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 1st order, of 2nd 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 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