State Automata (FSA), Transition from Regular Expressions to FSA, FSA Types: Cyclic, Acyclic, Deterministic, Mathematical Definition of Automata, FSA Extensions: Twins, Parallel, Transducers, FSA Applications, Morphological Analysis, the Morphological Model of Kay-Kaplan, the Two-Level Morphological Model, Formal Languages and Grammars, Chomsky Hierarchy, Chomsky Normal Form (CNF), CKY

Algorithm, Logarithms and Logprobs, Probabilistic Type-2 Grammars, Text Corpora Categories, PCFG to CNF Conversion, Probabilistic CKY, Language Models, Bigram Count Matrix, Bigram Probabilities Matrix, Laplace Smoothing, Backoff, Interpolation, Trigram Count Matrix, Language Model Files, Spell-Check Correction with Language Models, Entropy and Perplexity, Text Classification with Compression, WordNet. Speech production modeling modeling: Speech production mechanism, Speech sounds, Speech production model. Digital speech signal pre-processing: Selection of sampling frequency, Digitization, Short-term speech signal analysis, Frame length selection, Pre-emphasis, Window filter selection, Frame movement rate. Acoustic Parameters: Energy, Zero Transitions, Fundamental Frequency, Pitch Estimation Methods, Spectrum analysis, Formants, Linear Prediction Coefficients (LPC), Filter Bank, Reflection Coefficients, Cepstral Coefficients. Speech Processing Techniques: Auditory Pattern Matching, Dynamic Time Warping (DTW), Vector Quantization, K-means Algorithm, VQ Codebook with Density Mixing, Hidden Markov Models (HMM) Modeling, Forward-Backward Algorithm, Viterbi Algorithm. Speech recognition systems. Speaker recognition systems. Speech Synthesis: Basic Principles, Unit Size, Unit Types, Synthesis Methods, Limited vs Unlimited Vocabulary Systems. Synthesis with Formants, LPC synthesis, Modeling of the source of stimulation, Prosody Modeling, Evaluation of the LPC model by sample-sample procedure, Modeling the speech signal with poles and zeros, Methods of calculating the parameters of the ARMA model, Problems of the ARMA model. Digital noise filtering techniques. Speech coding: Techniques for coding the speech waveform (time domain), Coding using the speech spectrum (frequency domain), Coding techniques using analysis-synthesis (frequency domain), Linear prediction coding.

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|---|---|
| **Code** | **ECE_AK811** |
| **Title** | **Computational Geometry and 3D Modelling Applications** |
| Instructor | Moustakas |
| Credits | 5 ECTS |

**Content:**

1. Introduction and basic concepts of geometric algorithms
2. Capability to express common problems with geometric terms and resolution using computational geometry algorithms
3. Mathematical background for the representation of 2D-3D data and geometric primitives
4. Data structures and complexity analysis of computational geometry algorithms
5. Familiarization with object-oriented programming and computational geometry, 2D-3D representation libraries
6. Capability to generalize the acquired knowledge and apply it in problems of several scientific domains of Electrical and Computer Engineering

*Laboratory Exercises*

- Lab exercise 1: Introduction to geometry processing and programming in C++
- Lab exercise 2: Convex hulls
- Lab exercise 3: Sections
- Lab exercise 4: Triangulation
- Lab exercise 5: 3D bounding volumes and sections
- Lab exercise 6: Space partitioning
- Lab exercise 7: Linear programming
- Lab exercise 8: Application in 3D computer vision

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|---|---|
| **Code** | **ECE_AK812** |
| **Title** | **Digital Processing and Image Analysis** |
| Instructor | Moustakas |
| Credits | 5 ECTS |

**Content:**

- Introductory Concepts, Applications of Digital Image Processing and Analysis.
- Overview of 2D signals, image transformations.
- Basics of the digital image acquisition process.
- Image upgrade methods.
- Image restoration, presentation of basic techniques.
- Image compression (with - without loss).
- 3-D body reconstruction from 2D projections (images).
- Detection of contours.
- Define image areas.
- Description and representation of shapes.
- The basic structure of an image analysis and interpretation system. Aσ Basics of color theory and color image processing.

*Laboratory Exercises*

- Lab. 1: Image filtering in the frequency domain.
- Lab. 2: Quantum Image (Scalable and Vector).
- Lab. 3: Image Compression Using DCT Transformation.
- Lab. 4: Image Editing with Histogram Techniques.
- Lab. 5: Image Recovery (Reverse Filter Method and Wiener Method).
- Lab. 6: Detecting Outlines.

*Project* (*selection from list of topics*).

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|---|---|
| **Code** | **ECE_BK701** |
| **Title** | **Electrical Power Systems Analysis** |
| Instructor | Konstantopoulos |
| Credits | 5 ECTS |

**Content:**

Fundamental concepts of electric power systems engineering: concepts of real, reactive and complex power. Per unit system. The structure of electric power systems. Transmission capacity. Operational characteristics of power systems. Modelling of basic components of power systems: the synchronous machine, the power transformer, the high-energy transmission line. System modelling and load flow analysis: construction of the general equations, load flow solution by the Gauss-Seidel and Newton-Raphson iterative methods.

**Lab.1** getting familiar with basic equipment, phase sequence, active and reactive power measurement.

**Lab.2** active and reactive power flow on a transmission line feeding various load types.

**Lab.3** system operating parameters affecting active and reactive power flow.

**Lab.4** dependence of active power flow on delta angle difference between buses.

**Lab.5** the synchronous machine as a motor and as a generator.

**Lab.6** the synchronous compensator.

**Lab.7** Revision lab.

*Lab.exams*

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|---|---|
| **Code** | **ECE_BK702** |
| **Title** | **High Voltages** |
| Instructor | Pyrgioti |
| Credits | 5 ECTS |

**Content:**

This course provides the basic knowledge on the technology of High Voltages and their application on transmission, distribution and

industrial networks and facilities, by teaching the following subjects: The necessity of using High Voltages. The evolution of High Voltage networks in Greece, Europe and worldwide. Basics on the behaviour of solide, liquid nad gaseous dielectrics. High Voltage Electric fields. High Voltage neworks and substations. Open air and gas insulated substations. Generation of overvoltages. Low frequency dynamic and transient overvoltages. High Voltage network behaviour under lightning and switching overvoltages. Overvoltage propagation on High Voltage Transmission Lines. Regulations and standards for High Voltage techology. The necessity for testing of High Voltage electrical equipment. The behaviour of air and $SF_6$ gaps in different forms of High Voltages. Study and desing of dielectric insulation of Transmission Lines and Substations. Insulation coordination in Electric Power Systems. Phenomenon Corona in High Voltage Transmission Lines. Electromagnetic interference caused by High Voltage power systems. Applications of High Voltages in bioengineering and electrostatic precipitators and other industrial operations.

**Lab.1** *Impulse Breakdown test in air*
Aim of the exercise is the generation and measurement of Impulse High Voltage and stressing on Air gap. It is studied the impact of: the breakdown Voltage, the electrodes geometry, the timescale of the impulse voltage and the environmental conditions. Accordingly are statistically analyzed the experimental results estimation of V50%, σ derived from the tests and compared with the theoretical evaluation of these configurations.

**Lab.2** *Determination of the Voltage distribution along the insulator strings*
In this exercise it is determined the distribution of the High Voltage along the insulator strings, which is an indicative test for the quality of the insulator string condition. Hence, it is studied the impact of the addition of toroid on the insulator string. This method is also used for tracing of damaged insulator discs on the string. Furthermore the High Voltage laboratory is equipped with the aforementioned equipment for Electric Field measurement on insulator strings.

**Lab.3** *Grounding resistance and ground resistivity measurement*
On this exercise the values of installed groundings are measured along with measurement or evaluation of ground resistivity. The measurements are compared with the calculated theoretical formulas and analyzed.

**Lab.4** *Dielectric Liquids – Dielectric Strength*
On this study, Breakdown Voltage measurements are held in order to evaluate the conformity of the dielectric oil with the IEC standards. The measurements are made according the regulations with High Voltage AC and Impulse Voltage measurements.

**Lab.5** *Corona Discharge study for High Voltage transmission and distribution lines.*
It is calculated theoretically the initiation of Corona discharge for different types and configurations of lines under High Voltage. Accordingly the experimental initiation of the Corona discharge is compared with the calculated ones.

**Lab.6** *Fuell Cell*
On this case study an effort to acquaint with the operation of a PEM type fuel cell is done for three different loads. The voltage and the current are recorded for every ten degrees of elevation, and the I-V waveforms are obtained.

**Lab.7** *Standarized tests of equipments with Impulse High Voltage*
Aim of this work is to test the High Voltage equipment according to the International standards. Herein, the students are attuned with the test method and the standardized technique of measurement.

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|---|---|
| **Code** | **ECE_BK704** |
| **Title** | **Electrical Installations** |
| Instructor | Kromydas |
| Credits | 5 ECTS |

**Content:**
Effects of the electric current through the human body and protection according to IEC 479-1, 479-2, CENELEC 384 and IEC 364. Protection against electric and magnetic fields according to the ICNIRP-guidelines and the Norm CENELEC ENV 50166-1. Protection of low-voltage equipment: Protection devices, selective protection, protection of lines, transformers and motors. Description of low-voltage electrical installation's equipment: energy consumption devices, wires and cables, distribution boards, low-voltage switchgear, controlgear and protective devices etc. Lighting engineering: definitions, quantity and quality of illumination, lamps, luminaires, calculation methods for indoor- and outdoor lighting, floodlighting. Motor installations: technical and operational characteristics, switching of motors via contactors, starting, reversing, pole-changing and stopping, application of induction motors in pumps, ventilating fans, elevators. Selection criteria and calculations for electrical equipment: wiring systems, current-carrying capacity, cross-section of insulated conductors and cables, voltage drop in consumer's installations, selection of devices for isolation, switching and protection, power-factor correction.

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|---|---|
| **Code** | **ECE_BK705** |
| **Title** | **Power Electronics I** |
| Instructor | Tatakis |
| Credits | 5 ECTS |

**Content:**
Operation of high power electronic converters, semi-conductive elements, constructional and operational properties of thyristors and their static and dynamic behaviour, triggering, protection, cooling. Converters without commutation (ac-choppers), single-phase and three phase converters with anti-parallel thyristors and their control, reactive power, waveforms of the current and voltage. Converters with line commutation, fully controlled single-phase bridge, commutation phenomena, current and voltage wave-forms, reactive power, control of dc-machines, double single-phase converter, half controlled single phase bridge. Three pulse converter, three phase bridge, waveforms, power, single and double commutation. Calculation of a rectifying system, transformers for power electronic converters, commutation and control reactive power.

