Specialization Course in **Electronics Engineering** - A.Y. 2018/19

Didactical program - Syllabus

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Introduction.

The specialization course in Electronic Engineering for the academic year 2018/19 includes selected subjects from the BSc of Electronics Engineering program. The course is based on standard University of Genoa (UOG) Engineering subjects and teachers are from University of Genoa. The course address first the foundations of electronics followed by applied electronics and programming engineering, up to the most recent development and applications. In order to improve students' skill and leadership, during the course Electronics subjects are complemented by project management and personal growth subjects. It is an integrated course, designed to give to the students:

- Knowledge on basic and Specialization electronics engineering matters;
- Competences to be leader in their profession;
- Credits for future university experience in UAE or wherever in the world;
- Growth as men, conducting themselves in an intensive experience abroad.

Programs Highlights.

The Course starts with three months classroom on engineering foundations subjects and specific laboratory activities. The course is supported by a standard Moodle devoted web area. All the students receive own PC, licensed software and training for: classroom, lab activities, homework, project development and self-study. In the second part of the course highly specialized subjects on electronics are addressed. Specific seminars for the students and visits to factories are planned for the Course. Since course will be attended by UAEN Cadets a specific subject on naval system and related electronics technologies is added to program. A managerial and behavioural teaching module is spread through the courses. In parallel with classroom and labs it will run a project work. With the support of the teachers, the attendants will be organized in small teams, which collaboratively design and implement a complex electronic project involving several technologies. The aim is find engineering applications for learned theories, develop skills by designing and building complex prototypes, learn how to works in teams. At the end of each subject/module, for each subject, there will be tests and exams; project works ends with a formal/public presentation as thesis and evaluated together with exams for the University credits.

Organization of the Course.

The subjects of the course are selected from the three-year Bachelor (BSc) degree course in Electronic Engineering and Information Technologies (IETI) [1] degree course nr. 9273 (cl. L-8) from the University of Genoa [2]. A detailed list of subjects and face to face/classroom hours of lesson is provided in the following.
Course title and code number.
Specialization Course in Electronics Engineering - A.Y. 2018/19

Language of the course.
English.

Location of the teaching activity.
Department of Naval, Electrical, Electronic and Telecommunications Engineering (DITEN) – Polytechnic School [3] - University of Genoa (IT)

Duration.
9 months, from March 2019 to November 2019.

Total amount of hours.
Including theory, practice and internship: 1500
(About 1250 hours of lessons, practical activities, tests, laboratory and final project work preparation. About 250 hours of individual study).

Total credits.
80 ECTS.

Access requirements.
- High school diploma, with knowledge and interest in the area address by the Course, (L-6 EQF qualification framework).
- Knowledge of the English language

Admission procedure.
- Students pre-selected in UAE by Officer in charge from University of Genoa
- Selection by interview with Course management committee

Web support.
The learning support platform is standard Moodle [4], the home page is at http://programs.politecnica.unige.it/. Readings and required materials will be made available on that platform, where each student and teacher has individual access and can interact, also offline from classroom.

Evaluation systems and Quality monitoring.
In order to evaluate and monitoring the learning and skills acquired by the students, intermediate checks and final exam will take place at the end of each subject, the exam will be evaluated in thirtieths. In the second part of the course, candidates will be asked to draw up a project work that will be discussed during the final examination (Thesis presentation) by a Commission formed by representatives of the Management Committee and teachers of the Course. The final score will be evaluated in one hundred and ten.

The internal monitoring and evaluation activities of the training project, during the implementation phase of the training courses, will aim to detect, as far as possible,
the different dimensions of training quality: from the process variables to the result variables, up to those of organizational impact.

Qualitative surveys (group interviews) will be added to the quantitative, consolidated and standardized surveys (structured questionnaire) which will integrate and give greater emphasis to the motivations and explanations of the quantitative quantities measured with standardized tools.

The surveys will involve all the people involved in the project: teachers, tutors and students. In particular, the following will take place:
• surveys on teachers with the aim of verifying:
  - the degree of coordination to ensure consistency between the training modules and the continuity and articulation between the topics addressed
  - the degree of involvement and interest of the students with respect to the topics covered and the teaching methods used

• surveys on tutors with the aim of verifying:
  - the correct execution of the activities foreseen for the role
  - the degree of perception of the "classroom situation"
  - the degree of involvement and interest of the participants with respect to the topics covered and the teaching methods used
• detection of participants' expectations
• recognition of participants' satisfaction

Monitoring also includes the collection of information on achievements (attendance trends, changes in the routes, deviations between planned and implemented in terms of time, etc.).
Quarterly report will be compiled by the University of Genoa and provided to UAE Authorities whether required.

