UNIVERSIDAD PONTIFICIA
ICAI ICADE
COMILLAS
MADRID
ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA
INSTITUTO DE INVESTIGACIÓN TECNOLÓGICA

Instituto de Investigación Tecnológica (IIT)

Institute for Technological Research

A brief summary

www.iit.upcomillas.es

Presentation

- Non-profit **private** Research Institute integrated in the Engineering School (**ETSI-ICAI**) of the **Pontificia Comillas** University.
- Devoted to applied *research* and *education* in several fields of technology.
- Main activities developed through *research projects* in collaboration with industry, government agencies and international organisations.

Objectives

- **Promotion and management of applied technical research**
  - Technical analyses, studies and consulting for companies and institutions
  - Computer applications
  - Papers and technical reports
  - Design of prototype devices
- **Postgraduate training**
  - University specialist in research techniques (TEUTI)
  - Advanced Studies Diploma (DEA)
  - Doctoral theses

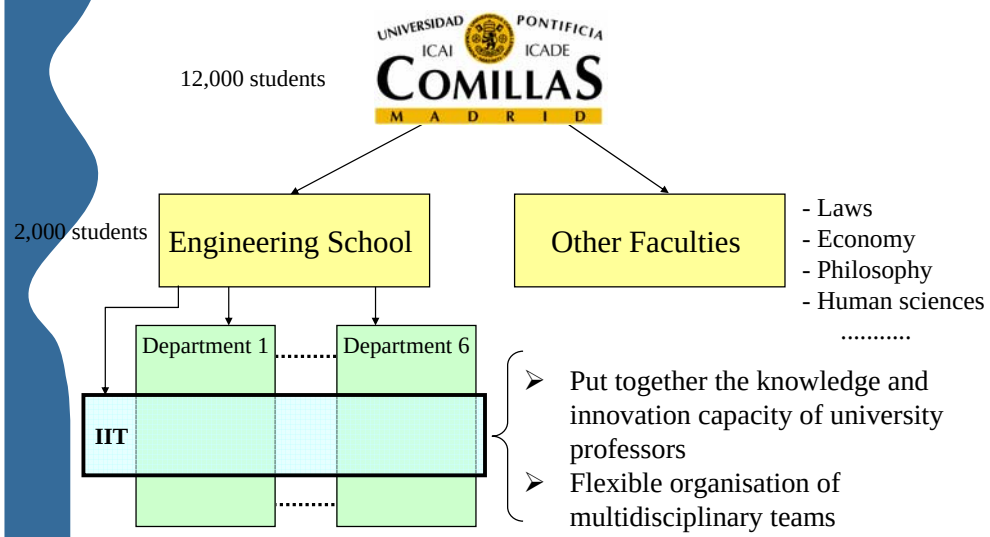
Research activities

- Projects for industry
- Consulting

90% of IIT financial support

- Institutional grants (COMILLAS, CICYT, EU, ...)
- Doctoral program
- Postgraduates courses
- Final year projects
- Pregraduate scholarships

IIT in the University



- Put together the knowledge and innovation capacity of university professors
- Flexible organisation of multidisciplinary teams

Human resources

- 53 partially dedicated professors
- 6 Full time researchers

} Doctors

- 45 researcher assistants → Post-graduates
- 6 administrative support
- Some pregraduate students

IIT Researchers

- Usually, every teacher belongs both to a department (teaching activities) and to the IIT (research activities)
  - Partial dedication may vary from 0% to 100% and may vary from year to year
- Teaching only covers its department time associated costs
- All the research costs have to be externally funded
  - Own wages direct & indirect costs
  - Grants to research assistant at his charge
  - Infrastructure costs
- It is the researcher responsibility to find the external funds
  - Equilibrium between consultancy and research projects

IIT Research assistants

- All research assistants are post-graduates (most of them engineers – 5 full years) fully devoted to the Institute
- Research assistants are Granted Students
  - University Specialist in Research Techniques (TEUTI)
  - Advanced Studies Diploma (DEA)
  - PhD
- Difficulty and challenge to simultaneously carry out research projects and thesis –> Doctoral thesis takes a long time (5-6 years in average)

Research results 04- 05

- 2 doctoral theses (4-5/year in average)
  18 in preparation (second phase of the Ph.D.)
- 75 technical papers (journals, conferences, etc.)
- 14 registered technical reports
- 144 on-going research projects and consultancy for companies or for the administration