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|---|---|
| **Code** | **ECE_BK706** |
| **Title** | **Electric Motor Drive Systems I** |
| Instructor | Mitronikas |
| Credits | 5 ECTS |

**Content:**
The purpose of the electric motor drive systems, their construction, the operation of the system motor-work machine, stability, torque of inertia, transient operation, the selection of the electric motors, losses and heating problems, operation behaviour and control, block diagrams and transfer functions, power electronic converters for controllable supply of electrical motors, automation. Special types of motors, very low power motors, applications, linear motor.

| | |
|---|---|
| **Code** | **ECE_BK707** |
| **Title** | **Thermal Plants** |
| Instructor | - |
| Credits | 5 ECTS |

**Content:**
Introduction to power generation devices and systems. Properties, state and balance, processes and cycles. Pure substances, phases, phase shift processes, property charts. Equations, Ideal gas. First Law of Thermodynamics (closed and open systems). Thermodynamic analysis of control volume, permanent flow processes, analysis of permanent flow devices in thermal networks. Second law of thermodynamics, efficiency coefficients, motionless. Carnot cycle and axioms, entropy, extrapolation, entropy growth principle, Balances. Heat Transfer by Action, Synthesis, and Radiation. Heat Transfer Problems, Alternators. Power cycles with air. Basic considerations, Otto, Diesel circles. The gas turbine cycle (Brayton) (Ideal, regeneration, reheating). Steam Power Generation Cycles - Power Plants (Power Plants). Ideal Rankine cycle, Rankine cycle with rejuvenation and regeneration. Complex circuits, cogeneration. Devices and fittings in thermal power plants (Stoves, Boilers, Superconductors, Steam Turbines, Condensers, Pumps, Regenerators, Steam Traps, etc.). Energy calculations. Example of steam generator thermal grid calculation. Refrigeration Cycles. Ideal and effective steam compression cooling cycle, heat pumps, absorption cooling, other cooling systems.

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|---|---|
| **Code** | **ECE_BK801** |
| **Title** | **Power Systems Control and Stability** |
| Instructor | Alexandridis Vovos P. Konstantopoulos |
| Credits | 5 ECTS |

**Content:**
Load dispatch centres. Control systems structure. Active power-frequency (P-f) control. Division of power system into control areas. P-f control of single and multi-control area systems. Optimum control strategy. Reactive power-voltage control. Methods for the bus voltages control. Series and shunt compensation. Thyristor controlled series or shunt capacitor or reactor. Static synchronous series compensator, static var compensator, static synchronous compensator, synchronous compensator and dynamic voltage regulator. Voltage stability. Power systems transient stability. Swing equation. Transient generator active power. Equal area criterion. Explanation of power systems transient stability. Computer solution of power systems transient stability. State estimation of electric power systems. Flexible AC Transmission Systems (FACTS) and Flexible Distribution System. Deregulation of electric power market.

**Laboratory Exercises**

Main purpose of the laboratory exercises is the practical training of students in power system control, which aims at maintaining constant balance between production and consumption of electricity.

**Lab.1** Introduction to symmetrical components in three-phase power systems.

**Lab.2** Identification, measurement and calculation of sequence impedances for synchronous machines, transmission lines and transformers.

**Lab.3** Analysis of balanced and unbalanced faults using sequence equivalent networks.
**Lab.4** Response of a synchronous machine to a sudden load change, study of dependences between maximum loading, power angle and field current on a synchronous machine.
**Lab.5** Study of shaft angle oscillations and stability of a synchronous generator after a disturbance.
**Lab.6** operation and configuration of protection relays in a power system.

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|---|---|
| **Code** | **ECE_BK802** |
| **Title** | **Renewable Energy Sources I** |
| Instructor | Makrigeorgou |
| Credits | 5 ECTS |

**Content:**
Fundamental principles of Electric Power Systems protection. The evaluation of Protective Relaying. Fundamental operating principles and characteristics of Electro-magnetic-Attraction and induction type relays. The impedance and reactance type distance relays. Line protection with overcurrent relays. Line protection with distance relays. Unit protection in lines. Line protection with wire-pilot relaying. Line protection with carrier-current pilot relaying. Line protection with microwave-pilot relaying. Line protection with phase and directional comparison. Bus-zone protection. Power transformer protection with gas relays. Percentage differential relaying for power transformers. AC generator and motor protection.

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|---|---|
| **Code** | **ECE_BK803** |
| **Title** | **Tests and Measurements of High Voltages** |
| Instructor | Svarnas |
| Credits | 5 ECTS |

**Content:**
*Introduction:* Generation and transmission of electric energy, voltage stresses, testing voltages (testing with power frequency voltages, testing with lightning impulse voltages, testing with switching impulses, D.C. voltages, testing with very low frequency voltage).
*Generation of high voltages:* direct voltages (A.C. to D.C. conversion, electrostatic generators), alternating voltages (testing transformers, series resonant circuits), impulse voltages (impulse voltage generator circuits, operation, design and construction of impulse generators), control systems.
*Measurement of high voltages:* peak voltage measurements by spark gaps (sphere gaps, reference measuring systems, uniform field gaps, rod gaps), electrostatic voltmeters, ammeter in series with high ohmic resistors and high ohmic resistor voltage dividers, generating voltmeters and field sensors, the measurement of peak voltages (the Chubb-Fortescue method, voltage dividers and passive rectifier circuits, active peak-reading circuits, high-voltage capacitors for measuring circuits), voltage dividing systems and impulse voltage measurements (generalized voltage generation and measuring circuit, demands upon transfer characteristics of the measuring system, fundamentals for the computation of the measuring system, voltage dividers, interaction between voltage divider and its lead, the divider's low-voltage arm), fast digital transient recorders for impulse measurements (principles and historical development of transient digital recorders,

errors inherent in digital recorders, specification of ideal A/D recorder and parameters required for h.v. impulse testing, future trends).
*Non-destructive insulation test techniques:* dynamic properties of dielectrics (dynamic properties in the time domain, dynamic properties in the frequency domain, modelling of dielectric properties, applications to insulation ageing), dielectric loss and capacitance measurements (the Schering bridge, current comparator bridges, loss measurement on complete equipment, null detectors), partial-discharge measurements (the basic PD test circuit, PD currents, PD measuring systems within the PD test circuit, measuring systems for apparent charge, sources and reduction of disturbances, other PD quantities, calibration of PD detectors in a complete test circuit, digital PD instruments and measurements).

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|---|---|
| **Code** | **ECE_BK804** |
| **Title** | **Electrical Power Systems Protection** |
| Instructor | Vovos P.<br>Vovos N. |
| Credits | 5 ECTS |

**Content:**
Fundamental principles of Electric Power Systems protection. The evaluation of Protective Relaying. Fundamental operating principles and characteristics of Electro-magnetic-Attraction and induction type relays. The impedance and reactance type distance relays. Line protection with overcurrent relays. Line protection with distance relays. Unit protection in lines. Line protection with wire-pilot relaying. Line protection with carrier-current pilot relaying. Line protection with microwave-pilot relaying. Line protection with phase and directional comparison. Bus-zone protection. Power transformer protection with gas relays. Percentage differential relaying for power transformers. AC generator and motor protection.

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|---|---|
| **Code** | **ECE_BK805** |
| **Title** | **Control Techniques in Renewable Energy Sources** |
| Instructor | Makrigeorgou |
| Credits | 5 ECTS |

**Content:**
Introduction to Renewable Energy Sources (RES). High RES Penetration and Scattered Production. Individual wind turbines and wind parks. Photovoltaic systems and parks. Electricity storage systems - Batteries. Electronic Power Converters as Controlled Power Interfaces. Topology used in wind systems. Fixed speed technology. Variable pitch technology. Variable rotor-speed controllers and serial controller design with internal current loop: Dual power AM, AM or DC with DC interface, AM Generator with electronically varying rotor resistance. Real and reactive power control. Flap pitch control. Environmental impacts from the installation of wind systems and other RES. Connection to Internet.

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|---|---|
| **Code** | **ECE_BK806** |
| **Title** | **Dynamics and Control of Euler-Lagrange Systems** |
| Instructor | Alexandridis |
| Credits | 4 ECTS |

**Content:**
The fundamental electromechanical system. Power conversion in a simple electro-mechanical system. Equations of linear and rotational motion. Voltage and torque

equations. Obtaining dynamic equations by using classical methods. Generalised dynamic and kinetic energy of the fundamental electromechanical components. The principle of the least action: Lagrange equation. Electromechanical systems for linear motion: Variable capacitors and coils. Dynamic model of the direct current (DC) machine. Universal motor. The synchronous machine: Calculation and measurement of self-inductances, mutual-inductances and rotating inductances. Active and orthonormal transformations: Park's transformation. The synchronous machine on the d, q, O axes system. Abnormal and transient condition. Vector description. The asynchronous machine: Park's transformation and dynamic description on the d, q, 0 axes system.

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|---|---|
| **Code** | **ECE_BK807** |
| **Title** | **Overvoltage Protection – Lightning Surge Arresters** |
| Instructor | Pyrgioti |
| Credits | 5 ECTS |

**Content:**

This course provides the basic knowledge for the protection of transmision lines, buildings and other facilities from overvoltages caused by lightning, by teaching the following subjects: Lightning discharges. Creation of lightning discharge. The consequences of lightning strike on buildings, industires, playing fields, telecommunication systems and other facilities. The consequences of lightning strike on Transmission Lines. Lightning electromagnetic fields. Evolvement and propagation of overvoltages on Transmission Lines. Overvoltage proctection of overhead transmission lines. The electrogeometric model. Surge arresters on High Voltage Transmission Lines. Lightning protection methods of buildings, industires, playing fields and other facilities.Lightning protection of high-rise buildings, danger structures and other facilities. Protection of ships and aircraft. Protection of telecommunication systems.

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|---|---|
| **Code** | **ECE_BK810** |
| **Title** | **Biomechanics II** |
| Instructor | Deligianni Mavrilas Mahinetzis |
| Credits | 5 ECTS |

**Content:**

Introduction in the relationship between the neuromuscular system and the response of the human musculoskeletal system. Neuromuscular human system. Neuron. The current and the conductivity functions of Na and K ions into the neuromuscular system. Rest potential and action potential. Neuromuscular unit. Correlation of biochemical and/or bioelectrical functions of neuromuscular system with muscle contraction and forces producing. Electromyography. Methodologies to musculoskeletal fatigue estimation.

Musculoskeletal system - cartilage, tendons, ligaments: Basic anatomy and physiology, mechanical functions, physiological functions, composition, microscopic-macroscopic structure, tissue mechanical characteristics, correlation with structure. 3-D musculoskeletal system modeling.

