Masters at

TelecomBCN

TELECOMBCN or ETSETB is the Telecommunications Engineer School of BARCELONATECH University

• Framework of university studies in Spain
• Master’s degree in Telecommunications Engineering (MET)
• Master’s degree in Electronic Engineering (MEE)
• Master’s degree in Photonics
• Master’s degree in Computer Vision
Structure of Spanish University Studies

- **Bachelor:**
  - Mainly 4 years duration – 240 ECTS
  - Since academic term 2017-18, some bachelors have a duration of 3 years – 180 ECTS

- **Master:**
  - From 60 ECTS to 120 ECTS

- **PhD:**
  - Courses are optional
  - Thesis
  - Admission requires at least 300 ECTS, with a minimum of 60 ECTS of master level:
    - 4+1; 3+2; 4+2;

Doctorate Access

- Minimum: 300 ECTS of which 60 ECTS must be master level
Types of Spanish Masters

• Masters with regulated professional skills
  • Professional competences regulated by law to practice a profession (professional associations):
    • Telecommunications engineer (CIN/355/2009 9th February).
    • Industrial engineer
  • Optionally, research competences

• Masters without regulated professional skills
  • Professional approach, but without a profession regulated by law:
    • Electronic Engineer
    • Software Engineer
  • Research approach: focussed to PhD.

Master Studies at TelecomBCN

• Master in Telecommunications Engineering (MET): 120 ECTS
  • Regulated professional competences
  • Two academic approaches: Professional profile - Research profile
• Master in Electronic Engineering (MEE): 120 ECTS
  • Two academic approaches: Professional profile - Research profile

• Master in Photonics: 60 ECTS
• Master in Computer Vision: 60 ECTS
• Master in Wireless Communications: 60 ECTS

• Erasmus Mundus Programmes: 120 ECTS
  • EuroPhotonics: Erasmus Mundus Master in Photonics Engineering, Nano-photonics and Bio-photonics
Admission criteria

- Official Spanish degree
- University diploma issued by an institution of the European Higher Education Space that authorizes admission to a master’s degree of the issuing country
- A university diploma issued by an institution outside of the European Higher Education Space that authorizes admission to a master’s degree of the issuing country, without official recognition
  - Under the criterion of the Master’s Commission

- Only for master MET:
  - The applicant’s degree is required to have at least 60 ECTS covering all topics of the Spanish Technical Telecommunications Engineer as in page 18153 and 48 ECTS covering several topics of pages 18154 and 18155 of BOE-CIN/352/2009

Master in Telecommunications Engineering (MET)
Suggested profiles of access

- Degree in Telecommunication Technologies and Services Engineering
- Degree in Science and Technologies of Telecommunications (generalist approach)
- Degree in Engineering of Audio-visual Systems
- Degree in Engineering of Electronic Systems
- Degree in Engineering of Telecommunications Systems
- Degree in Telematics Engineering
- Degree in Engineering Physics
  - 60 additional ECTS (30 can be recognized for elective subjects taken in the same degree)
- Telecommunications Engineers (possible recognition of 60 ECTS)
- Electronics Engineers (possible recognition of 45 ECTS)
- Telecommunications or Electronics Technical Engineers
  - 30 additional ECTS
- Degree in Software / Computer Engineering
  - 60 additional ECTS

MET Acquired competences

- Communication systems: wired and wireless, optical fibre.
- Computer networks, Internet, local area networks (Ethernet, Wi-Fi).
- Radio navigation, global positioning systems (GPS).
- Radar.
- Information processing: encoding, compression, error correction, image recognition, video clip recognition, voice recognition, voice generation.
- Electronic components and circuits: microprocessor devices (routers, switches, ...), sensors, actuators, transducers.
- Technology and electronics, analogue and digital electronic instrumentation, medical electronics, consumer electronics, control systems, robotics, automation.
- Micro and nanotechnologies.
- Bioengineering applications, telemedicine, e-commerce platforms, smart cities, smart metering, sensor networks, smart homes, green computing, cloud computing.
MET structure (120 ECTS)

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- Communication bridge courses:
  - Digital communications
  - Signal processing
  - Antennas and microwaves
  - Telecommunication systems fundamentals

- Networking bridge courses:
  - Data transmission protocols

- Electronics bridge courses:
  - Electronics for communications systems
  - Systems based on microprocessors

Which courses do I have to take?

