

**Master
In
Communication Systems
Engineering**

Prepared by:

CCNE Department

Objectives

It is a Bac+5 Degree. This Master aims to fulfil the requirements of the growing professional sectors and needing highly qualified graduates. It offers to students the possibility to strengthen their knowledge in the domain of communication systems, multimedia systems, wireless communications, security, radar, ...

The orientations of the degree will be redefined every year according to the market needs. Courses are completed with applied seminars and a long training period. The permanent and direct contact with the professional world can also be enhanced through professional instructors, visits or projects,

A multi-disciplinary curriculum: The Master provides opportunities by associating several different disciplines: Electronics - Communications, Image and signal processing, Teleservices, ... The multi-disciplinary aspect of its academic stuff and of its students will be very helpful in the integration of its graduates in the professional market or to follow the academic process toward the PhD.

Conditions of Admission

Candidates that can be admitted in the CSE Master must have:

- Bachelor of Science or its equivalent in Communications and Computer Engineering
- Or Bachelor of Science or its equivalent in Electronics
- Or Bachelor of Science or its equivalent in Applied Physics.

Grading System and Exams

The exams and grading system can be similar to that adopted at the UIT for the BS level, with an adaptation allowing flexibility in the substitution of the midterm for some courses.

Originality

The Master in Communication Systems Engineering CSE is qualified by:

1. Potential collaboration with other degrees at the Lebanese University such as BS in CCNE, Electronics, Applied Physics,... A part of the courses will be developed in order to complete these different studies.
2. Multi-disciplinary degree since it includes 3 essential scientific components: Communication Systems, Images and Signals and mobile communications and applications. In addition to generic courses that strengthen the curriculum in languages and communications. The Master covers a wide spectrum with courses related to communication systems, high-frequency, electronics, programming and signals. Graduates must also be able to develop a professional project and show the strength of their studies as well as their personalities.
3. It is the unique Bac+5 degree in the South of Lebanon and at the Lebanese University oriented toward communications and allowing students of the south region, from the UIT or other faculties, to complete their studies in the domain of technology.
4. Particular care is addressed in order to have a high percentage of the courses, followed in the BS or in the Masters, aligned with the programs of French Universities in order to obtain double diploma.

Courses Syllabus

Master of Communication Systems Engineering

M1- S1

Scientific English

- Fluency in technical English related to the master topics
- Analysis and synthesis of high level English texts
- Strengthen the fluency in reading and writing English
- Simulation of job interviews in English
- Understanding and analysis of research papers related to the curriculum and published in English
- Learning to enhance the knowledge and offering clear presentations in different domains.

Advanced Digital Communications

- Digital communication system
- Sampling and quantization: different techniques and characteristics
- Channel and interference : White noise, Inter-Symbol Interference, Bandwidth and Nyquist filter
- Characterisation and performance: Eye pattern, Bit Error Rate, Signal to Noise Ration, Bandwidth and link budget
- Different techniques of modern digital modulation : comparison and applicability in the different situations
- Synchronisation and non-coherent detection
- Multiplexing techniques: TDM, FDM and OFDM
- Spread-spectrum techniques
- Multiple-access techniques: TDMA, FDMA and CDMA.

Project Management

- Following dense and specific studies in short durations
- Attending seminars related to the ESC Masters
- Practicing acquired courses
- Being able to work within companies
- Apprehend problems, propose solutions and realize them following a well organized scientific methodology
- Being able to show the work value by reports or oral presentations.

Waves Propagation and Interactions

- Generalities of the propagation phenomena
- Relationship between mediums, characteristics of waves and expressions of fields
- Causes and effects of losses
- Energy aspects in propagation – Link budget
- Problem of the interface between two mediums
- Characterization of the interaction of electromagnetic waves with different mediums
- Superposition of two monochromatic waves – Waves package
- Waves at the interface between two dielectric and two materials.

Communication Networks

- Review on fundamental principles of networks
- Fundamental concepts of mobile networks (UMTS, WiFi, WiMax...)
- Architecture and protocols of wide-band networks (Ethernet, IP v4, IP v6, Frame Relay, MPLS)
- Introduction to SIP (Session Initiation Protocol)
- Advanced Services over IP (Telephony over IP, VOIP, Video-conference)
- Security in the communication networks.

Artificial Intelligence Techniques

- Classical Artificial Intelligence
- Search algorithms in states spaces with heuristic functions
- Inference Engines and Expert Systems
- Introduction to Fuzzy Logic
- Classification and neural networks
- Introduction: from the biological neuron to the formal neuron
- Learning: Hebb law
- Perceptron: simple perceptron, linear separability
- Multi-layers Perceptron: relationship with Bayesian classification, Gradient Retro-Spread
- Hopfield Model
- Kohonen model
- Illustrations.