**Academic integrity statement - plagiarism and collaboration.**
All homework assignments, projects, lab reports, and examinations submitted to a course are expected to be the student’s own work. Students should always distinguish their own ideas and knowledge from information derived from other sources, including other students of the course. Permitted collaboration in the completion of assignments can vary, depending upon the policy set by the teacher(s) of each subject. Students must assume that collaboration in the completion of assignments is prohibited unless explicitly permitted by the teacher.

**Attendance and lateness policies.**
It is expected all students to attend all timetabled lessons, be punctual for classes and daily sign the attendance record. Unauthorised absences count as a negative towards overall attendance. Lateness is defined as arriving at a timetable session more than ten minutes after the scheduled start of that session. Students whose attendance and/or punctuality falls below an acceptable level are subject to the Course management committee disciplinary procedures. Acceptable Absences are: medical appointment, sick leave, religious holiday, needs to look after a family member, paperwork for residence permits for study (all of them agreed in advance and/or validated by the Course supervisor for the Course management committee).
Policies on the usage of electronic devices.
Technology use (such as cell phones, laptops and tablets) during class is intended only to enhance the learning environment. The course teacher decides when, if, and what type of technology is to be used during class. Instructors are asked to allow the use of mobile computing devices to take notes and for activities related to computer labs. In any case it is not allowed messaging, game playing, and Internet surfing during class time because disruptive. Any usage of technology promoting academic dishonesty during exams will be reported to Course management committee.

Diploma issued.
Pursuant to art. 8 of the University of Genoa “Regulation of specialization courses, professional training and lifelong learning courses, courses for first and second level university masters”, at the end of the Specialization Course, students who, in the evaluation of the Course management committee, have performed activities and fulfilled their obligations, will receive the diploma with the final score award and attestation of acquired skills on each subject.
**Delivery of the Course.**

Detailed indication of the scientific disciplinary sectors, credits and hours of classroom lesson for each subject is detailed in the following table for the Electronics Engineering specialization:

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Subject</th>
<th>SSD</th>
<th>Credits</th>
<th>Classroom Tot. Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mathematics</td>
<td>MAT/08</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Physics</td>
<td>FIS/03</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Chemistry</td>
<td>CHIM/07</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>Circuit Theory</td>
<td>ING-IND/31</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>Electronic instruments</td>
<td>ING-INF01</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>Naval systems</td>
<td>ING-IND/02</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>Design and integration of hardware-software systems</td>
<td>ING-INF01</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>8</td>
<td>Digital electronics I</td>
<td>ING-INF01</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>9</td>
<td>Electronics for Makers and IoT</td>
<td>ING-INF01</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>Team and Project management</td>
<td>M-PSI/06, ING-INF/35</td>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>11.EO</td>
<td>Electromagnetism</td>
<td>ING-INF02</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>12.EO</td>
<td>Telecommunications</td>
<td>ING-INF03</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>13.EO</td>
<td>Analog electronics and components</td>
<td>ING-INF01</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>14.EO</td>
<td>Digital electronics II</td>
<td>ING-INF01</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>15.EO</td>
<td>Laboratory</td>
<td>ING-INF01, M-PSI/06</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>16.EO</td>
<td>Project work</td>
<td></td>
<td>5</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td>Self study</td>
<td></td>
<td>0</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>80</strong></td>
<td><strong>1500</strong></td>
</tr>
</tbody>
</table>

SSD=Italian standard subjects classification
Course Program.

Main contents

ELECTRONICS ENGINEERING FOUNDATIONS
(3 months)

 Mathematics analysis
 General Physics
 Chemistry fundamentals
 Circuit analysis
 Electromagnetism in vacuum and applied
 Principles of Electronic Devices and Circuits

MANAGERIAL and BEHAVIORAL program
(1 month)

 Leadership module
 Team management module
 Stress management module
 Project management Office module
 personal growth implementation
 Team briefing

ELECTRONICS ENGINEERING SPECIALIZATION
(5 months)

 Electronic laboratory and Instrumentation
 Digital electronics systems
 Implementations of electronics applications and systems
 Electronics Embedded systems
 Power electronics control systems and naval applications
 Analog, digital, makers electronics
 Computer engineering
 Telecommunications, radio engineering, signal processing
 Electronics systems engineering
Description of Subjects.

1. Mathematics.

Main contents.

Course in mathematical analysis and introduction to numerical methods.