• Elective courses that can be taken in 4th year of bachelor in order not to have to enrol bridge courses

MET: Bridge Courses

<table>
<thead>
<tr>
<th>MET bridge subject</th>
<th>CITTEL subject</th>
<th>GREITST subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antennas and microwaves (AM)</td>
<td>Antennas (ANTENES - 230053)</td>
<td>Antennas (MICROS - 230052)</td>
</tr>
<tr>
<td>Data transmission protocols (DTP)</td>
<td>Data transmission protocols (PTD)</td>
<td>-</td>
</tr>
<tr>
<td>Digital communications (DC)</td>
<td>Advanced digital communications (CDA - 230051)</td>
<td>-</td>
</tr>
<tr>
<td>Electronica for communications systems (ECS)</td>
<td>Electronica for communications (ECONCITTEL)</td>
<td>-</td>
</tr>
<tr>
<td>Signal processing (SIGPROC)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Systems based on microprocessors (SBMIC)</td>
<td>Electronic systems based on microprocessors (SEBM)</td>
<td>-</td>
</tr>
<tr>
<td>Telecommunication system fundamentals (TSF)</td>
<td>Radiocommunications (RADIOCITTEL)</td>
<td>-</td>
</tr>
<tr>
<td>Wire transmission (TC)</td>
<td>Wire transmission (RICOMISTTEL)</td>
<td>-</td>
</tr>
<tr>
<td>Radiocomunications (RADIOCOMISTTEL)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Core Courses

• Communications
  • Advanced communications for wireless systems (ACWS)
  • Wireless communications links and antennas (WLA)
  • Telecommunication systems (TSYS)

• Networking
  • Communication networks (CN)
  • Overlay networks (OVNET)

• Electronics
  • Electronic system design for communications (ESDC)
  • Electronic instrumentation and optoelectronics (EIO)

• Projects
  • Innovation based service management (IBSM)
  • Management of telecommunications projects (MTP)
MET Paths

• Intensification
  • Choose 3 from 6
    • [http://infoteleco.upc.edu/genweb/llistats_assignatures/assignatures_master_met_intensification.html](http://infoteleco.upc.edu/genweb/llistats_assignatures/assignatures_master_met_intensification.html)

• Specialization
  • 4 compulsory
  • 2 specialization electives
    • [http://infoteleco.upc.edu/genweb/llistats_assignatures/assignatures_master_met_specialization.html](http://infoteleco.upc.edu/genweb/llistats_assignatures/assignatures_master_met_specialization.html)

Distribution in semesters

• 1st semester:
  • (Bridge subjects)
  • Core subjects:
    • All except MTP
  • 1 or 0 specialization subject
    • All except IT
      • If WAN, simultaneously with CN
      • If QSN simultaneously with CN and OVNET
      • If AFOC or AMC simultaneously with TSYS

• 2nd and 3rd semesters: no restrictions
  • MTP as late as possible

• 4th semester: Master’s thesis (TFM)
### MET: Elective Credits

- Bridge courses
- Other courses of other or the same specialization tracks
- Elective transversal courses
- Seminars (2.5 ECTS)
  - One seminar to recognize activities organized by ETSETB or students organizations (conferences, short courses, ...)
- “Special subjects”
- Introduction to Research (up to 15 ECTS)
- Internship in technological companies or research laboratories (15 ECTS)
  - Also possibility of extra-curricular internships
  - Inici ▶ Empreses ▶ Convenis de cooperació educativa ▶ Informació per a estudiants
- Recognized credits for working experience (max 15 ECTS)
- Courses of other masters (under tutor supervision)

### Double degrees and mobility

- **Mobility:** Erasmus+, SICUE, ....
- **Current Double Degrees:**
  - KTH (Kungliga Tekniska Högskolan) Stockholm, Sweden
  - IIT (Illinois Institute of Technology) Chicago, USA
  - SUPAERO (École nationale supérieure de l’aéronautique et de l'espace) Toulouse, France
  - Telecom Bretagne (ENST), Brest, France
  - IST (Instituto Superior Técnico) Lisboa, Portugal
  - Pontificia Universidad Católica del Perú (PUCP)
- **To be shortly signed:**
  - Politecnico de Milano, Italia

- [http://etsetb.upc.edu/ca/international/international-partners/double-degree-partners](http://etsetb.upc.edu/ca/international/international-partners/double-degree-partners)
Scholarships

- Fundació Catalunya-La Pedrera:
  - 1 MET: 10,000 € (5,000 € per year)
- Everis:
  - 3 MET: 2,500 €
  - Work placement in Everis. 4 hours/week during 1 semester
- Telecogresca:
  - 1 MET: 3,000 €
- Telecommunication and Electronics Forum:
  - 1 for MET or MEE: 3,000 €