Possible colaborations CEEM-IIT

- Particular research projects
  - Comparative analyses Australia-Europe
  - Exchange of information/results
  - Common papers publication
- Exchange of researchers and/or PhD students
  - Sabbatical years
  - Short stays
- Short courses and workshops
- For this to happen
  - Personal contact & Funding

IIT Technical areas

Power Systems

- Modelling, analysis and control
- Regulation and economy
- Planning and operation
- Management and environmental analysis

Industrial Systems

- Analysis and design in mechanical engineering
- Software engineering
- Electronics and automatic control
- Intelligent systems

IIT Technical areas

Power Systems

- Modelling, analysis and control
- Regulation and economy
- Planning and operation
- Management and environmental analysis

Modeling, analysis and control of PS

- **Electrical analysis of transmission & distribution networks:**
  - Power flows (optimal)
  - Voltage control and reactive power analysis
  - Design of distribution networks and industrial electric installations
  - Protection (digital)
  - Harmonics
  - Neutral grounding
  - Impact of embedded generation
  - Quality and reliability of supply

Modeling, analysis and control of PS

- **Modeling, analysis and control of dynamic systems:**
  - Stability studies for large bulk electric systems
  - Power-frequency control, AGC
  - Voltage collapse
  - Electromagnetic transient analysis
  - International interconnections (DC cables)
  - Impact of wind generation on stability
- **Electric machines**

Regulation & Economics of PS

- **Regulation and new organizational schemes for the electricity industry :**
  - Organizational design
  - Power market design
  - Long term security of supply: Capacity issues
  - Transmission and distribution networks regulation
  - International exchanges
  - Regional markets
  - Quality and reliability of supply

Regulation & Economics of PS

- **Electricity economics:**
  - Electricity costs studies
  - Optimal economic signals in power markets
  - Cost analysis and incentive mechanisms for Transmission networks
  - Cost analysis, incentive mechanisms, quality of supply signals for Distribution networks
  - Tariffs

Operation & Planning of PS

- **Traditional models**:
  - Generation and transmission expansion models
  - Generation operation models
    - Stochastic hydrothermal models
    - Unit commitment models
    - Probabilistic simulation models
  - Large bulk operation models
    - Optimal dispatch DC based models
    - Optimal dispatch AC based models
  - Distribution network models
    - Expansion models with GIS information
    - Operation models (reliability, …)

Operation & Planning of PS

- **Market based models:**
  - Economic models with a detail representation of the underlying physical assets
    - Short term: Market bidding models (energy, ancillary services)
    - Medium term: hydro scheduling, contracts
    - Long term: equilibrium models, market strategies, contracts strategy
    - Investment models

Operation & Planning of EES

- Risk management
  - Modeling of uncertainty
  - Modeling of contracts in all their variety
  - Exploring pure financial models
- Information systems
  - Database technology
  - Market analysis
  - Forecast and prediction analysis
  - Supporting tools to manage offer data through all markets
  - Advanced software for graphical interfaces

Management & Environmental management

- **Management:**
  - Organization of production processes
  - Industrial statistics
  - Decision theory
  - Economy and finance
  - Environment

Management & Environmental management

- **Environment**
  - Environmental evaluation
  - Economic evaluation of environmental impact
  - Incorporation of environmental aspects in decision making processes
  - Estimation of emissions
  - Renewable generation
    - Wind generation
    - Solar thermal plants
  - Externalities of electric production processes
  - Externalities of the nuclear cycle

IIT Technical areas

Industrial Systems

- Analysis and design in mechanical engineering
- Software engineering
- Electronics and automatic control
- Intelligent systems

Analysis and design in Mechanical Engineering

- **Numerical Analysis:**
  - HIFREN: Optimization of hydraulic turbine brakes
  - SIGEVI: Life Prediction System for Power Generation Stations
  - SEDUCTOR: Analysis and design of high-speed flywheels made of composite materials for application in remote wind and diesel powered generators
  - HIPERCRACK: High performace simulation of dynamic fracture in metals
- **Mechanical Design:**
  - ANASMET: improved design of a "densimetric table" for the refinement of urban solid residuals & compost refinement