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|---|---|
| **Code** | **ECE_CK701** |
| **Title** | **Computer Architecture** |
| Instructor | Koubias<br>Serpanos |
| Credits | 5 ECTS |

**Content:**
Computer abstractions and technology. Integrated circuits. The role of performance. Measuring performance. Performance metrics. Instructions: Language of the machine. Operations and operands of the computer hardware. Computer Instructions. Procedures, arrays and pointers. Arithmetic for computers. Negative numbers. Addition, subtraction multiplication and division. Floating point. The processor: Datapath and control. Building a datapath. Simple and multiple clock cycle implementations. Microprogramming. Enhancing performance with pipeline. Pipeline datapath and control. Data and branch hazards. Exceptions and performance of pipelined systems. Large and fast: Exploiting memory hierarchy. Caches. Virtual memory. Interfacing processors and peripherals. I/O performance measures. Types and characteristics of I/O devices. Buses. Interfacing I/O devices.

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|---|---|
| **Code** | **ECE_CK702** |
| **Title** | **Operating Systems** |
| Instructor | Housos<br>Valouxis |
| Credits | 5 ECTS |

**Content:**
Definitions, historical progress, main components of an operating system. Operating System Structures. Concurrent processes, semaphores. Process communication. Memory management, paging, virtual memory. CPU scheduling, dead-locks and deadlock prevention, avoidance and detection. Secondary storage management, file systems, protection. Distribution and parallel systems. Introduction to the Unix operating system.

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|---|---|
| **Code** | **ECE_CK703** |
| **Title** | **Data Bases** |
| Instructor | Avouris<br>Sintoris |
| Credits | 5 ECTS |

**Content:**
This course is an introduction to the subject of databases with particular emphasis on the relational model and SQL.
Unit 1. (weeks 1 and 2) Introduction, conceptual design of databases. Data Modeling with the Entity-Relationship Model.
Unit 2. (week 3) Introduction to the relational model, transformation of entity-relationship model to a relational schema.
Unit 3. (Week 4) Relational Algebra.
Unit 4. (weeks 5-7) SQL, embedded SQL, programming interfaces to SQL.
Unit 5. (weeks 8-9) Internal Scheme, file Organization, indexes, multi-level indexes, B trees.
Unit 6. (weeks 10-11) Large Databases, transaction systems, security, interface of relational databases to the internet, interface of database to XML, X Schema, Xpath.
Unit 7. (weeks 12-13) NoSQL databases, MongoDB.
**Laboratory Exercises**
The laboratory work includes guided analysis, design and development Database in a web DBMS, following the schedule below (10 lab sessions, total contact time 20 hours/ semester):
**Lab.1** Entity Relationship Model (ERD): An example of creation of an ERD is given and the the students are asked to design a

new entity-relation model using online tools (www.gliffy.com or www.draw.io).

**Lab.2** As Lab 1, with a different case (tools as in Lab.1).

**Lab.3** From Entity Relationship Model (SSD) to the Relational Model. For the design of the Relational model we use Database design tool Mysql workbench. (Https://www.mysql.com/products/workbench/).

**Lab.4** In this lab we use Mysql Workbench to design the relational model and SQL code generation for building a database. There is particular emphasis on the integrity constraints of the database model produced.

**Lab.5** Create a database in the MySQL environment. Using data definition language (DDL SQL). MYSQL included in XAMPP distirbution will be used. H database itself is built in the Mysql Workbench environment and XAMPP (PHPMyadmin). (www.apachefriends.org).

**Lab.6** Data manipulation with SQL in XAMPP (PHPMyadmin). Example: Academic Library.

**Lab.7** Data manipulation with SQL in XAMPP (PHPMyadmin). Example: Company.

**Lab.8** Data manipulation with SQL in XAMPP (PHPMyadmin). Example: Company - Part B Connection with programming environment.

**Lab.exam** This session is dedicated to the laboratory examination. Given a problem (microworld) the students are asked to design the ERD, RM, SQL ddl, SQL dml.

**Lab.10** Recovery Laboratory.

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|---|---|
| **Code** | **ECE_CK704** |
| **Title** | **Microcomputers and Microsystems** |
| Instructor | Kalivas<br>Koubias |
| Credits | 5 ECTS |

**Content:**

- Study in depth of the philosophy CISC microprocessor architectures
- Architecture and programming methods using as vehicle the Intel 8085 microprocessor. Assembly language programming using the instruction set of 8085. Timing diagrams.
- ROM/RAM memories. Design of memory devices and selection methods.
- Input / Output controlled by a program. Device selection circuits, implementation of I/O ports.
- Parallel communication. In-depth study and use of INTEL-8155 and -8255 peripherals. Application examples.
- Systems and interrupt mechanisms. The 8085 interrupt system. Input / Output through interrupt.
- Introduction to serial interfacing (asynchronous, synchronous). In-depth study and use the USART 8251. Application examples.
- Connection to external systems (I/O) for control and processing. Design and implementation of microsystems.
- Introduction to INTEL 8086, internal architecture, description of control signals, programming model.

The course offers laboratory training using appropriate H/W, in order to deepen the knowledge of the objects that are taught in the Theory (course ECEC7031 Microcomputers and Microsystems I). The subject of the lab. includes the design and implementation of specific applications based primarily on the INTEL 8085 microprocessor and its peripherals.

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|---|---|
| **Code** | **ECE_CK705** |
| **Title** | **Digital Signal Processing** |
| Instructor | Moustakides<br>Paliouras<br>Kouretas |
| Credits | 5 ECTS |

**Content:**
Introduction. Discrete-time signals and systems. Signal and system representation in the frequency domain. Z-transform and its properties. Analysis of signals and systems in the frequency domain. Discrete-time system architectures. Discrete-time system implementation issues.
The architecture and functions of an advanced DSP processor (Texas Instruments DSP C6711) are presented and analyzed. Then a series of 5 exercises, completed in two 3-hour sessions each, is executed, in assembly programming of the C6711.
The Laboratory Exercises focus on:
**Lab.1** Learning of the TI C67XX basic assembly instructons and their execution in hardware. Familiarization with the TI Code Composer Studio software
**Lab.2** Construction of complex assembly programs and forming of basic DSP algorithms (e.g.: convolution)Data representation and their dynamic ranges
**Lab.3** Interrupt requests and their use in increasing the processor's efficiency in communicating with its peripherals. Comparison to polling.
**Lab.4** Analog/digital/analog conversion and audio signal sampling through the PCM3003 (de)coder and its communication with the processor through a serial port (McBSP).
**Lab.5** Digital FIR filter implementation on the processorMATLAB design of various filters and their TI DSP processor implementation in the processing of a sampled audio signal.

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|---|---|
| **Code** | **ECE_CK706** |
| **Title** | **Advanced Analogue/Digital Integrated Circuits and Componets** |
| Instructor | Kalivas<br>Birbas A.<br>Birbas M. |
| Credits | 5 ECTS |

**Content:**
Basic structures of analogue integrated circuits. Integrated circuits. Integrated operational amplifiers, analogue comparators and voltage regulators. Tuned amplifiers and oscillators, switching capacitor filters. Mixed analogue and digital circuits including principles of A/D-D/A and V/F-F/V converters). Design of circuits based on surface acoustic wave (SAW) devices. Interfaces between analogue and digital arrays in a system. Electromagnetic interference (EMI) in analogue circuits.

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|---|---|
| **Code** | **ECE_CK707** |
| **Title** | **Integrated Circuits Design I** |
| Instructor | Theodoridis<br>Koufopavlou<br>Kouretas |
| Credits | 5 ECTS |

**Content:**
CMOS Processing Technology: Silicon Semiconductor Technology, Layout Design Rules, Latchup.
Circuit characterisation and performance estimation: Resistance and Capacitance Estimation, Inductance, Switching Characteristics, Transistor Sizing, Power Dissipation, Design Margins, CMOS Logic Structures.
Physical design: CMOS Logic Gate Design, Physical Design of Logic Gates.

CMOS circuit and logic design: Power Dissipation, Yield, Reliability, CMOS Logic Structures: CMOS Complementary Logic, BiCMOS Logic, Pseudo-nMOS Logic, Dynamic CMOS Logic, Clocked CMOS Logic (C2MOS), Pass-Transistor Logic, CMOS Domino Logic, NP Domino Logic (Zipper CMOS), Cascade Voltage Switch Logic (CVSL).

**Lab.1** *Design and Simulation of Basic CMOS Circuits.*

Introduction to the CAD tool Microwind and understanding of its basic capabilities and features through the design and simulation of a CMOS inverter and a NAND gate. Homework: Design and simulation of different logic gates and delay measurement.

**Lab.2** *Study of the gate and diffusion capacitance and the delay of CMOS Circuits.*

Study of the parameters that affect the delay of CMOS circuits with emphasis in its capacitances. Layout design of logic gates with different parameters and delay analysis. Homework: Theoretical calculation of the capacitances and comparison with the experimental results, and computation of the gates' sensitivity.

**Lab.3** *Study of the Power Consumption of CMOS Circuits.*

Exploration of the parameters that affect the total power consumption through the layout design of logic gates. The designed circuit is exported from Microwind and imported to Spice, where the consumption is measured. Homework: Layout design and power measurement in different logic gates, comparisons and evaluation of the parameters that affect the consumption. •

**Lab.4** *Layout Design of Complex CMOS Logic Gates.*

Layout design of compound gates through the method of Euler paths, so that the gate shares more diffusion regions and requires less area and has less delay. Homework: Layout design of complex gates with discrete gates and Euler paths, and delay comparison between the two methods.

**Lab.5** *Study of the Critical Path Delay.* Experimental study of the characteristics that affect the critical path delay through the layout design of a 4-bit full adder. Homework: Theoretical calculation of the adder's delay and comparison with the experimental results. Adder design with Euler paths and evaluation of the circuit. •

**Lab.6** *Circuit Design and Simulation in Spice.*

Introduction to the CAD environment Capture CIS and design of complex logic functions in transistor level. Circuit design using static CMOS, pseudo-NMOS and dynamic logic. Homework: Design of a different logic function and comparison of the power consumption of different logic families.

**Lab.7** *Study of the Logical Effort.* Experimental study of the delay of CMOS circuits using the logical effort. Design of logical functions with default transistor size and stages of logic and their calculation through the logical effort. Redesign of the circuit with the optimal transistor size and stages and evaluation by measuring the delay. Homework: Design of complex logic functions using the method of logical effort, study and improvement of their delay •

*Lab.exams* Design of a CMOS circuit which has already been design during the exercises, .measurement of the performance characteristics and evaluation of the results.