Information Theory and Coding

- Entropy, mutual information, source coding, discrete channel, Gaussian channel, capacity
- Block codes: linear block codes (Hamming, Golay), performance, decoding with maximum likelihood
- Convolution Codes: structure of convolution codes (non-recursive, recursive), graphical representation(s) of convolution codes, Viterbi decoder

- Turbo Codes and LDPC codes: construction (parallel concatenation), design optimisation (choice of codes, interleaves), decoding (sub-optimal) iterative, analysis in convergence.

Advanced Signal Processing

- Random process (concepts, statistical characteristics, stationnarity, ergodicity, power spectral density)
- Spectral analysis (estimation, periodogram, averaged periodogram, Welch periodogram, correlogram)
- Parametric Modelling (autoregressive model, linear prediction, moving average models, moving average autoregressive models, spectral estimation)
- Time-Frequency Analysis, Time scale (representations, Fourier transform, wavelet transform, set of filters, multi-resolution analysis...)
- Elements of decision theory, detection.

Master in Communication Systems Engineering

M1- S2

Antennas

- Review on antennas free space radiation patterns
- Characterisation of antennas: Gain, bandwidth, radiation pattern, polarisation ...
- Typical antennas and their applications (aperture antennas, wired antennas, array and printed antennas)
- Methods of antennas design, optimization and characterization: finite difference, method of moments, finite elements.
- Experimental techniques: methods for measurements in near and far fields
- Radiation in a propagation medium, antennas mobility, multipath.

Propagation Channel

- Review on free-space propagation, power at reception, antennas characteristics, link budget and interference.
- Environment modelling: ground waves, ground reflection, atmospheric refraction, diffraction, vegetation and precipitation effects, depolarisation.
- Multipath and fading, prediction models.
- Characterisation and modelling of propagation channels: time domain, frequency domain.
- Direction of arrival

Engineering of Radio-Systems

- RF functions: complete Tx-Rx radio-frequency system, VCO, PLL, frequency synthesis
- Low Noise Amplifier LNA, mixer, filter, antenna
- Power Amplifiers
- Project of "Simulation of a radio-communication system using ADS
- Measurement of a receiving system.

Marketing

- Acquire knowledge about the challenges of markets globalisation
- Develop an expertise in the process of marketing and product management
- Conduct strategic marketing plans and market studies
- Economy and Business management
- Principles of economic analysis
- Introduction to the regulation of economic activity
- Organisation of production and accounting
- Find the competitive environment of a company and the strategic options
- Business game: simulation of the life of competing companies
- Decision making process.

Bibliographic Research

- Knowing the essential strategies to adopt for a good scientific presentation
- Realizing a bibliographic research about a certain topic
- Being able to synthesize publications related to a specific topic
- Present results within a conference.

Wireless Communications Systems

- GSM: Architecture and elements. Example of procedures: establishing a call, mobility management (authentication, localisation update, outgoing and ingoing calls, Handover. Layers: RLC, MAC and PHY (physical and logical channels) GPRS and EDGE: Architecture and procedures. Logical Channels GPRS/EDGE
- UMTS: CDMA technique. UTRAN architecture. Logical Channels, transport channels, physical channels. Radio resources management.
- HSDPA/HSUPA/HSPA : Channels, modulation, coding, HARQ, scheduling and power control
- LTE/LTE Advanced: OFDM and OFDMA/SCFDMA techniques. Architecture and functions Evolution. Example of procedures (synchronisation, cell search, Access). MIMO techniques. Scheduling Techniques
- Evolution toward 5G: Heterogeneous networks, Coexistence, cooperation, Inter layers Optimisation and overlays.

Image Processing

- Introduction (Colour perception and images types)
- Image Transformation (Unitary Transformations)
- Image filtering (Linear filtering, Remove Noise....)
- Image enhancement
- Morphological Transformation
- Edge detection
- Image segmentation
- Image compression
- Image restoration

Training and Data Mining*

- Information statistical analysis
- Bayesian networks
- Case study
- Neural networks
- Statistical training
- Data mining algorithms: Association rules (Motivation and terminology, Correlation analysis, etc.)
- Data mining algorithms: Classification (Basic learning/mining tasks, decision trees, etc.)

- Data mining algorithms: Prediction
- Evaluating what's been learned
- Mining real data
- Clustering
- Advanced techniques, Data Mining software and applications (Text mining, Web mining, Data mining, etc.).

