SUPPLEMENTARY AGREEMENT TO THE GENERAL AGREEMENT BETWEEN THE UNIVERSITY OF DELAWARE AND THE UNIVERSIDAD INDUSTRIAL DE SANTANDER

DUAL Ph.D. DEGREE PROGRAM

between

The College of Engineering
Department of Electrical and Computer Engineering (DECE)
Newark, Delaware, U.S.A

and

La Facultad de Ingenierías Físicomecánicas
Escuela de Ingenierías Eléctrica, Electrónica y de Telecomunicaciones (E3T)
Bucaramanga, Santander, Colombia

Underlying Principles and Aims

The University of Delaware (UD) and the Universidad Industrial de Santander (UIS) based on their previous graduate programs experiences, considering an analysis of their engineering curricula and with the purpose of facilitating student exchange, AGREE to expand the cooperation between them by creating a Dual Ph.D. Degree Program (DPhDDP) in Electrical and Computer Engineering (ECE).

Thus, the present agreement describes the academic and administrative conditions concerning the realization of the dual degree program between UD, Department of Electrical and Computer Engineering, and UIS, Escuela de Ingenierías Eléctrica, Electrónica y de Telecomunicaciones (E3T).

The aim of the present agreement is to provide qualified students a joint graduate education program so that upon program completion, they can simultaneously receive a Ph.D. Degree from the Department of Electrical and Computer at UD and from the Escuela de Ingenierías Eléctrica, Electrónica y de Telecomunicaciones at UIS.

Present Status

The University of Delaware (UD) offers a Ph.D. Degree Program in Electrical and Computer Engineering with coursework and research conducted on UD main campus. The UD program has sufficient access to required facilities for conducting basic and applied research in electrical and computer engineering, and an adequate faculty for mentoring graduate student research.

The Universidad Industrial de Santander (UIS) offers a Ph.D. Degree Program in Engineering in the areas of Electrical, Electronics and Technological Management, on UIS main campus. Enrollment has been steady and students in the program receive a solid base of course work.

This agreement encompasses mutual understanding between universities and acceptance of the terms for the DPhDDP in ECE between the Department of Electrical and Computer
his/her concentration. **Oral Component.** The oral component consists of a closed question and answer session. Questions may cover foundation course material and current research topics in the student's area of concentration.

- **Research and Study Program:** Students must submit a Research and Study Program (RSP) prior to taking the Qualifying Examination. The RSP details: (1) all courses taken by the student, (2) all future courses planned to be taken in fulfilment of the degree requirements, (3) an abstract of the research to be undertaken in fulfilment of the degree requirements, and (4) a list of the individuals that have agreed to serve on the student's dissertation committee.

- **Ph.D. Committee:** For both modalities the Ph.D. committee consists of at least four individuals. The committee is chaired by the student's faculty research advisor and must include at least two additional faculty members from DECE at UD.

- Applicants in both modalities should have a BS in electrical or computer engineering, or a related field, such as math, physics, or computer science. They are expected to have combined verbal and math GRE scores in excess of 1050, with a mathematics score in excess of 600. (Applicants in modality 1 with low verbal scores will be considered if the applicant's TOEFL score is acceptable and quantitative GRE score is high.) Applicants in modality 1, that have not graduated from a US institution must have minimum TOEFL scores of 550/213/79 (papers/computer examination/IBET) for admission and 600/250/100 for consideration as a Teaching Assistant (TA).

- Students in modality 1 who do not pass their Qualifying Examination or whose Research and Study Program is not approved, can continue as regular students of the PhD program in engineering at UIS and their stay at UD can be considered as research stay by UIS if it has lasted at least one academic semester. In this case a PhD degree in Engineering will be awarded by UIS if all doctoral requirements from UIS are accomplished.

