# Università degli Studi del Sannio, Benevento, ITALY

# Doctorate Course in “Information Technologies for Engineering” (ITE)

# Corso di dottorato di ricerca in “Tecnologie dell'Informazione per l'Ingegneria”

## General presentation and study plan (Cycle XLI)

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## Reference

The PhD course in *Information Technologies for Engineering* (ITE) follows the regulations established by the University of Sannio regulations for the Ph.D. courses, published with Rectoral Decree n. 335 on March, 15, 2022: https://www.unisannio.it/sites/default/files/sito/ateneo/amministrazione/avvisi/uo-post-laurea/it/REGOLAMENTO_DI_ATENEO_IN_MATERIA_DI_DOTTORATO_DI_RICERCA_DR 335_2022.pdf

# Presentation of the course

The PhD course in *Information Technologies for Engineering* (ITE) aims at deepening theoretical and practical aspects of information technologies and applying them to develop applications in a number of domains under the guidance of experts. The course is characterized by a variety of teaching and research topics, often related to ongoing national or European research projects, promoted by the researchers of the Department of Engineering of the University of Sannio.
The PhD program aims to train researchers with a strong ability to develop information technologies and/or apply them to create innovative solutions in various fields of engineering. For this reason, the program has a strong interdisciplinary nature, encompassing both scientific-disciplinary sectors specific to information engineering as well as other sectors, particularly those related to civil and energy engineering.

# Educational Objectives

The aim of the PhD program is to train researchers with an in-depth scientific background and a research-oriented design mindset in their respective fields. The program is characterized by an interdisciplinary vision and approach to developing innovative solutions capable of ensuring high levels of effectiveness, efficiency, and sustainability.

The acquired competencies—both technical-scientific and related to the organization of research activities—will enable graduates to carry out high-level research in public institutions or private organizations.

The training will focus on the acquisition of theoretical, experimental, methodological, and technological tools, both traditional and especially innovative, to be used in modeling, design, prototyping/simulation, and experimentation in information technologies and their application to complex systems—such as computing, mechanical, energy, electrical systems, and civil works in natural or built environments.

The acquired knowledge may also allow PhD graduates to develop highly innovative start-ups. The training will be enriched by international mobility projects and research experiences—both fundamental and applied—within an integrated academic and industrial framework.

The program will also include the possibility of company internships to promote applied research in industry, healthcare, societal safety, and environmental sustainability.

The course comprises two curricula, Information Technologies and Energy and Environment.

The **Information Technologies curriculum** focuses on the study of topics related to various disciplines within information engineering. Students will be able to conduct new research in fields such as computer science and engineering, automation, electronics, measurements, electromagnetic fields, and telecommunications. Additionally, prospective students may develop new applications of information technology in other domains of engineering and science.

The **Energy and Environment curriculum** aims to train researchers capable of acquiring and developing knowledge and skills in the research areas of civil and industrial engineering. In particular, students will explore—through new approaches and methods—the development, modeling, and sustainability of transportation, hydraulic, and building infrastructures; the optimization of energy consumption, particularly in buildings; energy production, transmission, distribution, and usage systems; chemical processes; and quality assurance in industrial and manufacturing processes.

# Employment Outlook

A PhD in Information Technologies for Engineering offers a wide range of career opportunities, based on the skills acquired during the program. These include the ability to manage research activities, write high-quality scientific and technical reports, develop practical outcomes, and collaborate within national or international working groups, all supported by strong written and spoken English proficiency.

PhD graduates may pursue careers in academia as well as in public or private organizations whose products and services are related to information technologies, or that can be effectively, efficiently, and sustainably enhanced through such technologies.

Graduates will contribute to research, innovation, and technology transfer in various sectors, such as:

- Design and management of software systems, cyber-physical systems, and distributed systems;
- Application and network security;
- Modeling, simulation, and design of antennas, wired/wireless links, and microwave devices;
- Modeling and development of systems for measuring electrical quantities in telecommunications, aerospace, biomedical applications, industrial production, and civil engineering;
- Design and simulation of sensors and systems for the acquisition and processing of satellite data;
- Automation of industrial processes;
- Management and planning of electric energy resources at regional, national, and transnational levels;
- Modeling, simulation, and design of systems for energy conversion and management;

- Simulation and design of chemical plants and combustion processes;
- Modeling and analysis of complex components and innovative materials in the automotive, aerospace, railway, biomedical, telecommunications, and civil construction sectors;
- Computer-aided design of structures, infrastructures, and networks in the civil engineering field;
- Simulation of structures, systems under dynamic stress, and territorial and transportation systems.