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|---|---|
| **Code** | **ECE_CK708** |
| **Title** | **Photoelectronic Devices** |
| Instructor | Skouras |
| Credits | 5 ECTS |

**Content:**

Solar irradiance. Characteristics of the terrestrial and extraterrestrial solar spectrum. Photovoltaic effect. A diode p-n as a solar cell. Spectral response, photocurrent. Equivalent solar cell circuits. Recording and analysis of I-V characteristic curves. Short circuit current, open circuit voltage, maximum power point. Efficiency, quantum efficiency and fill factor. Factors limiting efficiency and maximum power generated. Parasitic resistances. Effect of series and shunt resistances on the efficiency of cells and modules. Solar cells connected in series and in parallel. Photovoltaic modules. Stand-alone photovoltaic systems. Power consumption demands. Calculation using minimum number of PV panels. Optimal cable sizing in photovoltaic systems. Inverters. Advanced methods of fabricating high efficiency Si solar cells. Surface texturing. Increase of photon path length. Emitter wrap-through and semi-transparent Si solar cells. Laser drilling, cutting, engraving, surface texturing and fired contacts. Environmentally friendly ohmic connections. Homo- and hetero-junction III-V solar cells. Concentrator and vertical architecture photovoltaic systems.

| **Code** | **ECE_CK801** |
|---|---|
| **Title** | **Advanced Programming Techniques** |
| Instructor | Thramboulidis Valouxis |
| Credits | 5 ECTS |

**Content:**

1. Introduction to embedded systems. Technologies for the design and implementation of embedded systems. Internet of Things.
2. Advanced programming constructs in C. Pointers to functions, low level file handling.
3. Low level programming. C language constructs for low level programming.
4. The C programming interface to assembly language.
5. Interfacing to the operating system services.
6. Direct access to the system's hardware. Handling Interrupts.
7. Case Study: Development of an application to exploit the UART 8250. Programming using the ARM® Cortex™-M0+ processor. (ARM University Program).
8. Concurrent Programming. Conceptual model of concurrent programming. The mutual exclusion problem.
9. The Dekker's algorithm. Semaphores. Monitors. The producer-consumer problem. Java mechanisms for concurrent programming. Case study: The sleeping Barber problem.
10. Using the Object technology for the development of embedded systems. Introduction of the UML for system design - basic diagrams.
11. Java as a programming language for IoT.
12. The real time Java specification.

**Lab.1** Advanced C. Pointers to functions, low level file handling, dynamic memory handling. Development of address book application.

**Lab.2** Development of an application to exploit the UART 16550 in x86 systems. Programming using the ARM® Cortex™-M0+ processor. (ARM University Program). Handling of interrupts. Use of OS series, Direct access to hardware. Interfacing to assembly.

**Lab.3** Development of sleeping barber application. Utilizing semaphores and monitors and java constructs for concurrent programming.

**Lab.4** Development of application in the context of IoT. THe Liqueur Plant example application using Raspberry Pi.

**Lab.5** Concurrent programming using low level constructs. Development on ARM embedded board ARM® Cortex™-M0+ processor (ARM University Program).

| **Code** | **ECE_CK802** |
|---|---|
| **Title** | **Internet Programming** |
| Instructor | Avouris<br>Sintoris |
| Credits | 5 ECTS |

**Content:**

The objective of the course is the study of the architecture and structure of the Internet, basic Internet application development tools, both from the client and server side.

1. Introduction to the Internet architecture, protocols.
2. Programming on the client side (HTML)
3. HTML: forms
4. HTML: stylesheets (CSS)
5. JavaScript, basic structures
6. JavaScript, objects, DOM, events
7. PHP: Introduction
8. PHP, Part 2
9. PHP and interface to databases
10. Introduction to XML
11. XML DTD, XML Schema, XSLT
12. AJAX

**Laboratory Exercises**

The lab includes guided programming exercises and software tools for designing web applications, according to the following schedule ( 10 lab sessions, total contact time every semester: 20 hours):

**Lab.1** Designing a website using simple commands of HTML. Students are asked to design an application concerning the creation of an online form for requesting a certificate to a website on a service. In the first 2 exercises it is recommended to use editors such as Notepad and Notepad++ which allow the students to focus mainly on focusing on basic commands of HTML

**Lab.2** Students are asked to improve the design of the Lab 1 website, using more advanced commands of HTML and constructs of HTML5 with the same tools of Lab.1.

**Lab.3** Javascript, Extending the functionality of website of Lab 2 with JavaScript code. The JavaScript is intended to check validity of user input data before sent to the Server. In this Lab more specialized editors (free JavaScript editors) are used.

**Lab.4** The website of Lab 3, is re-designed with CSS (Cascading Style Sheets), which allow to define flexible rendering of the various items on our website and create special effects.

**Lab.5** Introduction to PHP, which is suitable for developing web applications with dynamic web pages, using basic commands and inherent data structures. In this phase the student will have to install the XAMPP package (https://www.apachefriends.org/index.html) and make use of the environment of MYSQL and PHPMyadmin, editing PHP files.

**Lab.6** Create an application that combines the technologies of previous labs (HTML, CSS, JavaScript, PHP), without a database. Interface design that allows user with the help of a browser to submit queries to Web Server and receive responses.

**Lab.7** Design an application (using HTML, CSS, JavaScript, PHP), in order to connect to a given database. Development of full web application.

**Lab.8** Experimenting with XML (Extensible Markup Language), data description language interface via XML with web application.

**Lab.9** Revision Workshop.

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|---|---|
| **Code** | **ECE_CK803** |
| **Title** | **Advanced Microcomputers Systems** |
| Instructor | Koubias<br>Birbas M.<br>Konstantinides<br>Mitropoulos |
| Credits | 5 ECTS |

**Content:**

- CISC (Complex Instruction Set Computers) microprocessor architectures. Architecture of INTEL x86 microprocessors.
- In depth study of the architectures and applications of the latest products in INTEL x86 family: 8086, 80286, 80386, 80486, embedded μικροεπεξεργαστών 80386EX and 80196, Pentium and P6.
- Segmantation, pipelining, paging etc.
- I/O programming, multi-programming.
- Structural presentation of modern microprocessors such as PENTIUM and POWER PC as well as of interfacing architectures (PCI Bus).
- RISC (Reduced Instruction Set Computers) architectures. Study of embedded architectures using as presentation vehicles the 80960 and ARM microprocessors.
- Application of the aforementioned microprocessors to complex systems (Microsystems). Programming Models. Development tools.

**Laboratory Exercises**

The course offers laboratory training using appropriate H/W, in order to deepen the knowledge of the objects that are taught in the Theory.

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|---|---|
| **Code** | **ECE_CK804** |
| **Title** | **Data Mining and Learning Algorithms** |
| Instructor | Makris<br>Megaloikonomou |
| Credits | 5 ECTS |

**Content:**

1. Introduction
2. Preprocessing and Data Compression
3. Classification Algorithms
4. Clustering Algorithms
5. Association rule discovery algorithms
6. Bayesian networks, neural networks.
7. Web Mining
8. Spatial Data Mining
9. Temporal Data Mining
10. Data Mining from sequences

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|---|---|
| **Code** | **ECE_CK805** |
| **Title** | **Distributed Real-time Embedded Systems** |
| Instructor | Koubias<br>Gialelis |
| Credits | 5 ECTS |

**Content:**

- The Real Time Environment, Modeling of Real Time Systems, Modelling of RT systems.
- Embedded systems, Architectures of Distributed Embedded Systems.
- Wired/wireless local networking structures, Time/event triggering networking architectures Event/Time-Triggered Protocols and Architectures.
- Hardware/Software Interaction, Fault Tolerance.
- Real Time Communications, Communication Delay Estimation.
- Input-Output, Real Time Operating Systems, Real Time Scheduling, Performance Analysis. Design of a complete

Real Time System Based on Embedded Architectures.

- Design (hardware and software) of Distributed Control Systems Using Advanced Embedded Architectures.
- Case stydy: Real Time Fieldbuses. Real time industrial networks.

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|---|---|
| **Code** | **ECE_CK806** |
| **Title** | **Linear and Combinatorial Optimization** |
| Instructor | Daskalaki Valouxis |
| Credits | 5 ECTS |

**Content:**

Modeling optimization problems with linear programming techniques. Simplex algorithm. Duality Theory. Complementary relaxation. Dual - Primal Simplex Algorithm. Sensitivity analysis. Integer programming. Branch & Bound Method. The knapsack problem. The problem of the street vendor. Square Programming. Modeling techniques using integer variables. The Simplex algorithm for networks. Transport and transhipment problems. Internal point method. Networking flows Problems.

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|---|---|
| **Code** | **ECE_CK807** |
| **Title** | **Network Architecture** |
| Instructor | Serpanos |
| Credits | 5 ECTS |

**Content:**

Fundamental architectures of networking systems. Performance of networking systems. Architecture of packet switches. Architecture bridges. Architecture of routers and gateways. Architecture of advanced network adapters). Special functions to support real-time services. Protocol processors. Network processors. Subsystems of special functions.

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|---|---|
| **Code** | **ECE_CK808** |
| **Title** | **Telecommunication Electronics** |
| Instructor | Kalivas |
| Credits | 5 ECTS |

**Content:**

Features of High Frequency (RF) Receivers, Lighter Design Parameters, Noise Indicator, Nonlinearities, Dynamic Receiver Range.

Phase –Locked Loops (PLLs) and their design parameters. Loop stability, analogue and digital phase, Voltage Controlled Oscillators (VCO). PLL applications in telecommunications (composite frequencies, modifiers, phase recovery and timing subsystems).

Analysis, design of high frequency receiver (RF, IF) amplifiers with emphasis on low noise.

High frequency (RF) transmitter power amplifiers. Adaptation for maximum transmission power.

Analysis, design of circuits of mixed and analog multipliers.

FM, PM Modulator / Modulator Implementation Circuits.

Examples of high frequency systems for wireless applications

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|---|---|
| **Code** | **ECE_CK809** |
| **Title** | **Integrated Circuits Design II** |
| Instructor | Theodoridis Paliouras |
| Credits | 5 ECTS |

**Content:**

- *Sequential Circuit Design*: Static Sequential

Circuits, Design of latches and flip-flops, Dynamic Sequential Circuits, Synchronizers, Wave Pipelining.