- For both modalities, the coursework requirements for completing the Dual Ph.D. Grade will be those of DECE at UD:
  - Candidates are required to complete one continuous academic year of full-time study at UD.
  - Candidates must complete the UD course requirements for the thesis master's degree, or have been awarded a master's degree in electrical or computer engineering, or a closely related field.
  - Candidates must take at least two foundation courses outside their area of concentration in DECE.
  - Candidates must take at least 9 credits of Doctoral Dissertation (ELEG 969) at UD.

- **Research Program and Dissertation.** Following formal admission to candidacy, students must complete: **Pre-Dissertation Examination:** The pre-dissertation examination is an in-depth written document and presentation of the student's thesis proposal to members of his/her committee. **Ph.D. Dissertation:** Candidates must carry out a program of substantial original research on a topic agreed upon by his/her committee and the Departmental Graduate Committee of DECE at UD. **Final Oral Examination:** In the final oral examination, the student presents the results of his/her dissertation research to members of the faculty of DECE at UD.
After students complete at least their first two academic semesters, DECE-UD will send to E³T-UIS, a ranked list of interested students.

The E³T at UIS will select students to be incorporated into one of the areas of its Ph.D. program in engineering offered: Electrical, Electronics or Technological Management, in order to complete the Dual Ph.D. Degree Program. Selection process will be based on the UD ranking and standard graduate admissions criteria. Student should choose the area of the UIS Ph.D. program where they will be incorporated according to the topic of their Ph.D. thesis work.

Students can be accepted into E³T at UIS in a conditional status. These students must take courses offered by Languages Institute at UIS in order to accomplish Spanish admission requirements for a Ph.D. Program of E³T at UIS. Payments of courses will be the responsibility of the student and/or the supporting institution.

No later than the end of their third semester, students can apply for the Dual Ph.D. Degree Program. Applications will be evaluated first by the home institution and then presented to the partner institution (which will become the student's host institution) for review and approval.

Financial Support

Both UD and UIS will make their best efforts to obtain financial support for DPhDDP students from supporting institutions. Resources may include funds from other Colombian universities and other Colombian institutions such as Colciencias and ICETEX, from the College of Engineering and the Department of Electrical and Computer Engineering at UD and from US external research funds, such as the National Science Foundation or and private sector sponsors.

1. Both institutions will make their best effort to find funding opportunities for students enrolled at UD. Opportunities to be explored include encouraging students to work with faculty of UD or externally supported research and/or obtaining economical support for students from Colombian fellowships.

2. Students or their supporting institutions will pay for tuition and fees at the institution where they earn their credits.

3. Both institutions can require payment of local fees for their students.

4. Students or their supporting institutions will cover payments for appropriate visas to study in Colombia or the United States, housing, international transportation, health insurance and living expenses while they are abroad.

Program Directors

Each partner unit will designate a faculty member to be in charge of DPhDDP. At moment of signing this Supplementary Agreement, the two program directors are: Professor Gonzalo R. Arce at the Department of Electrical and Computer Engineering at UD; Professor Rodolfo Villamizar Mejía at the Escuela de Ingenierías Eléctrica, Electrónica y de Telecomunicaciones-E³T at UIS. The respective unit heads may designate alternative faculty at their discretion and in coordination with each university's principal point of contact.
Both parties agree to work cooperatively toward commercialization of the Intellectual Property.

Signatures for the Institutions
For the University of Delaware

_____________________________  Date: __________
Dr. Batunde A. Ogunnaike
Interim Dean

_____________________________  Date: __________
Dr. Kenneth E. Barner
Department Chair

For the Universidad Industrial de Santander

_____________________________  Date: __________
Dr. Adolfo León Arenas-Landínez
Decano

_____________________________  Date: __________
Dr. Ruben Darío Cruz-Rodríguez
Director de la E³T
## Relationship of Transferable Courses

**Supplementary Agreement to the General Agreement Between the University of Delaware and the Universidad Industrial de Santander**