- The real and complex number systems
- Some special functions: exponential, logarithmic, trigonometric, etc.
- Sequences
- Limits of functions and continuity
- Differentiation and Taylor’s expansion
- Supremum and infimum of subsets of the real line
- Riemann integration: analytical and numerical methods
- Introduction to Matlab
- Numerical method for nonlinear equations
- Ordinary differential equations: analytical and numerical methods
- Functions of several variables: partial differentiation and some applications
- Multiple integrals

2. Physics.

Main contents

Course in mechanical physics and applied physics.

Mechanics:

- Harmonic motion.
Electromagnetism in vacuum:

Electric field
- Electrical conductors. Capacitors. Energy density of the electric field.

Magnetic field
- Lorentz force. Magnetic field.
- Torque on a loop. Magnetic moment of a loop.
- Ampère law. Biot-Savart law.

3. Chemistry.

Main contents

Chemistry fundamentals and seminars.

Materials Structure:
The structure of atoms; periodic properties of the elements; covalent, metallic and ionic bonds, intermolecular forces. Solids, liquids, gases and equations of state of the gas. Elements of inorganic and organic nomenclature.

Transformation of matter:

Material properties:
Classification and nomenclature of the main classes of organic compounds. Essentials on natural and synthetic polymers. Electric and magnetic properties. Metallurgy and corrosion.

Visits to labs.
4. **Circuit Theory.**

Main contents

1. Introduction and basic DC circuit analysis methods:
   - Definition of basic electric quantities and components;
   - Kirchhoff laws;
   - Main theorems for circuit analysis.

2. Analysis of circuit transients:
   - Definition of capacitance and inductance;
   - First and second order circuit analysis;
   - Use of Laplace transforms;

3. Analysis of sinusoidal steady-state circuits:
   - Use of phasors and definition of impedance;
   - Generalization of basic circuit laws;
   - Active, Reactive, apparent and complex power in sinusoidal steady-state circuits;
   - Three phase circuits.

5. **Electronic instruments.**

Main contents

Gathering data and making measurements on any system is a fundamental aspect of any engineering field. As well as are important: the representation of data in the appropriate domain, transmission and exploitation for analysis and control. The course aims to present the main electronic instruments and tools available for measuring physical quantities, their selection and integration criteria.

**Understanding complex electronic instrumentation:**
- Phase locked loop systems.
- Frequency conversion.
- Analog modulations and introduction to digital modulation techniques in electronic measurements.

**Instrumentation:**
- Introduction to automated measurement systems
- Synthesizers.
Arbitrary waveform generators.
Digital oscilloscopes.
Logic state analyzers.
Spectrum analyzers / FFT.
Vector analyzers.
Network analyzers.

Lab. Training:
- Synthesis of analog and digital signals via generators and arbitrary waveform using programmable platforms and embedded systems and subsequent experimental analysis using the instrumentation of the course.
- Programming Fundamentals in LabView and MatLab.
- Using MatLab and LabView software environments for the design, management of instrumentation and conducting measurement sessions.
- Characterizations of electronic systems.

6. Naval systems.
Main contents

Fundamentals, electrical and electronic technologies in naval systems:
- Nomenclature and descriptions,
- Types of ships, Shapes and sizes, Functional layout,
- Shipbuilding, construction of hull and systems, Buoyancy and stability,
- Controls and transducers,
- Electrical and electronic technologies installed on board and the related issues.
- Safety,
- Regulatory principles and international context.
- Technical visits.

7. Design and integration of hardware-software systems.
Main contents

This course addresses studying and practicing on building Electronic circuits and systems. Hardware and software developments tools and several programming environments are studied and applied, in order to design and develop complex electrical systems, including: building interfaces, wired network.

In particular the course address:
- Practicing with hardware components in building electronics circuitry
- Programming language fundamentals
- Programming environments
8. **Digital Electronics I.**

Main contents

The course introduces the basics of digital systems design. In the first part, the course covers elements of Boolean algebra and binary arithmetic, and the methods of analysis and design of combinational and sequential digital networks. Sequential systems will be modelled using the finite state machines methodology, with the help of Algorithmic State Machine charts. Next, the course covers digital systems structured on data-path and controller modules. The course introduces also the basics on programmable device techniques and on hardware description languages. In the last part, after the definition of the elements of microcomputer architectures, the course introduces the development of embedded systems, particularly with respect to the machine language programming, interfacing with external devices, interrupt techniques, and the use of the microcomputer as system controller.