- *Digital Circuit Timing:* Timing Circuit Sorting, Contemporary Design, Self-timing Circuits, Clock Distribution.
- *Data Handling Subsystems:* Adders / Subtractors, "1" / "0" Detectors, Comparators, Counters, Boolean Logic Operators, Error Detection / Correction Codes, Sliders, Multipliers, Parallel Architectures.
- *Memory Subsystems and Table Structures Table:* Static Random Access Memory (SRAM), Dynamic Random Access Memory (DRAM), Read Only Memory (ROM), Serial Access Memory, Data Interface Memory, Programmable Structures.
- *Special Purpose Subsystems:* Power Distribution, Clock Circuits & Clock Distribution, Input / Output Circuits
- *Digital Integrated Circuit Design Strategies:* Full custom and variants. Design with pre-designed cells. Table type structures. FPGA technology. Design methodologies and design flows.

| **Code** | **ECE_CK810** |
|---|---|
| **Title** | **Nanoelectronics** |
| Instructor | Skouras |
| Credits | 5 ECTS |

**Content:**
Students after successful completion of the course:

- Know the sequential steps and chemical processes used to construct the ohmic contacts of an electronic device. They understand what a lift-off is and what the conditions for a successful lift-off are.
- They know how conductive channels are made between the ohmic contacts of an electronic device by techniques such as optical lithography and liquid chemical etching.
- Understand the differences between isotropic, anisotropic and selective chemical etching.
- Understand the techniques of shaping electronic device surfaces.
- They know how to apply the technique of building and sacrificing materials to build a micro bridge.
- Understand the different techniques of controlled etching.
- Understand the different methods of making a T-shaped gate less than 100 nanometers long with bilayer or trilayer resists.
- They can describe in detail how the self-alignment method is applied to the manufacture of MOSFETs, MESFETs and MODFETs of Nanoelectronics.
- They are aware of the advantages and disadvantages of Optical Lithography, Electron Beam Lithography and Nano Print Lithography.
- Understand and can design a III-V HEMT that operates at very high frequencies.
- They know what the mechanics of energy bands are and can design III-V HEMTs with Type-I (straddling), Type-II (staggered) and Type-II (broken-gap lineup) interfaces.
- They know what modulation doping is and what d-doping is.
- They know how to apply the laws of quantum mechanics to two-dimensional systems, quantum wires and single-dimensional nanotransistors.
- They know how to prove and apply the Landauer type.
- They know what quantum ballistic transfer is of a nanotransistor conduction electrons and the quantization of resistance.

In particular, students through the lectures of the course acquire knowledge on modern methods of nanoelectronics construction and

understanding the phenomena of ballistic quantum transfer of conductors in nanometer-sized devices and circuits. They are also taught to apply the Landauer formula and to calculate the current flowing through a nanotransistor and the quantization of the resistance.

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|---|---|
| **Code** | **ECE_CK811** |
| **Title** | Cryptography |
| Instructor | Serpanos |
| Credits | 5 ECTS |

**Content:**

The subject of the course is the field of cryptography and cryptanalysis, and in particular the mathematical background governing the respective cryptographic protocols. Desired, sometimes contradictory, design goals will be outlined, and the principles of traditional and modern cryptographic protocols will be explored, with emphasis on encryption, digital signature, and more specialized protocols, such as, the commitment protocols. The connection of cryptography to the fields of algorithm design and computational complexity will also be analyzed. The general topics of the course are:

- Cryptographic protocols
- Recipient-sender interaction
- Keys - managing them
- DES - other Block Ciphers
- Secure False Number Sequences
- Public key cryptography
- Digital signatures - sender certification
- Legal issues

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|---|---|
| **Code** | **ECE_CK812** |
| **Title** | **Data Processing and Learning Algorithms** |
| Instructor | Moustakides |
| Credits | 5 ECTS |

**Content:**

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|---|---|
| **Code** | **ECE_DK701** |
| **Title** | **State-Space Linear System Analysis** |
| Instructor | Kazakos |
| Credits | 5 ECTS |

**Content:**
Introduction - The state space approach to the design of control systems. - Controllability and observability of dynamical systems – Canonical forms of linear systems - Stability analysis: Stability under persistent perturbations. Bounded Input-Bounded Output stability . Stability under instantaneous perturbations.

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|---|---|
| **Code** | **ECE_DK702** |
| **Title** | **Applied Optimization** |
| Instructor | Konstantopoulos |
| Credits | 5 ECTS |

**Content:**
Local minima of multivariable functions. Stationary points of multivariable functions under equality and inequality constraints. Lagrange multipliers. Linear programming and the Simplex method. Non-linear programming: Optimisation algorithms (gradient methods etc.) Curve fitting. Minimisation using iterative methods. Applied optimisation using iterative methods. Applied optimisation on industrial processing. Optimisation of parallel and cascade processing systems.

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|---|---|
| **Code** | **ECE_DK801** |
| **Title** | **Digital Control** |
| Instructor | Kazakos<br>Tsipianitis |
| Credits | 5 ECTS |

**Content:**
Conversion of continuous-time systems to digital ones with samplers and holders. Definition, properties and applications of z-transform. Digital system transfer functions. Stability systems analysis on the time and frequency domain. Properties of digital filters and methods of discretizing of analogue filters. Realisations of digital filters with the state variable technique. Digital control algorithms (PID, Deadbeat). Realisation of digital filters with microprocessors. Determination of sampling period, wordlength of the microprocessor and the A/D and D/A converters. Error analysis and non-linearities due to Discretisation. Digital control applications of a mechanical artificial hand, of an automatic pilot and target tracking system.

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|---|---|
| **Code** | **ECE_DK804** |
| **Title** | **Industrial Automation** |
| Instructor | - |
| Credits | 5 ECTS |

**Content:**
Instrumentation in industrial process control automation. Basic devices for automation systems implementation. Human-machine dialogue, detection and signal processing devices. Relays in control applications. Relay-Ladder diagrams. Design of automation arrangements. State diagrams in designing control circuits and state reduction. Basic Electropneumatics process control.
Programmable Logic Controllers. Hardware: structure and operation, central processor unit, input-output modules, analogue-digital modules. Software: ladder, Boolean statement list and control system flowchart programming, MATH functions, programming applications. Petri net theory. Modelling of complex systems with petri nets. Applications of petri nets in industrial automation systems. Special topics in automatic control applications: Step motors and their control with microprocessor. PID controllers and their industrial applications. Automated process control systems planning.

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|---|---|
| **Code** | **ECE_DK805** |
| **Title** | **Robotics** |
| Instructor | Dermatas<br>Mandellos<br>Christogianni |
| Credits | 5 ECTS |

**Content:**
Historical perspectives, Robot configuration and classification. Direct and inverse kinematics, Trajectory planning, Static analysis (Jacobian matrix and torque/force transformation), Robot Dynamics (N-E and Lagrange approaches), Fundamental of robot control (PID, feedforward).

**FIFTH YEAR**

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|---|---|
| **Code** | **ECE_AK901** |
| **Title** | **Laboratory of Communications II** |
| Instructor | Antonakopoulos<br>Denazis<br>Koulouridis<br>Kotsopoulos<br>Karavatselou<br>Hatziantoniou<br>Christogianni |
| Credits | 5 ECTS |

**Content:**

**Electromagnetic Wave Propagation:** Doppler and radar effect. Wireless channel and losses. Channel Loss Study Models. Field measurements

**Information Transmission:** DSL protocol. Channel Estimation and Noise Transfer Function Estimation. Synchronization Techniques. Transmission Error Detection and Correction Codes.

**Telecom Systems networking:** Parts of a modern communications system. Access to the microwave signal. Mobile system. System management.

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|---|---|
| **Code** | **ECE_AK902** |
| **Title** | **Programmable Networks and Management** |
| Instructor | Denazis |
| Credits | 5 ECTS |

**Content:**

Overview of the different network management approaches and models proposed (OSI, Internet, TMN etc), their structure and the corresponding specifications (standards) issued. The basic concepts of network management architectures, their organization in functional areas, and their system components. Detailed presentation of the Internet model based on SNMP protocol suite as specified by IETF through selected RFCs. It comprises the Information model and the definition of the basic MIB objects along with RMON 1 & 2 for the collection of monitoring data and statistics with analytic examples, the communication model based on SNMPv1 & SNMPv2 protocol suite and the organizational model based on the client-server paradigm between the Network Management Station and the Agent of the network devices. Design of network topologies and IPv4 address assignment to the various network interfaces. Introduction to modern trends in network management and network control. This includes Netconf protocol specification that includes Data model and Communication model and comparison with SNMP. Presentation of the basic principles of Software Defined Networking and Network Function Virtualization architectures and their impact on network management and control. The theoretical presentations above are complemented with practical examples in the form of lab exercises in order for the student to acquire important hands-on experience.

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|---|---|
| **Code** | **ECE_AK903** |
| **Title** | **Multimedia Communications** |
| Instructor | Lymperopoulos |
| Credits | 5 ECTS |

**Content:**

- **Introduction:** Definitions. Necessity for multimedia communication. Basic requirements in transmission / storage. Multimedia implementation over IP

infrastructure. Sources of multimedia data (Image, Speech, Audio, Still images, Moving video, Audiovisual information). Multimedia data structures. Processing of multimedia data. Integration of multimedia data in services and applications.

- **Next Generation Networks (NGN):** Definitions. Layer and Architecture Analysis of NGN. NGN Interfaces. Access Network Structure of NGN. Basic NGN Services. IP Multimedia Subsystem (IMS). Creation - Distribution - Management of multimedia Services over NGN/IMS.
- **Multimedia Sessions:** Definitions. SIP Protocol Analysis. Multipoint Control Unit (MCU). Analysis of establishing sessions in selected Applications. Analysis of data streaming processes. RTP / RTCP protocol analysis.
- **Interactive Multimedia Communication Structures:** Definitions. Interactions Analysis among Terminal Entities. Analysis of Interactive Multimedia Communication Support Protocols.
- **Examples of multimedia implementations.**

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|---|---|
| **Code** | **ECE_AK904** |
| **Title** | **Broadband Networks** |
| Instructor | Logothetis |
| Credits | 5 ECTS |

**Content:**

**Introduction** - Trends in Requirements for Telecommunication - Progress in Technology and in System Concept. Narrowband-ISDN and Broadband -ISDN Services. Transfer Modes - Circuit Switching - Multi-rate Circuit Switching - Fast Circuit Switching - Packet Switching - Fast Packet Switching - Asynchronous Transfer Mode (ATM) - Frame Relay - Switched Multi-Megabit Data Service (SMDS).

**ATM Technology**. B-ISDN Protocol Reference Model (PRM) - ATM PRM. Asynchronous Transfer Mode - An Overview - ATM Network Interfaces - Protocol Layers - ATM Cell Header Format - Connection Identifiers - VP/VC Assignment - Header Error Check (HEC) - LAN Emulation - ATM Virtual LANs - IP Over ATM. Comparison of ATM with other Transfer Modes.

**Statistical Multiplexing in ATM Networks**. Resource management in ATM networks. Principles of Traffic and Congestion Control in ATM Networks.