Analysis and design in Mechanical Engineering

- **Areas of activity:**
  - Biomechanics
  - Railways
  - Automobiles
  - Soil movement
  - Life management
  - Piezoelectric materials
  - Composite materials
  - Aerogenerators
  - Analysis and design
- **Applied techniques:**
  - Finite elements
  - Discrete deformation analysis
  - Kinematics and dynamics
  - Flexible and rigid mechanisms
  - Computational fracture
  - Mechanics
  - Fatigue
  - Structural dynamics
  - Computational contact
  - Creep
  - High-temperature materials

Software Engineering

- **Simulation, planning and automatic control of railway traffic:**
  - GIF: Design, system integration and traffic control for the Madrid-Barcelona high-speed railway line
  - SIRO-SIRAT: Traffic control tools for Metro de Madrid & Metro de Barcelona
- **Safety digital systems:**
  - Design, development and test of built-in-test (BIT) subroutines for the Transmission Based Signalling (TBS) system boards
  - Development of the safety module for the reception of track codes (TCM) of the TBS system

Software Engineering

- **Areas of activity:**
  - Transport
  - Logistics
  - Telecommunications
  - Computer-aided education
  - CASE tools for security applications
- **Applied techniques:**
  - Complex systems simulation
  - Control and planning
  - Direct search optimization
  - Computer-aided software design and validation
  - Pattern recognition
  - Security analysis

Electronics & Control

- **Instrumentation & Electromagnetic Compatibility:**
  - IELAS Electrical Current Measurement Based On Elastic Waves Propagation In Dielectric Materials
  - Filter design for EMC for single-phase and low-power applications
- **Power electronics & Control:**
  - MIDAS: Current limiters using a superconducting coil for electric-energy systems
  - Design of a switched-mode voltage and current amplifier to test power system protection units.
- **Comunications & Digital Systems:**
  - Design, development and testing of a new generation of digital protections using DSP's
  - Analysis of fault tolerance on data transmission for mobile office using GSM technology

Electronics & Control

- **Areas of activity:**
  - Electronic Instrumentation
  - EMC
  - Automatic Control
  - Power electronics
  - Digital Communications
  - Digital Systems
- **Applied techniques:**
  - Sensors
  - Optoelectronics
  - Electromagnetic waves propagation
  - EMI filter design
  - Adaptive Control
  - Real Time Control
  - Switched power supplies
  - Inverters
  - Chaotic DC-DC converters
  - Microprocessors and embedded systems
  - IC Design. ASIC's
  - Digital Signal Processing

Intelligent Systems

- **Maintenance, Diagnosis & Reliability:**
  - ODISEO: Optimization and diagnosis of the operation of coal power plants using expert systems
  - SEVILLA: Expert system for on-line monitoring of the flame of a boiler in a coal power plant
  - DIAMOND. Distributed architecture for monitoring and diagnosis based on multi-agent systems
- **Data Mining:**
  - SGO: Development of an integrated bidding computer system for the Spanish electrical market
  - FRAC: Intelligent system for fraud and anomaly detection in electricity invoicing
  - PATRONES: Medium-term forecasting tool of Spanish natural gas consumption

Intelligent Systems

- **Areas of activity:**
  - Predictive maintenance, diagnosis and reliability
  - Electrical power systems operation
  - Time series forecasting
  - Industrial applications of thermoelectricity

Intelligent Systems

- **Applied techniques:**
  - Artificial Intelligence:
    - Expert systems
    - Neural networks
    - Fuzzy logic
    - Automated learning
    - Decision trees
    - Genetic algorithms
    - Qualitative reasoning.
  - Diagnosis and reliability techniques:
    - Predictive maintenance
    - Modal analysis of structures
    - Vibration & noise analysis
    - Data adquisition and continuous monitoring systems
  - Advanced information processing:
    - Statistical analysis of data
    - Non-linear system identification
    - Digital signal processing
    - Artificial vision
    - Intelligent control