<table>
<thead>
<tr>
<th>COURSES</th>
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<tbody>
<tr>
<td>Department of Electrical and Computer Engineering University of Delaware</td>
<td>Escuela de Ingenierías Eléctrica, Electrónica y de Telecomunicaciones Universidad Industrial de Santander</td>
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### Foundation

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>ELEG 652</td>
<td>Principles of Parallel Computer Architectures</td>
<td>Provides an introduction to the principles of parallel computer architecture. Begins at a level that assumes experience in introductory undergraduate courses such as digital system design, computer architecture, and microprocessor based systems.</td>
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| 24287       | Arquitectura de Computadores                      | **Computer Architecture**  
| ELEG 651    | Computer Networking Communications                 | Presents basic concepts in computer network analysis and design. Emphasizes generic principles developed over the last two decades in the specification, implementation and evaluation of modern computer networks and networking systems. |
| 24653       | Redes de Computadores I                           | **Computer Networks I**  
Generalities, Application level, Transport level, Network level, Data connection level, Physical Level. |
| ELEG 635    | Digital Communications                            | The theory and applications of digital communications including modulation, pulse shaping, and optimum receiver design for additive, white gaussian noise and bandlimited channels. PREREQ: Undergraduate course in probability, signals and linear systems. |
| 24662       | Comunicaciones Digitales                          | **Digital Communications**  
| ELEG 633    | Digital Signal Processing                         | Theory of discrete-time signals and systems with emphasis on the frequency domain description of digital filtering and discrete spectrum analysis, fast Fourier transform, z-transform, digital filter design, relationship to analog signal processing. PREREQ: ELEG305 |
| 24271       | Procesamiento Digital de Señales                  | **Digital Signal Processing**  
Introduction to DSP, Z Transform conceptual revision, Frequency Domain Analysis for signals and systems, Discrete Fourier Transform (DFT), Efficient computation of DFT, Signal Sampling and rebuilding, Discrete systems implementation on time domain, Digital Filters Design, Multi rate digital signal processing, Wavelet Transform Analysis: Introduction |
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<tr>
<td>ELEG 633: Image Processing</td>
<td>Procesamiento Digital de Imágenes</td>
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<tr>
<td>Review of concepts of linear systems and spectral analysis, human visual response, scanning and display of images, Fourier optics, image enhancement and feature extraction, design of digital filters for image processing, 2D fast Fourier transform algorithms and computed tomography.</td>
<td><em>Digital Image Processing</em></td>
</tr>
<tr>
<td>ELEG 650: Semiconductor Device Design and Fabrication</td>
<td><strong>24284 Diseño Avanzado de Circuitos Integrados Analógicos</strong></td>
</tr>
<tr>
<td>Instruction in design and fabrication of simple bi-polar and MOS integrated circuits. Specific topics include semiconductor device and integrated circuit design, photolithographic mask design and fabrication, photolithography, N-diffusion and P-diffusion, P-MOS, metallization, and device and integrated circuit testing.</td>
<td><em>Advanced design of Analog Integrated Circuits</em></td>
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<tr>
<td></td>
<td>Introduction and general aspects about microelectronics, fabrication and modeling of MOS transistor, reference sources, advanced design of OpAmps, commuted capacitor circuits</td>
</tr>
<tr>
<td>ELEG 812: Wireless Digital Communications</td>
<td><strong>24856 Comunicaciones Inalámbricas y Convergencia</strong></td>
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<tr>
<td>Fundamentals and current techniques in wireless digital communications, including propagation, modem design, fading countermeasures, and multiple access techniques, such as FDMA, TDMA, and CDMA.</td>
<td><em>Wireless communication and convergence</em></td>
</tr>
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<td></td>
<td>Introduction and basic concepts (frequencies reutilization, cells, roaming, frequencies sectoring), Multiplexing methods, code division multi-access (CDMA) as main SSM (Spread Spectrum Modulation) application, encoding and decod practices.</td>
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