

# ELECTRICAL ENGINEERING

Programme of written-exams - November 2017

## PROGRAMME FOR A 2-HOUR WRITTEN EXAM FOR BACHELOR STUDENTS IN ELECTRICAL ENGINEERING

3 exercises of 40 minutes each to be chosen among five (in the fields of signal and systems, digital elect., analogic elect., power system)

### Signals and Systems

#### Signal and systems temporal representation

- Deterministic modeling of signals, Dirac impulse, energy, power, correlation, modeling of signals and systems using ordinary differential equations, difference equations.
- Linear time-invariant models, input-output relation, convolution, impulse response
- State-space representation, transfers function. Laplace and Z transforms. Stability

#### Systems of 1<sup>st</sup> order, of 2<sup>nd</sup> order, of order n

- Asymptotic Bode diagram
- Correspondence between the poles and zeros location and the responses
- Minimum-phase system, all-pass systems, pure time-delay

#### Spectral Representations

- Fourier transform.
- Energy, power density, Parseval relation.
- Frequency response, ideal filtering (low-pass, high-pass, band-pass...)

#### Sampling and reconstitution of signals

- Sampling, spectral aliasing, Shannon Theorem, anti-aliasing filtering
- Ideal reconstitution, zero-order hold, interpolation
- Analog to digital conversion, quantization

#### Deterministic signal analysis

- Discrete Fourier transform, properties
- FFT
- Spectral analysis: windowing

### **Filtering**

- FIR and IIR filters. Group delay. Synthesis of analog filters: frequency transformations, approximation functions, minimization criteria (quadratic error)
- Synthesis of IIR digital filters: impulse invariance, Euler and bilinear transforms.
- Synthesis of FIR digital filters: linear phase filters, synthesis through windowing, by frequency sampling, using optimisation

## **Digital and Analogic electronic**

### **Combinational logic systems**

- Implementation of a circuit by assembling logic gates, logic/timing characterization
- Standard combinational building blocks. Iterative structures

### **Sequential logic systems**

- Finite-state machines, Moore and Mealy machines.
- Memory element and diagram. Latches and flip-flops.
- Timing characterization. Timing conditions for proper operation, metastability.
- Standard sequential blocks and their combination: counters, registers, memories.
- Design of sequential systems by using a programmable circuit (FPGA).

### **Digital electronics**

- Logic circuit characterization and interfacing, logic families.
- CMOS design based on switch network

### **Hardware description languages**

- VHDL basis. Simple combinational and sequential block description

### **Analog Electronic Circuits design:**

#### **Electronic device modelling**

- Diode, bipolar junction and field-effect transistors

#### **Design and analysis methods**

- Biasing, large and small signal analysis, influence of temperature and component tolerance.

#### **Linear circuits**

- Basic linear structures with MOS and bipolar transistors

#### **Basic structures in switching mode**

- Basic structures using a transistor as a switch, analog current routing. Switched capacitor circuits.

### **Functional electronics**

- Piecewise linear circuits (rectifier without threshold). Relaxation circuits. Applications of operational amplifiers.

## **Power electrical engineering**

### **Physics for electrical engineering**

- Electromagnetism applied to electrical engineering, magnetic materials, field canalization, magnets

### **Transport and the use of electric energy**

- Single-phase, three-phase. Dimensioning and power factor.

### **Single-phase and three-phase transformers**

- Function and structure; the perfect transformer; modeling of real transformers; design: magnetic circuit, insulating materials and conductors

### **Electromechanical Conversion**

- Links between electric, magnetic and mechanical energy. Mobile part system, calculation of forces and torques; reluctance torque

### **DC Machines**

- Excitation modes. Functioning problems. Speed control and variation.

Same programme for Oral Exam