Collaborators

- **ALSTOM - Transporte**
- **ASG Visualización Digital, S.L**
- **Bosch España S.A.**
- **CAM, Conserjeria Educacion.**
- **Canal de Isabel II.**
- **CDTI.**
- **Central Dock Sud S.A.**
- **Comisión Nacional del Sistema Eléctrico (CNSE).**
- **Comisión Europea**
- **Compañía Sevillana de Electricidad.**
- **Dimetronic, S.A.**
- **Dto. Materiales Etsi Aeronauticos Upm.**
- **Dto.Estructuras Etsii Uz.**
- **Educación y Ciencia Aplicada, S.L.**
- **Eléctricas Reunidas de Zaragoza (ERZ).**
- **Electricité de France (EdF).**
- **Electrotécnica Arteche Hermanos S.A.**
- **Endesa.**
- **European Space Agency.**
- **GMV S.A.**
- **Iberdrola Ingeniería y Consultoría (IBERINCO).**
- **Iberdrola.**
- **Instituto Energias Renovables, CIEMAT.**
- **Mancomunidad de Servicios de Castilla - La Mancha**
- **Metro de Madrid S.A.**
- **Ministerio de Educación y Ciencia. CICYT y PETRI.**
- **Ministerio de Medio Ambiente.**
- **Molinos del Ebro (Grupo SAMCA).**
- **Protectfire S.A.**
- **Rasacal, S.L.**
- **Red Electrica de España.**
- **Semi S.A.**
- **Sthim Maquinaria S.A.**
- **Tecnatom.**
- **Tiruña S.A.**
- **Unión Eléctrica Fenosa, S.A.**
- **Westinghouse Signals Limited**

International educational activities

- Electric Energy Systems-University Enterprise Training Partneship (EES-UETP)
- Leonardo Program
- ALURE Program. CREG Project
- ALFA-FORSEE Network

EES-UETP

Electric Energy Systems University Enterprise Training Partnership

http://www.ees-uetp.org

- **Organisation:** consortium of 6 enterprises and 14 universities in 8 European countries. The Partnership began its activities in 1992 within the framework of the European COMETT Program. IIT/Upco: coordinator of the Network.
- **Objective:** to provide an advanced technical and economic basis for the interconnected European Electric Energy System.
- **Main activities:** organisation of international courses.
  1992-2001: organised 45 international courses on generation, transmission and distribution in electric energy systems; 990 participants, 252 instructors
- **Funding:** - Up to 1996 ⇒ Commet program
  - From 1996 ⇒ Annual contributions from industrial partners
  - From 2002 ⇒ Annual contributions from all partners
- **Next challenge:** **set up of an European Excellence Network (open to new partners)**

CREG/ALURE

Cooperation for the restructuring & management of electric energy systems

http://www.iit.upco.es/alure

- **Organisation:** consortium of 8 enterprises, 6 universities, 2 energy regulatory commissions and 1 research center in 8 European and Latin-American countries.

  The Partnership began its activities in 1998 within the framework of the Alure Program. IIT/Upco: coordinator of the Network.
- **Objective:** to promote the cooperation between European and Latin - American partners, in order to restructure and improve the Electric Systems management on the new deregulated scenario.
- **Main Activities:** organization of advanced international courses in Latin-America within the electric field. 1999-2002: 12 courses (Colombia, Mexico, Chile, Brazil & Argentina), 450 participants, 114 instructors.
- **Financiación:** Alure European Program (Economic Cooperation between Latin America and Europe in the Energetic Field).

ALFA/FORSEE

Latin America - Europe Association for Electric Energy Systems Training

http://www.iit.upco.es/alfa/alfa.html

- **Organisation:** network of 5 European and 10 Latin-American universities working in training and research in electric energy systems.

  It began its activities in 1996 within the framework of the Alfa Program. IIT/Upco: coordinator of the Network.
- **Objective:** to create a Postgraduate Course Programme in Operation and Economics of Electric Power Systems to be implemented in those

  Latin-American universities not offering such a programme.
- **Main Activities:** academic meetings, platform for research and training projects (CREG) and mobility activities.
- **Financiación:** Alfa European Program

LEONARDO/GOYA

Leonardo da Vinci Program: Goya project

http://www.upco.es/becasgoya

- **Organisation:** The Universidad Pontificia Comillas de Madrid is the institution in charge of promoting this project along with 11 Universities from the region of Madrid participating in the program.
- **Objective:** To offer to university students from the region of Madrid the opportunity to undertake a training period in European companies.

  There are 350 grants available. The length of the training period is 3 months.

  The grants addressed students that are currently taking university studies or doctorate in Universities in the region of Madrid participating in the Goya-Leonardo Project.
- **Support:** The Project is co-financed by Leonardo Da Vinci Agency and the Education Department of the Regional Government of Madrid.