- Only for students beginning in September
- [http://etsetb.upc.edu/ca/empreses/premis-i-beques-empresa](http://etsetb.upc.edu/ca/empreses/premis-i-beques-empresa)

Special subjects

- Subjects on innovation and entrepreneurship for a reduced amount of students:

<table>
<thead>
<tr>
<th>Course</th>
<th>Term</th>
<th>Semester</th>
<th>Students</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBI@CERN</td>
<td>Fall</td>
<td>2nd-4th</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>imagine-IoT</td>
<td>Fall</td>
<td>2nd-4th</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Colibri</td>
<td>Spring</td>
<td>3rd-4th</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>I2P</td>
<td>Spring</td>
<td>1st-3rd</td>
<td>12-20</td>
<td>5</td>
</tr>
</tbody>
</table>

- Multidisciplinary
- International
- Innovation / entrepreneurship / disruptive design
Special subjects

- **CBI@CERN**: Fall term, 2nd - 4th semester, 4 students, 10 ECTS
  - UPC + ESADE + IED students
  - Three intensive weeks at Ideasquare@CERN

- **Imagine IoT**: Fall term, 2nd - 4th semester, 4 students, 10 ECTS
  - UPC + EADA + Elisava students
  - Friday afternoon + Saturday morning + intensive periods

3 challenges (companies) + 1 social challenge
A travel of inspiration through Barcelona, different locations
• **Colibrí**: Spring term, 3rd - 4th semester, 4 students, 5 ECTS
• Colibrí consortium

![Map of Colibrí consortium with Erasmus+ logo]

**Special subjects**

• **Colibrí**: Supporting personalized learning approaches, collaborative learning, by making use of ICT and Open Educational Resources, and by exploring the use of blended and virtual mobility

![Timeline diagram showing mobile work, project work, supervision meetings, and exam dates]

![Erasmus+ logo on the diagrams]
Special subjects

- **I2P**: Spring term, 1st – 3rd semester, 12 - 20 students, 5 ECTS
- Mixed teams: ESADE MBA + Telecom MET-MEE + FIB

Internship Innovation Project (I2P) is a master level course where student teams tackle a challenge presented by an organization.

Special subjects

- **I2P**: Can be done instead of IBSM (1st semester) or later as an elective

[Diagram showing project timeline: Understand, Create, Deliver, End of project in May.]

[Graph showing project phases: February - Course kickoff intensive week, March - Coaching session 2, April - Coaching session 3, May - Final presentation.]
Master in Electronic Engineering (MEE)

Why a Master?
• Labour market is becoming more and more competitive. Master degree allows you to increase your income and gives you additional opportunities to improve your position.

Why MEE?
• Students that have finished MEE have an easy access to industrial/research activities.
  • Employability rate of 97.4%.
  • The 88.6% has taken less than 3 months to find the first job.
  • 90.3% of the graduates during academic year 2009-2010 have a salary considered "More than 2000 € per month".
• MEE comes from a 25 years of experience teaching electronics at master level.
• Master in Electronic Engineering
  • 120 ECTS

• Two academic approaches:
  • Professional profile
  • Research profile

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Suggested profiles of access

• Degree in Engineering of Electronic Systems
• Degree in Engineering of electronic industrial and automatic
• Degree in Science and Technologies of Telecommunications (generalist approach)
• Degree in Engineering of Audio-visual Systems
• Degree in Engineering of Telecommunications Systems
• Degree in Telematics Engineering
• Electronics or Telecommunications Engineers
  • Recognition of 60 ECTS
• Electronics or Telecommunications Technical Engineers
• Industrial Technical Engineers
MEE structure

Level B2 of English required

- Compulsory subject area (45 ECTS):
  - Power Control and Processing
  - Advanced Analog Circuits
  - Instrumentation and Sensors
  - Advanced Digital Systems
  - Micro and Nano electronic Design
  - Micro and Nanotechnologies
  - Signal Processing
  - Innovation Based Service Man.
  - Management of Telecomm. Projects

- Elective subject area (max. 45 ECTS)

- Master's thesis (30 ECTS)

1 semester

120 ECTS

Level A

- 2B: Master thesis (30 ECTS)

- 2A: Elective subjects (45 ECTS)

- 1B: Elective subjects (20 ECTS)

- 1A: Management in telecom projects
  - Signal processing
  - Innovation based service management
  - Power control and processing
  - Advanced analog circuit techniques
  - Instrumentat and sensors
  - Advanced digital systems
  - Micro and nano technologies
  - Micro and nano electronic design