**Synchronous Digital Hierarchy (SDH)**: architecture of Transmission Systems. Principles of ATM Switching.

**Multi-Protocol Label Switching (MPLS)**. Packet Switching and Forwarding. Label Switching Routers (LSR, LER). Forwarding Equivalence Classes. Labels: Label Maping, Creation, Distribution and Control. Compatibility between ATM and MPLS. Tunneling. Explicit routing. Quality of Service. MPLS and Differentiated Services. MPLS and Integrated Services.

**Optical Networks** – Architecture. Wavelength Division Multiplexing. Optical Time Division Multiplexing. Optical Switching. Optical Network Componets. Core/Backbone networks, Metropolitan Area Optical Networks and Optical Access Networks. Passive Optical Networks (PON) for Broadband Access.

**Gigabit Ethernet Technology** – Need for Gigabit Ethernet. Description of Gigabit Ethernet. Pros and cons of the Gigabit Ethernet.

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|---|---|
| **Code** | **ECE_AK905** |
| **Title** | **Personalised Telemedicine and Biomedical Systems** |
| Instructor | Lymperopoulos |
| Credits | 5 ECTS |

**Content:**

- **Introduction:** Concepts, prospects and domains of biomedical technology, employment areas of biomedical engineers, electronic health, telemedicine, mobile and pervasive health.
- **Electronic health record systems:** Incentives, definition, relevant terms, uses, data types, functional components, interoperability issues and standards, approaches to acquiring and displaying electronic health record data, virtual electronic health record, personal health records.
- **Medical imaging and medical image processing:** Architecture of imaging systems, modern medical imaging techniques and devices, quality features, representation, management, digital processing and integration of medical images.
- **Telemedicine systems and applications:** Concept, objectives, historical evolution, system architecture, technological infrastructure, operational modes, types of medical data, types of involved networks and use cases of telemedicine.
- **Introduction to pervasive computing.** Concept, operational framework, device types, basic functions, properties, key features and examples of pervasive computing applications.
- **Context awareness.** Definition, parameters, categories and uses, architectures and types of context-aware systems, middleware (software infrastructure) services, design process and examples of context-aware systems.
- **Mobile and pervasive health.** Definitions, drivers of emergence, impact in healthcare, technology and application domains of mobile and pervasive health, mobile and pervasive computing in professional medical care facilities; end users, range, general architecture, categories and non-functional requirements of mobile and pervasive health and wellness management systems for citizens.
- **Sensors and wireless technologies in health.** Wireless sensor networks; types, measured parameters and sensor operating principles, wireless communication technologies, sensor network development platforms for health applications.
- **Biomedical signal processing.** Types and examples of biosignals, biomedical data acquisition and processing architecture and procedures, conversion from analogue to digital, digital signal processing basics, analog and digital filters and examples of their application to biomedical signals.
- **Clinical decision support systems.** Definition, motivation, uses, characteristics, architecture, types, approaches to data acquisition, data processing algorithms, design and development challenges, implementation guidelines, current status and examples of clinical decision support systems.
- **Mobile and pervasive health applications.** Range of systems, user types, requirements, usε cases and examples of mobile and pervasive health applications.
- **Ambient assisted living.** Definition, target audience, needs, technological infrastructure, ambient assisted living scenarios and applications, Internet of Things systems architecture and examples of their application to health.

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|---|---|
| **Code** | **ECE_AK906** |
| **Title** | **Parallel Programming in Machine Learning** |
| Instructor | Dermatas<br>Sgarbas |
| Credits | 5 ECTS |

**Content:**

Serial and parallel programming. Computational Power Limits on Serial Computers, Moore's Law. Parallel programming. Parallelization of serial computations. Laws of Amdahl and Gustafson. Multi-unit hardware, Flynn sorting. Computer Networks, Multi-Core CPUs, GP-GPUs. Computational models: Message-Passing, Shared-Memory, Accelerators. Implementations: openMPI (message passing interface), POSIX threads, OpenMP, openACC. Debugging. Examples of simple implementations in gcc and PGI compilers. Implementation of stochastic optimization algorithms (simulated annealing, genetic algorithms, swarm algorithms) in parallel processing machines. Deep-Learning Neural Networks Training. Big-Data Parallel Processing: Recommender Systems, Gene Sequence Analysis. Laboratory Excercises:

• Lab 1. Matrix Operations. Serial and parallel implementation in openMPI, pthreads, openMP. Performance measurement.
• Lab 2. Simulated annealing and swarm optimization. Finding extreme values in Discontinuous Multivariable Functions. Implementation in pthreads, openMP.
• Lab 3. Parallel implementation of genetic algorithms. Implementation in openMP
• Lab 4. Solution of the travelling salesman problem with random search and genetic algorithms. Implementation in openMP and openMPI.
• Lab 5. Recommender system for movies. Implementation in openMPI and openMP.
• Lab 6. Construction of a Similarity Finding System in a Flu Virus Gene Sequence. Implementation in openMP and openACC.
• Lab 7. Development of an automated clustering of influenza virus gene sequences. Implementation in openMP and openACC.
(Laboratory exercise titles and objects are in dicative and may change.)

| | |
|---|---|
| **Code** | **ECE_AK907** |
| **Title** | **Advanced Topics in Information Theory** |
| Instructor | - |
| Credits | 5 ECTS |

**Content:**

Continuation of Information Theory; Compression and Transmission are revisited, albeit at a more advanced and detailed level. Introduction to Network Information Theory. Review of important properties and results that were covered in Information Theory.
Asymptotic Equipartition Property (AEP) and Typical Sequences. The Entropy is equal to the optimal compression rate. Fixed and variable length coding. Kraft inequality. Optimality of Huffman codes.
Channel Capacity. Jointly Typical Sequences, Joint AEP. Channel Coding Theorem. Source-Channel separation Theorem.
Network Information Theory: The Multiple-Access Channel (MAC), the Broadcast Channel (BC), the Relay Channel, the Interference Channel.

| | |
|---|---|
| **Code** | **ECE_AK908** |
| **Title** | **WEB Services** |
| Instructor | - |
| Credits | 4 ECTS |

**Content:**

Need for information systems integration, Middleware Technologies, Enterprise Application Integration (EAI) and Service Oriented Architecture (SOA). Web Services, core functionality and standards. XML, SOAP, Web Services Description Language(WSDL), Universal Description, Discovery and Integration (UDDI). Web Services Governance, Service composition, Web Services Orchestration and Choreography. Unified Modeling Language (UML), Software Agents and Agent Systems, characteristics and properties of Agents, Agent modeling according to gaia method, case study.

| | |
|---|---|
| **Code** | **ECE_BK901** |
| **Title** | **Electrical Economy** |
| Instructor | Vovos P. |
| Credits | 5 ECTS |

**Content:**
Power generation units and their characteristics. Load behaviour and load forecast. The economic dispatch problem for thermal units. The lambda-iteration method. Thermal units dispatching with network losses considered. Optimization within constraints. Constraints in unit commitment. Unit commitment solution methods. The short-term hydrothermal scheduling problem. Dynamic-programming solution to the hydrothermal scheduling problem. Hydro-units in series. Economy interchange between interconnected utilities. Interchange evaluation with unit commitment. Multiple-utility interchange transactions. Energy banking. Power pools.

| | |
|---|---|
| **Code** | **ECE_BK902** |
| **Title** | **Advanced Control of Electric Machines** |
| Instructor | Alexandridis Mitronikas |
| Credits | 5 ECTS |

**Content:**
Models Overview: DC Motor, Asynchronous Motor (AM), Synchronous Motor (SM). Conventional and Advanced PID Engine Control of DC Motor. Current Model for AM and Transformation to the Synchronous Rotating dq Reference System. Linear and complete nonlinear AM model. Dynamics and flow estimation in AM. Balance points. AC Three-Phase Motor Vector Control Principle. Direct and Indirect Vector Control. Torque and torque control of AM. Stability analysis and advanced control techniques. Vector control and control

techniques for SM with permanent magnet. Analysis of serial controllers with internal loop current. Controlled power inverters: Analysis on the modern rotating dq reference system, models and input characteristics (segmentation ratio). Modeling control and stability with integrated topology of electronic power inverters in an advanced machine driver control system.

| | |
|---|---|
| **Code** | **ECE_BK903** |
| **Title** | **Renewable Energy Sources II** |
| Instructor | Konstantopoulos |
| Credits | 5 ECTS |

**Content:**
Solar cells, photovoltaic effect, equivalent circuit, current-voltage characteristics, energy conversion efficiency, solar cell materials and technologies. Solar cell arrays, definitions, mismatch loss and hot-spot effects, optical, mechanical and electrical characteristics, blocking diodes. Storage batteries, general description, charging, discharging, capacity, efficiency, battery types, storage battery applications in photovoltaic systems. Economic analysis of energy systems. Power conditioning units, voltage regulators (linear, switch-mode), maximum power point trackers, DC to AC conversion. Design of stand-alone photovoltaic systems.

| | |
|---|---|
| **Code** | **ECE_BK904** |
| **Title** | **Electrical Insulation Technology and Nanostructured Dielectrics** |
| Instructor | Svarnas |
| Credits | 4 ECTS |

**Content:**

**Electrical breakdown in gases:** classical gas laws (velocity distribution of a swarm of molecules, the free path of molecules and electrons, distribution of free paths, collision-energy transfer); ionization and decay processes (Townsend first ionization coefficient, photoionization, ionization by interaction of metastables with atoms, thermal ionization, deionization by recombination, deionization by attachment-negative ion formation, mobility of gaseous ions and deionization by diffusion, relation between diffusion and mobility); cathode processes – secondary effects (photoelectric emission, electron emission by positive ion and excited atom impact, thermionic emission, field emission, Townsend second ionization coefficient, secondary electron emission by photon impact); transition from non-self-sustained discharges to breakdown (the Townsend mechanism); the streamer or 'kanal' mechanism of spark; the sparking voltage – Paschen's law; penning effect; the breakdown field strength; breakdown in non-uniform fields; effect of electron attachment on the breakdown criteria; partial breakdown, corona discharges (positive or anode coronas, negative or cathode corona); polarity effect – influence of space charge; surge breakdown voltage – time lag (breakdown under impulse voltages, volt-time characteristics, experimental studies of time lags).
**Breakdown in solid and liquid dielectrics:** breakdown in solids (intrinsic breakdown, streamer breakdown, electromechanical breakdown, edge breakdown and treeing, thermal breakdown, erosion breakdown, tracking); breakdown in liquids (electronic breakdown, suspended solid particle mechanism, cavity breakdown, electroconvection and electrohydrodynamic model of dielectric breakdown, static electrification in power transformers).