Embedded Processors*

- Review on FPGA and VHDL - Introduction to Co-design
- FPGA and CPLD oriented methodology
- Parametric VHDL description
- Full synchronous design – Clock signal
- Microprocessors
- SOPC, Design re-use
- Processor NIOS II.

** Elective Courses*

Master in Communication Systems Engineering

M2- S3

Bio-Signals Analysis

- Objectives of Bio-Signal Processing
- Digital Filters for bio-signal Applications
- Different types of biomedical signals
- Event Detection and Feature Extraction Techniques
- Bio-signal recording System
- Pattern classification and diagnostic decision
- Bio-signal analysis
- Overview of bio-signal processing systems
- Time and frequency domain analysis
- Challenges and recent trends in bio-signal processing systems.

Advanced Microwave Circuits

- Linear and non-linear microwave circuits and devices
- Filters, phase shifters, mixer
- Integrated RF and MIC circuits
- MMIC fabrication technology.

Advanced Wireless Communications

- Evolution of Radio technologies Radio and Software Defined Radio (SDR) concept. Architecture and concepts of radio networks
- SDR definition and implementation
- Broad-Band digitization circuits – Data conversion circuits
- Concepts of smart RF sub-systems- Architectures of wide band radio systems
- Parameters and architectures of wide band transceivers
- Examples of radio systems technologies.

Optical Communications

- Particularities of optical networks
- The fibres: Attenuation and distortion - Amplification and regeneration
- Multiplexing (TDM and WDM)
- Switches : WADM Multiplexer; WXC switch; Wavelengths conversion
- Splitting
- SONET/SDH technology: Principle, technology and protection
- WDM networks: optical routing
- Constraints on wavelengths
- Wavelengths allocation
- Unicast algorithms, Multicast and Broadcast in optical networks

- Next generation networks
- Packet or burst optical commutations
- Applications and future developments.

Scientific Programming

- Data types and its digital representation
- Flow control and functions
- Input and output
- Signals and sampling
- Fourier analysis and spectrogram
- Filtering
- Curve fitting and interpolation
- Filters bank and wavelet transforms
- Signal decomposition and reconstruction
- Real-time signal processing.

Multimedia Systems

- Key concepts and multimedia elements: image, audio, video and animation techniques
- Structure of multimedia applications: videoconferences, documents edition, IP telephony and Animation
- Multimedia switching techniques
- Video digital processing: making video signals, sampling and conversion, modelling, motion estimation, coding and compression standards and control of errors in video communications
- Forms of interaction in advanced multimedia: virtual reality, mobile technologies
- Multimedia management: resources, real-time multimedia, quality of service and synchronisation
- Multimedia data bases : reference models, standards, applications and watermarking
- Design and implementation of a multimedia system.

Security in Wireless Networks*

- Presentation of Mobile Ad hoc (Mobile Ad hoc Networks (MANETs)) network
- Vulnerabilities of mobile Ad hoc networks (vulnerable communication channel, no defence line, non-sure environment non-sure, cooperation problem, smart attacks (inter-layers)).
- Security in the mobile Ad hoc networks
- Public Key Infrastructure (PKI)
- Intrusion Detection system (IDS) for Mobile Networks (MANETs).

Multi-Antenna systems *

- Introduction to multi-antenna techniques
- SIMO, MISO and MIMO systems
- Capacity of a MIMO system
- Time – space coding
- Reception techniques.

Real-Time Systems *

- Types of real-time systems
- Representation of time, time constraints, clock, clocks synchronisation
- Specific Formalisms in real-time systems: state machine, state charts, Petri networks, Grafcet
- Axiomatic approach for the specifications of the time constraints
- Architecture of real-time systems
- Acquisition and information real-time processing
- Models used in the design of a real-time system: events based models, graphs based models, tasks models, process models, control models
- Programming of applications.

Big Data Technologies *

- Big Data presentation (concepts, stocking modes (NoSQL, HDFS), MapReduce, other tools (Hortonworks, Cloudera, MapR, Aster), Hadoop platform, technologies (Talend, Tableau, Qlikview ...)
- Big Data processing (Hadoop Distributed File System (HDFS), SQL queries (HIVE, PIG, ETL, Talend For Big Data)
- Big Data analysis techniques (Exploration methods, Segmentation and classification, Estimation and prediction)
- Big Data Implementation.

**Elective Courses*

Master in Communication Systems Engineering

M2- S4

Seminars, Training or Project

- Following dense and specific studies in short durations
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