Level B1

- Bridge courses (max. 35 ECTS)

Level A1

- Level B2 of English required

120 ECTS

Level A2

- Master thesis (30 ECTS)

Level B3

- Elective subjects (45 ECTS)
MEE structure

Example:

2B
Master thesis (30 ECTS)

2A
Management in telecom projects

Elective subjects
(Bridge+electives 45 ECTS)

1B
Signal processing

Innovation based service management

Advanced digital systems

Power control and processing

Micro and nano electronic design

Advanced analog circuit techniques

1A
Instrumental and sensors

Micro and nano technologies

Bridge courses
(Bridge+electives 45 ECTS)

MEE: Bridge Courses

Degree in Engineering of Electronic Systems: no necessity of bridge courses.

Any other degrees need some bridge courses, unless the equivalent subject has been taken as an elective one.

- Control Theory and Applications
- Electronics for communications systems
- Introduction to Microelectronic technologies
- Programmable Electronics
- Sensors, Instruments and Measurement Systems
- Systems based on microprocessors
MEE Compulsory Courses

• Advanced analog circuit techniques (AACT)
  • Amplification
  • Continuous time and switched capacitor filtering
  • Analog – Digital conversion

MEE Compulsory Courses

• Advanced digital systems (ADS)
  • Memory design
  • Communication architectures
    • Scratchpads and cache memory
    • SOC memory systems
    • Board-based memory systems
  • Real-time operating systems (RTOS)
  • Physical communication mechanisms
MEE Compulsory Courses

- **Power control and processing (PCP)**
  - Switching converters modelling
  - State-space linear control techniques in switching power converters
  - Control applications in power electronics

MEE Compulsory Courses

- **Instrumentation and sensors (IS)**
  - Instrumentation systems
    - Advanced instrumentation systems architectures
    - Virtual instrumentation
    - Error analysis and specification
    - Estimation theory
    - Instrumentation systems calibration techniques
  - Sensor systems
    - Sensor principles, implementation and characteristics review
    - Advanced sensor conditioning techniques
    - Coherent detection methods for AC sensors
    - Self-correction and self-calibration techniques
    - Smart-sensor structure and standards
    - Sensor networks
    - Energy harvesting techniques for sensor systems
MEE Compulsory Courses

- Micro and nanotechnologies (MNT)
  - Field effect transistors and advanced devices
  - Power devices
  - Fabrication technology
  - Sensors
  - Electrokinetics
  - Advanced materials

MEE Compulsory Courses

- Micro and nano electronic design (MND)
  - Basic digital blocks and their characterization
  - Basic analog blocks and their characterization
  - Practical aspects of VLSI design
  - Basic concepts of testing
  - Laboratory of VLSI design
MEE Compulsory Courses

- Signal Processing for Electronic Engineers
  - Fundamentals of signal processing
  - Basic estimation theory
  - Nonparametric spectrum estimation
  - Signal modelling and parametric spectral estimation
  - Wiener filtering

Management Compulsory Courses

- Innovation based service management (IBSM)
  - Service economy
  - Strategy and innovation management
  - Innovative business models for a new economy
  - Collaborative consumption and open source
  - Service marketing
  - Service quality
  - Design services: the QFD methodology
  - The importance of organizational behaviour to managers
  - Group behaviour
• Management of telecommunication projects (MTP)
  • CDIO subject
  • Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.
  • Ability to develop, direct, coordinate, and technical and financial management of projects mainly in the field of telecommunication systems

Management Compulsory Courses

• Elective credits (45 ECTS):
  • Bridging courses
  • Practical work in technological companies or research laboratories
  • Recognized credits for working experience
  • Elective courses
    • Professional oriented
    • Research oriented
  • Seminars (2.5 ECTS, 20 h, February and July)

• Master Final Project (30 ECTS)

Mobility is possible! Europe, USA, China, Japan,…
Contact International Mobility Office at ETSETB.
Apart from the elective subjects, even further specialization can be done through:

- **Introduction to Research (15 ECTS):** small project developed in a research group in order to specialize in a particular topic.

If the student has followed a minimum of 20 ECTS in one of the intensification topics, the school will certify it once the student award the master title.
Sources of information


- Academic Secretary: administration, payments, etc.
  Ground floor at B3 building, masters@etsetb.upc.edu

- Academic Supervisor: he/she will guide you in the election of subjects

- MEE coordinator: credit recognition, mobility and internships in companies and universities, etc.
  Isidro Martín, isidro.martin@upc.edu

- Students’ delegate: his mission is to gather information about the day-to-day running of MEE and transmit to MEE coordinator suggestions to improve the Master development.