Industrial applications perspective of nanodielectrics: introduction and background; polymer nanocomposites; the commercial impact of enhanced electric strength and endurance; opportunities for enhanced high-temperature dielectrics; cryogenic applications and other extreme environments; high-voltage stress grading materials and conducting nanocomposites; applications in the capacitor industry; multi-functional opportunities.

**Electrical properties:** charge storage and transport in polymers and nanocomposites (introduction, charge transport in insulating systems, charge transport in polymers, electrode effects, space charge effects, effect of nanoparticles and interaction zone on charge transport, percolation effects, examples of charge movement in nanocomposites, internal charge distribution in nanocomposites, concluding remarks on charges in nanocomposites); dielectric response (dielectric spectroscopy, dielectric response of nanocomposites); electrical breakdown (introduction, polyethylene nanocomposites, epoxy nanocomposites, PVA nanocomposite, surface functionalization of nanoparticles, voltage endurance).

| | |
|---|---|
| **Code** | **ECE_CK901** |
| **Title** | **Analysis and Design of Software Systems** |
| Instructor | Thramboulidis |
| Credits | 5 ECTS |

**Content:**

1. Introduction to Software Engineering. Embedded systems, Mechatronic Systems, Cyber Physical Systems, IoT. Software and system life cycle process. The concept of Model.
2. Software life-cycle models. Basic software and system development phases. CASE tools. The Scrum method. The concept of the model.
3. Modern structured analysis (SA) methodology. Requirements specification document. Data flow diagrams (DFDs), data dictionary, mini specification techniques, entity relation diagrams (ERDs), state transition diagrams (STDs).
4. Moving into the design phase. Quality of the design specification, coupling, cohesion.
5. Object Technology. The UML as a language to represent analysis and design models. UML's main diagrams. Structural and behavioral models.
6. System architecture. Architectural models.
7. Model driven development. Model-to-model transformations.
8. System development using the component-based development paradigm.
9. Development based on the concept of service. Service oriented Architectures (SOA). Basic concepts and technologies. The CORBA architecture.
10. System modeling. The system modeling language SysML.
11. Verification and Validation. Safety critical systems. Safety Engineering.
12. State-of-the-art trends in system development.

*Case Study:* Analysis, design and implementation of an embedded system. Typical examples: Liqueur Plant system, washing machine, Intruder Alarm System, Festo Modular Production System (Festo MPS), Multi cabin elevator system, Festo Mini Pulp Process (Festo MPP).

| | |
|---|---|
| **Code** | **ECE_CK902** |
| **Title** | **Computer and Network Security** |
| Instructor | Koubias<br>Serpanos |
| Credits | 5 ECTS |

**Content:**

Analysis, design and implementation of secure systems. Architecture of secure military and commercial systems. Cryptography with secret keys and public keys. Digital signatures and certificates. Cryptographic protocols. Computer Security. Communications security. Architecture of cryptosystems and computer/network security systems. Topics on how to implement secure systems.

| | |
|---|---|
| **Code** | **ECE_CK903** |
| **Title** | **Parallel Processing** |
| Instructor | Housos<br>Valouxis |
| Credits | 5 ECTS |

**Content:**

Parallel processing and algorithms for parallel and distributed computing systems. Historical overview of the development of parallel computing systems. Computational grid systems (GRIDS). Procedure of access to grids, with execution procedures and information storage. Synchronize Distributed processes. Web services and grid. Programming for parallel / distributed systems.

| | |
|---|---|
| **Code** | **ECE_CK904** |
| **Title** | **Interactive Technologies** |
| Instructor | Avouris<br>Moustakas<br>Sintoris |
| Credits | 5 ECTS |

**Content:**

1. Introduction, overview of human-computer interaction and design of interactive systems
2. Modeling of human as a user of computer system - Cognitive models of perception, attention and memory, knowledge representation and organization
3. Mental models, cognitive user models, distributed cognititve models.
4. Models of interaction
5. Interactive technologies - Interaction Style
6. Physical Man-machine interfaces
7. Haptic interaction
8. Methods and rules of interactive systems design
9. Usability Engineering
10. Evaluation of interactive systems
11. Tools and methods of interactive systems specifications.
12. Introduction to collaborative technology and technology for people with disabilities

| | |
|---|---|
| **Code** | **ECE_CK905** |
| **Title** | **Internet of Things** |
| Instructor | Dermatas<br>Sgarbas |
| Credits | 5 ECTS |

**Content:**

1. Introduction to the Internet of Things - IoT.
2. Basic concepts - fields of application.
3. Models, Architecture and Technologies for IoT.
4. The IoT Protocol Stack - Application Level Protocols.
5. Application-level protocols for devices with limited resources.

6. Cloud Computing.
7. System development using IoT technologies.
8. System Design - Case Study.
9. Basic Sensory Structures for IoT and Interfaces.
10. Interconnection of IoT devices.
11. Communication protocols for IoT-Zigbee, Bluetooth / Smart Bluetooth, PLC (Powerline Communications), disadvantages-advantages.
12. Sensor Networks, RFIDs and their combination, RFID Sensor networks - enabling technologies for IoT.
13. Examples of IoT applications (healthcare, smart home, smart cities etc.)

| **Code** | **ECE_CK906** |
|---|---|
| **Title** | **Integrated Systems Design** |
| Instructor | Theodoridis Koufopavlou |
| Credits | 5 ECTS |

**Content:**
System Specification, Formal Methods, Validation, Design of Data Paths and Control Subsystems, Interfaces, Design of Bus Oriented Versus Local Interconnect Structures, Area-Time-Power-Optimisation, Memory Management, Design Based on Existing Subsystems (IP Design), HDL Languages, Design Methodologies Based on VHDL Hardware Structural Specification, Design Organisation and Parameterisation, Data Flow Description and Behavioural Description, Realisation of DSP Systems, e.g. VLIW, Harvard and Modified Harvard Structures, Multiprocessors. Design of Special Purpose Processors, ASIP Design, Hierarchical Design of Layout, Power Management.

**Lab.1** Basic structures of VHDL. Data types, operators, and attributes. Valid and invalid operation between different data types. Arrays (1D, 1Dx1D, 2D). Description of ROM circuits.

**Lab.2** Concurrent VHDL code. Circuit implementation of concurrent statements. Development of combinational circuits with concurrent code such programmable priority encoder, barrel shifter with fixed amount of shifting, comparison circuits, Hamming distance calculation etc.

**Lab.3** Multiple VHDL descriptions per circuit with concurrent code and study the impact of the descriptions in the speed and area of the synthesized design. Circuits' examples: addition/subtraction of signed and unsigned numbers, addition/subtraction of BCD numbers, conversion from HEX to ASCII, driving a seven segment display etc.

**Lab.4** Sequential VHDL code. Understanding the process structure statement and the difference between signal and variables. Circuit implementation of the sequential statements. Development with sequential code of typical circuits such as counters (simple, decimal counters, up/down counters, universal counters), serial to parallel, calculating the average value of an input set etc. Study of existing codes in terms of correct functionality, generation of unwanted latches and flip-flops, delay, and area.

**Lab.5** Multiple VHDL descriptions per circuit with sequential code and study the impact of the descriptions in the speed and area of the synthesized design. Circuits' examples: register file, merge sort implementation, switch debounce, programmable pulse width generator, driving LED display with time multiplexing etc. Study of existing codes in terms of correct functionality, generation of unwanted latches and flip-flops, delay, and area.

**Lab.6** Development and synthesis of circuits based on Finite State Machines. Circuits' examples: programmable and not programmable arbiter, FIFO memory, extraction of FSM from specifications, FSMs with programmable timers, Mealy and Moore FSM implementations etc.

**Lab.7** Parametric structural VHDL, function, procedures, and packages. Circuits' examples: counters, adders, substractors, multipliers, registers with multiple operations etc.
**Lab.8** FPGA implementations of RTL circuits in Xilinx development platforms. Functional simulation and verification, development of constraint files, synthesis and study of the reports, pin assignment, implementations strategies, Place and Route (P&R) post-P&R simulation and design verification, FPGA programming, simulation with ChipScope
**Lab.Project** Complete development of an algorithm (finding of the architecture, application of design techniques such parallelism, pipeline, folding/unfolding, and resource sharing, RTL VHDL development, functional verification, synthesis, and FPGA implementation and verification). Algorithms' application domains: DSP and multimedia (e.g. filters, FFT, DCT), cryptography (e.g. DES, GOST, FEAL, IDEA) etc.

| **Code** | **ECE_CK907** |
|---|---|
| **Title** | **High Speed Electronics** |
| Instructor | Kalivas<br>Birbas M. |
| Credits | 5 ECTS |

**Content:**
Design issues and basic systems concepts for high-speed signaling, modern integration technologies.
Design of high-speed digital basic building blocks (inverters, gates, flip-flops), speed optimization and consumption.
High-speed interconnections, modeling of interface lines.
Receiver circuits (preamplifiers, clocked comparators, limiters), distributed circuits.
Jitter noise and other sources of noise, jitter effect on performance.
Timing / Data Recovery (CDR) circuits, PLL for CDR applications.
Damping amplifiers, bandwidth enhancement techniques.
Multiplexers.

| | |
|---|---|
| **Code** | **ECE_DK901** |
| **Title** | **Adaptive Control** |
| Instructor | Kazakos |
| Credits | 5 ECTS |

**Content:**
Paradigms and historical perspective of adaptive control. Fundamentals of adaptive control and self-tuning systems. Introduction to system identification. Off-line techniques (Least Squares, Maximum Likelihood, Deconvolution-based algorithms). On-line transfer function estimation (ETFE, Recursive Least Squares, Least Mean Squares, Projection algorithms) and system output prediction. Controller design framework (Pole-placement, Generalized minimum variance, LQ-suboptimal control, Generalized Predictive Control). Model Reference Adaptive Control (MIT-Rule, Backstepping techniques). Adaptive Internal Model Control.

| | |
|---|---|
| **Code** | **ECE_DK902** |
| **Title** | **Non Linear and Robust Control** |
| Instructor | Kazakos |
| Credits | 5 ECTS |

**Content:**
1. Nonlinear phenomena: Multiple equilibrium situations. Limit cycles. Chaos. Regions of attractors.
2. Analysis of nonlinear systems: analysis in the phase domain. The description of the function.
3. Stability. Stability in persistent disturbances-stability clogged Inlet clogged state. Stability in temporary disturbances. The first method of Lyapunov. The second method of Lyapunov. Rating stability regions.
4. Controllability of nonlinear systems: Controllable and approachable situations.
5. Control of nonlinear systems: Design of control systems based on the linear approximation. Design of control systems based on linearization. Control methods with the help of Lyapunov functions. Control of linear and nonlinear systems with bounded inputs and situations. Control of chaotic systems.
6. Transfer function of Multivariable Control System with multi inputs and multi outputs. Smith MacMillan form. Poles, Zeros, Eigenvalues, Eigenfunctions, Eigenvectors. Characteristic Locus, analysis and design. Transfer function factorization.
7. Uncertainty and System Robustness. Uncertainty Models of Control Systems.
8. Robust Stability and Robust Performance of Multivariable Systems. Structured singular value (SSV/μ) analysis. $H_2$ Optimization and Loop Transfer Recovery (LTR). Robust/ H∞ Control, Two Port Formulation of Control Systems and mu synthesis.
9. Stabilizing Controllers Parameterization. Youla factorization. H∞ Controllers design using Transfer Function and State Space Models. Applications on Distillation Column, and Flight Control.