In particular the course address:

- Binary codes and binary arithmetic. Conversions between binary, decimal, hexadecimal number formats. Representation of signed integer numbers using the two-complement technique. Alphanumeric representation codes.
- Introduction to Finite State Machine (FSM) model (Moore and Mealy machines). FSM representation and design: Algorithmic State Machine (ASM) charts. Status Block, Conditional Block, Conditioned Outputs. Examples of simple synchronous FSMs' design. State assignment. Introduction to asynchronous FSM.
- Digital systems composed of standard elements controller by a timing module, FSM based; digital systems based on “data-path and controller” architecture.
9. **Electronics for Makers and Internet of Things.**

**Main contents**

This course addresses studying and practicing on the many subjects involved in designing a complex engineering system based on Electronics and Electrical components, like: sensors, actuators, computational unit etc. suitable for Internet of Things (IoT) applications. The approach follow a COTS approach in building main units and involved International standards and regulations are also addressed. In particular the course address:

- Internet of Things: general overview, Key features of the involved equipment into Internet of Things (IoT) Communication networks to connect IoT devices. Main network protocols used in IoT environment and comparison to the ISO-OSI model, Network simulators for IoT devices, Contiki OS as a IoT devices simulator, Network Communication inside the IoT world, Data transmission networks for IoT devices: IPv4 / IPv6 vs 6LowPAN
- IoT Sensors: Hardware and Software key features in terms of power consumption, computational power and memory usage.
- Receiving communication data from IoT sensor devices
- Specific system example for data reception: the GPS system Communication data transmission to IoT sensor devices
- Specific system data transfer example: the STM Nucleo board for PWM control module, Connection between sensors and signal processors.
- Application example: connection among ESC - PWM Module - Autopilot to control the rotation speed of a brushless motor
- Type of mini and micro electric motors: Brush motors, Brushless motors, Step-by-step motors, Features and operating modes of these engines, Motivation for the use of brushless motors in self-moving units (i.e. UAV - Drones) Integration between home automation and home appliances: the case of the intelligent fridge.
- Batteries: types, voltage and charge for each cell, methodology to calculate the battery time of life, Calculating the flight time of a drone by knowing maximum weight, battery rating and engines characteristics
- The propellers: the principle of operation, characteristics, differences between the pushing propeller and the tractor propeller, Propellers: aeronautical and naval use. The propellers: problem of cavitation in water and air. Graphic interfaces for the representation of data from sensors and IoT devices Basic drone flying elements: Acceleration, power, gravity and centre of gravity forces.
- International standards, safety and legislative regulations.
10. **Team and Project management**

Main contents

**Leadership module:**
- Leadership definitions and leadership most known models
- Leadership versus management
- Situational leadership: the three main competences
- Situational leadership profile: behavioural inventory
- Participants’ profile discussion
- Diagnosis of development level of human capital
- Diagnosis interview behavioural simulations. Feedback session.
- Flexibility: personal leadership profile awareness
- Matching the right style with the specific management situation
- The 4 leadership situational styles: directive, lead, participative, delegating.
- Partnership competences
- How to handle a partnership interview
- The 5 steps of a partnership interview: setting objective, diagnosis, matching style, action plan follow up
- How to manage a low performer
- How to manage a bad work habit
- How to empower good performance

**Team management module:**
- Introduction to the lifecycle of a team
- Forming step: role, rules and objective
- Storming step: how to handle conflicts
- Social constructivism
- Trust issues in a team
- Confrontation skills
- Norming step: the group starts to perform
- Feedback techniques for a strong team alignment
- How to facilitate openness and right information sharing
- Realization as individual among the team
- Realization of the team on front of challenges
- How to observe group dynamics
- Assessment of the team in term of Belbin Role Model
- Cross perception and cross feedback
- Team action plan

**Stress management module:**
- Stress definitions: medical, legal and organizational
- Effects of stress: short, medium and long term, both physical and psychological
- Analysis of the main stressors: organization, relation, effectiveness
- Personal stress profile. Coaching provided
Working on motivation
Dealing with relations as stressor
Listening skills
Negotiation skills
Dealing with personal effectiveness as stressor
Time management fundamentals
Setting priorities: the time matrix
Assessment on personal abilities in time management
Dealing with stress in emergencies
Dealing others in emergencies
Resilience factors
Analysis of personal resilience profile: reactivity and control
Handling crisis and recovery plans

Project management Office module:
- Project cycle
- Setting of the main aspects of a project
- SMART objectives: specific, measurable, achievable, realistic, time-bound
- KPIs (key performance indicators) in a project
- Roles and responsibilities: RACI matrix
- Setting the communication plan of a project
- The most important tool: the WBS (Work Breakdown Structure)
- Cost control and project budgeting
- Risk assessment
- Proactive plans and contingency plans
- Dealing with time and durations: the GANTT tool
- The critical path and the PERT tool (Programme Evaluation Techniques)
- Teamwork in the project
- TKI model for handling internal conflicts
- Managing the stakeholders of a project
- The “5 why” techniques
- Systemic thinking applied to complex teams
- Fundamental Office Applications
- Windows Project