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Master thesis in the ETSETB

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Development of the Universal Gateway for the Barcelona Municipality:

- Wireless Network Group
- Ajuntament de Barcelona
- First smart city pilot build in 2007 in Sant Vicenç dels Horts
- Mobile nodes on board of public transportation buses to measure data (parking available places) and collect information from sensors.
- One single equipment on the street to collect information from different sensor manufacturers

Train on Board Monitoring:

- Wireless Network Group
- Funded by ALSTOM
- Development of a system to perform train on board monitoring
  - Preventive maintenance
  - Sensing mechanic parts (Temperature, Vibration)
  - Transport information inside the train
  - Process, transfer and generate alarms
  - Solution implemented: 802.15.4 + Gateway
  - Energy harvesting by vibration
Develop Advanced Driver Assistant Systems for Buses:

- Image Processing Group
- Advanced Hardware Architecture Group
- Funded by Arcol S.A.
- 360° vision system
- Blind Spot Detection and Line departure

Topics in Master:
- 230620: Digital Image and Video Processing
- 230621: Introduction to Computer Vision
- 230660: Programmable Electronics
- 230659: Sensors, Instruments and Measurement Systems

Drivers Drowsiness Detection:
- Drowsiness detection through the analysis of driver’s biological data.
- FICOSA
  - Portable biomedical sensor that sends variations of the thoracic effort through Bluetooth.
  - Application in the Smartphone to analyse and store data and used as interface

Topics in Master:
- 230643: Instrumentation and Sensors
- 230674: Biomedical Instrumentation Design
- 230659: Sensors, Instruments and Measurement Systems
High Efficiency Solar Cells:
- Micro and Nanotechnologies Research Group
- Funded by European Union
- PERC: Passivated Emitter and Rear Cell
- IBC: Interdigitated Back-Contacted solar cells: Efficiency > 22% (Spanish record!)

Non-intrusive monitoring of coronary stent:
- RF & Microwave Systems, Devices and Materials
- Hospital Universitari Germans Trias i Pujol
- Micro-wave based monitoring of coronary stents.
- Commonly, stent monitoring requires invasive procedures (catheterization) or exposition to X-rays.
- Topics in Master:
  - 230608: Microwave, Terahertz and Photonic Technologies (MET)
  - 29407: Design and Analysis of RF and Microwave Systems for Communications
**RESCUECELL: Potable kit for detecting trapped and buried people in ruins and avalanches:**

- Signal Processing and Communications Group
- Funded by the European Union
- RESCUECELL project aims at developing a cost-effective, robust and lightweight technology, that can easily be transported to the affected zone (avalanche or earthquake), and by spreading several nodes covering the entire zone, the technology will lead to the location of possible injured people swiftly within some minutes.

**ICT for High Throughput Low Latency infrastructures based on dynamic all optical networks:**

- Optical Communications Group
- Funded by the European Union
- COCONUT: “COst-effective COhereNt Ultra-dense-WDM-PON for lambda-To-the-user access”:
Design of superconductive filters with fractal geometry:

- RF & Microwave Systems, Devices and Materials
- Funded by the European Union
- Collaboration with Fractus S.A.

UPC Cube-Sat:

- Passive Microwave Remote Sensing Group
- Companies or consortium
- Some testing facilities @ UPC NanoSat-lab
  - Shake table, Thermal Vacuum Chamber and Sun Simulator, Amateur Ground Station, Helmholtz Coils and Air Bearing
- More than 90 students have been involved in the Cat-1 Cube-Sat development.
Display technology:

- Electrowetting: Geometric changes to liquid by applying electric fields
- Amazon will develop ebooks or tablets with pixels based on this technology
- Technology also applicable to liquid lenses

Topics in Master:

- 230669: MEMS. Microelectromechanical Systems

Graphene-enabled Wireless Communications:

- Graphene nanoantennas for nano-range communication
- Samsung Advanced Institute of Technology
- Intel Research
- Mid-term: Graphene-based Wireless Network-on-Chip for Multi-Core processors
- Long-term: Wireless Nano-Sensor Networks

Topics in Master:

- 230675 - EDIS - Edison: Energy Management for Distributed and Integrated Systems
Nanofabrication:

- Polystyrene nanospheres
- Diameter: 200nm (1/50 human hair)
- Deposited by electrospraying

- Used as sacrificial element in nanofabrication, also by unique optical properties
- Patented technology

Topics in Master:

- 230645 - MNT - Micro and Nanotechnologies