| | |
|---|---|
| **Code** | **ECE_DK903** |
| **Title** | **Optimal Control** |
| Instructor | Alexandridis |
| Credits | 5 ECTS |

**Content:**
Introduction to the Calculus of Variations. Functionals. Minimisation of functionals: Euler-Lagrange equation. Minimisation of functionals under constraints. Cost criteria. Optimal control of continuous or discrete time systems. The linear quadratic (LQ) regulation and tracking problem: Open and closed-loop solution, infinite time solution, Riccati equation. The minimum Principle of

Pontryagin. Bang-bang control. Optimal control of systems, with input and state constraints. Optimal PI controllers. Hamilton-Jacobi-Bellman theory. Dynamic programming. The linear quadratic Gaussian (LQG) problem.

| **Code** | **ECE_DK803** |
|---|---|
| **Title** | **Estimation Theory and Stochastic Control** |
| Instructor | Koussoulas |
| Credits | 5 ECTS |

**Content:**
Introduction and overview. Review of probability theory, stochastic processes and linear system theory. The stochastic approach for modelling uncertainty. White noise. Analysis of the behaviour of stochastic dynamic systems. Fundamentals of estimation theory. Discrete time Kalman filter. Continuous time Kalman filter. Stochastic observers. Optimal smoothing. Extended Kalman filter. Applications. Error analysis and implementation. Solution of algebraic Riccati equations. Square root algorithms. Stochastic control techniques. The LQG problem. Non-linear stochastic control and the dual effect. Robustness issues.

# POSTGRADUATE STUDIES - RESEARCH

## Postgraduate Studies

The Department of Electrical & Computer Engineering offers postgraduate studies leading to the Doctorate in Electrical & Computer Engineering. The general regulations for attending a Postgraduate Programme (PGP) and acquiring a Doctorate are stated in law 2083/92.

The specific regulations for the PGP at the Department of Electrical & Computer Engineering are included in the decree 562 T.B./ 28.6.95, by which this PGP was accepted by the Ministry of Education and Culture.

Candidates have to apply to the Secretariat of the Department either in September for studies starting in WS or in January for studies starting in SS designating the division(s) in which they want to study. They must possess a diploma in Electrical & Computer Engineering from a University department in Greece or an equivalent, recognised department abroad. Furthermore, candidates with a diploma in Computer and Information Engineering, Mechanical or Chemical or Civil Engineering and Candidates with a certificate in Physics, Mathematics, Computer Science or Informatics may be accepted. The selection of candidates is performed by the "General Assembly" of the Department (GAD) upon recommendation of the "Co-ordinating Committee of the Post Graduate Programme (CCPP)" of the Department on the basis of the diploma grade, the marks in the diploma thesis and in the main courses of the designated division, two recommendation letters and an interview with the CCPP. Accepted candidates with a diploma other than in Electrical & Computer Engineering (or equivalent) have to attend and pass examinations in a number of under-graduate courses in addition to the courses of the PGP.

The PGP includes several specialised, elective courses offered by the four divisions of the Department. Each postgraduate student has to select and attend six courses, and pass the corresponding examinations in the first four semesters of his/her studies. Furthermore, he/she has to start working in the first semester on a doctorate thesis, the subject of which is determined in co-operation with a faculty member that is willing to serve as the principal supervisor of the thesis. Upon request of this faculty member and recommendation of the CCPP, the GAD appoints a three member supervisory committee headed by the principal supervisor.

Postgraduate studies have a minimum duration of 6 semesters and a maximum duration of 12 semesters. As soon as the supervisory committee considers that the student has completed all requirements, a 7 faculty member examination committee, including the 3 supervising committee members, is appointed by the GAD, upon recommendation of the CCPP.

The candidate defends his/her thesis in public before the examination committee which decides whether the thesis is original and contributes to the advancement of science. In a positive case, the GAD awards the doctorate degree naming the candidate who possesses a diploma in Electrical &

Computer Engineering "Doctor of Electrical & Computer Engineering", and a candidate with a different diploma, "Doctor of the Department of Electrical & Computer Engineering".

## Research

The backbone of post-graduate studies is the Research and Development (R & D) that is being carried out in the Department of Electrical & Computer Engineering. As a rule, the research is conducted in the existing Laboratories of the Department, within the framework of the research programs of each Laboratory. The research programs are supported either by current state funding awarded to the University Laboratories, or by non-university institutions (*The General Secretariat of Research and Technology, Industry, the EU,* etc.) which, by various means, fund research and development at the University.

Ever since it was founded, the Department of Electrical & Computer Engineering has developed intense activity in research as well as in development. Its participation in international research projects, and its collaboration with the industry is of special importance. The result of this effort is manifested in the high number of doctorates awarded and of papers presented at international conferences and published in international journals.

## Coordinating Committee of the Post Graduate Programme

***Headed by:***

Prof. **A. Alexandridis**
Division of *Division of Electric Power Systems*
Electrical & Computer Engineering Building, East Wing
Tel.: +30 2610 996 404
Fax: +30 2610 997 350
Email: alexandridis@ece.upatras.gr

***Members:***

Prof. **J. Mourjopoulos** (Associate Director, Divison A)
Prof. **V. Paliouras** (Division C)

# POSTGRADUATE PROGRAMS

## Specialised Programs

A list of Specialised (Master) Programs offered at the Department of Electrical & Computer Engineering is given below.

| A/A | Master Program | Website | Director |
|---|---|---|---|
| 1 | **Applied Optoelectronics** | www.upatras.gr/el/node/7819 | *From Material Science Dept.* |
| 2 | **Biomedical Engineering** | www.biomed.upatras.gr | K. Moustakas |
| 3 | **Green Electric Power and the Advanced Network Infrastructure for its Management and Economy** | greenpower.upatras.gr | A. Alexandridis |
| 4 | **Human-Computer Interaction** | hcimaster.upatras.gr | N. Avouris |
| 5 | **Integrated Hardware and Software Systems** | www.ics.ece.upatras.gr/osyl | V. Paliouras |
| 6 | **Processing Systems of Information and Machine Learning** | xanthippi.ceid.upatras.gr/dsp | *From Computer Engineering & Informatics Dept.* |
| 7 | **Space Technologies, Applications and Services** | star.uoa.gr | *From Informatics & Telecommunications Dept. of Kapodistrian Univ. of Athens* |

# Appendix

**A:** Division of Telecommunication & Information Technology
**B:** Division of Electric Power Systems
**C:** Division of Electronics & Computers
**D:** Division of Systems and Control

## Directory of Faculty

| Name | Position | Division | Telephone | Email address |
|---|---|---|---|---|
| Alexandridis A. | Professor | B | +30 2610996404 | a.t.alexandridis@ece.upatras.gr |
| Antonakopoulos T. | Professor | A | +30 2610996487 | antonako@upatras.gr |
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| Birbas A. | Professor | C | +30 2610996426 | birbas@ece.upatras.gr |
| Birbas M. | Assis. Prof. | C | +30 2610996426 | mbirbas@ece.upatras.gr |
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| Koubias S. | Professor | A | +30 2610996427 | koubias@ece.upatras.gr |
| Koufapavlou O. | Professor | C | +30 2610996444 | odysseas@ece.upatras.gr |
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| Koussoulas N. | Professor | D | +30 2610996451 | ntk@ece.upatras.gr |
| Logothetis M. | Professor | A | +30 2610996433 | mlogo@patras.gr |
| Lymperopoulos D. | Professor | A | +30 2610996479 | dlympero@upatras.gr |
| Markakis M. | Assis. Prof. | B | +30 2610996882 | markakis@upatras.gr |

| Name | Position | Division | Telephone | Email address |
|---|---|---|---|---|
| Mitronikas E. | Assis. Prof. | B | +30 2610996409 | e.mitronikas@ece.upatras.gr |
| Mourjopoulos J. | Professor | A | +30 2610996474 | mourjop@upatras.gr |
| Moustakas K. | Assoc. Prof. | A | +30 2610969809 | moustakas@ece.upatras.gr |
| Moustakides G. | Professor | C | +30 2610997321 | moustaki@ece.upatras.gr |
| Paliouras V. | Assoc. Prof. | C | +30 2610996446 | paliuras@ece.upatras.gr |
| Perdios E. | Professor | D | +30 2610996201 | eperdios@upatras.gr |
| Pyrgioti E. | Assoc. Prof. | B | +30 2610996448 | e.pyrgioti@ece.upatras.gr |
| Serpanos D. | Professor | C | +30 2610996437 | serpanos@ece.upatras.gr |
| Sgarbas K. | Assoc. Prof. | A | +30 2610996480 | sgarbas@wcl.ee.upatras.gr |
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| Skouras E. | Assoc. Prof. | C | +302610996425 | eskuras@ece.upatras.gr |
| Stylianakis V. | Assis. Prof. | A | +30 2610996477 | stylian@upatras.gr |
| Svarnas P. | Assoc. Prof. | B | +30 2610996417 | svarnas@ece.upatras.gr |
| Tatakis E. | Professor | B | +30 2610996412 | e.c.tatakis@ece.upatras.gr |
| Theodoridis G. | Assis. Prof. | C | +30 2610996445 | theodor@ece.upatras.gr |
| Thramboulidis K. | Professor | C | +30 2610996436 | thrambo@ece.upatras.gr |
| Tomkos I. | Professor | A | | itom@ece.upatras.gr |
| Vovos P. | Assis. Prof. | B | +30 2610969866 | panagis@upatras.gr |

**Directory of Special Technical Educational Staff (ETEII)**

| Name | Division | Telephone | Email address |
|---|---|---|---|
| Drakontaidis Charis | COPUTER ROOM | +30 2610962463 | kiterdra@upatras.gr |
| Petrou Constantinos | B | +30 2610996429 | petrou@upatras.gr |
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| Tzouras Georgios | C | +30 2610996447 | tzouras@ece.upatras.gr |

**Directory of Laboratory Teaching Staff (ΕΔΙΠ)**

| Name | Division | Telephone | Email address |
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