11. EO Electromagnetism.

Main contents

The course provides the basic concepts of applied electromagnetic, electromagnetic compatibility (EMC). It mainly concentrates on the following topics

- motivation for studying electromagnetic compatibility: examples of electromagnetic interference in civil and military applications
definitions and electromagnetic compatibility targets: governmental constraints and effective electromagnetic compatibility

fundamental issues related to electromagnetic fields (transmission lines; plane, cylindrical and spherical waves; energy considerations; frequency spectrum; polarization)

radiated emissions and susceptibility (overview of radiated phenomena; near and far fields; main classes of antennas; transmitting and receiving antennas; antennas figures of merit; performances versus frequency; wideband antennas; differential and common mode currents)

conducted emissions and susceptibility; considerations related to transient phenomena

crosstalk

measurements of radiated and conducted emissions and susceptibility tests for verification of compliance

protective measures against EMI (grounding, shielding, bonding, EMI filters, cables, connectors and components)

considerations related to system design

first considerations related to EMI/EMC modelling techniques and to numerical simulators for EMC analysis and design

first considerations related to the biological effects of electromagnetic fields

12. EO Telecommunications.

Main contents

Modulation and Coding:

Multiplexing of multiple signals in the frequency domain (FDM) and time (TDM).

Analog modulations, linear and angular.

Sampling and pulse modulation.

Digital Modulations.

The structure of a telecommunications network:

Functional levels, protocols and interfaces, packet switching networks / circuit switching networks, introduction to internetworking.

The data link level: the concept of encapsulation and transport, the action of a switch.

Ethernet and its extensions.

802.2 and 802.3 standards.

VLAN.

PPP.

IP protocol, IP addressing and routing.

TCP and UDP.
Problems in the exploration of the sea
Nature of sound waves; characteristic quantities
Propagation of sound in the marine environment; computation of attenuation
Outline of underwater acoustic transducers
Passive sonar systems and active sonar systems; computation of benefits through balance equation
Applications of civil and military sonar equipment

13. EO Analog electronics and components

Main contents

- Elementary semiconductor physics
- Introduction to circuit simulation with PSPICE
- The p-n junction: construction and polarization. Circuit models and sample circuits
- Bipolar and MOS transistors: physical structure and models of operation
- Analog and digital circuits: amplifiers, current mirrors, logic gates
- Operational amplifiers and principles of A/D and D/A converters
- Laboratory experiences with diodes, BJT transistors and Operational Amplifiers

14. EO Digital Electronics II.

Main contents

- Introduction to programmable digital systems: PLD, CPLD, FPGA: introduction to the Hardware Description Languages (VHDL basics).
- Basic elements of a digital computer: Central Processing Units, Memory, Input/Output System. Bus systems: address, data and control signals. Solid state memories concepts. Introduction to embedded system concepts.
- Hardware design of a microcomputer suitable for embedded system applications. Clock Generator, reset circuits, address decoder. Memory sub-system and memory management.
- Introduction to RISC 32-bits microprocessors (ARM7).
- Data acquisition, I/O, algorithms implementations.

15. **EO Electronics Laboratory.**

Main contents
Laboratory activities devoted to training on applications of theoretical subjects learned in classroom, for each subject, by making electronics circuits, software programs, exploiting electronics instruments and software simulation of circuits and systems. Training activities devoted to the Final project works and thesis.

16. **EO Project Work.**

Main contents
The project work has the main goal to let students apply what they have learned during the courses from three points of view:
- Technical learnings (on electronics, informatics and telecommunication)
- Teamwork learnings (on communication, collaboration, leadership)
- Project management learnings (on organization, prioritization, cost and other resources controlling, reporting)

Project works run in the second part of the course, in parallel with class and labs. With the support of the teachers, the attendants are organized in small teams, which collaboratively design and implement subsets of a complex electronic project involving several technologies. Students receive a general description and main requirements for the system to be developed. They are free to discuss and update objectives and route. The project work may exploits some of the previous year project work results, in order to represent a continuum learning cycle for the students, set clear and realistic goals and being close to engineering real world. The system is composed of sub systems, each of them developed by the teams. The output form each team goes together to build a unique prototype. The project work goes through phases: exploration, formalization, preparation, development, reporting and presentation. Project works ends with a formal/public presentation as thesis.
Reference

[2] www.unige.it