## The Work Programme

A tutor is appointed for each student. During the first year the tutor will be one (or more) of the researchers and professors of the Department of Engineering, after whom an external scholar, approved by the school, can be added.

The course lasts 3 years during which the student must take courses, perform research, write papers (and get them published), and develop a Ph.D. thesis.

| Activity | Year | CFU | CFU/YEAR |
|---|---|---|---|
| **1st YEAR** | | | |
| Exams | Ph.D. courses | 18 | 60 |
| Research | Study/research | 40 | |
| Reporting | Final year report | 2 | |
| **2nd YEAR** | | | |
| Exams | Ph.D. courses | 6 | 60 |
| Research | Study/research | 52 | |
| Reporting | Final year report | 2 | |
| **3rd YEAR** | | | |
| Research | Study/research | 40 | 60 |
| Reporting | Thesis preparation/writing | 20 | |
| | | TOTAL | 180 |

As shown in the Table above, the study plan consists of a total of 180 CFU (credits).

Of these, 24 are related to exams, 132 related to study and research, and 24 for reporting and thesis writing.

The teaching activities specific to the Ph.D. program will be related to (1) topics specific to information engineering, including enabling technologies, empirical methods, and research methods, (2) topics related to other engineering fields. Such activities will be complemented by soft skills related to technical writing, presentation, and research organization.

Students can freely choose any course, provided that, for Masters' or Bachelors' courses, they have not previously taken them. There is no fixed prerequisite, and the students can place the courses in the first or second year at their choice.

The choice of the courses must fulfill the following criteria:

1. The English course (6 CFU) is compulsory, unless the student is native English speaker (in that case the course must be replaced by a different one) or the student has acquired an ESOL certificate at least equivalent to C1 level.
2. The course on Research Organization and Technical Writing (4 CFU) is compulsory.
3. Up to 9 CFU can be filled by courses provided by other PhD programs (e.g., other Departments or Universities), or by PhD schools, pending approval by the Doctorate Committee.
4. As for the credits specified at item 2), it is possible to choose max. 6 CFU from PhD schools and mini-courses.

It needs to be emphasized that, in all cases, *acquisition of credits requires a formal exam at the end of the course*.

A "credit" is defined as a number of hours of study (typically 25) including both class attendance and home study in a ratio of approximately 1:3. In consideration of the "high level" of the courses taught to Ph.D. students and their presumed familiarity with study method and rhythms, less class attendance is required to earn a credit, and more home study. In particular, to earn 1 credit it is necessary to attend 6 hours of lectures, followed by approximately 19 hours of study; the combination is assessed through a final exam. As a consequence, attending seminars does not provide credits *per se*.

Credits cannot be earned by attending a course taught by the PhD student's tutor.

Courses are taught in English; they may be taught in Italian if no foreign student is attending.

*Each year the student presents his/her study plan, pre-agreed with the tutor, through the Enrollment system. The study plan is then approved by the Doctorate Committee.*

A limited number of hours (no more than 40) may be devoted to activities of teaching assistantship, according to the tutor's indications. Whenever available, the University may provide scholarships for teaching assistantship and undergraduate students' tutoring. These scholarships will be assigned to

applicants based on the results of an interview.

Further hours (no more than 20) can be devoted to technological transfer activities, according to the tutor's indications.

The students will carry out their activities by leveraging the premises, equipments, and libraries provided by the University of Sannio. Wherever appropriate or required, the student can perform an internship in industry or in another university abroad.

The **research activity** is devoted to the development of research products worth publication in scientific papers in prestigious archival journals and presentation at major conferences. The contributions of the various papers produced along the course can be included in the final PhD thesis with the goal of forming a comprehensive, self-contained, and far-reaching piece of work.

Students are encouraged to spend at least 3 months at another research institution, preferably abroad, to improve their knowledge and widen their cultural horizon. During the stay, the scholarship is increased by 50%. These external periods need to be authorized in advance by the Doctorate Committee.

## Proficiency evaluation

Each year, the students' activities are evaluated by the Doctorate Committee, which decides on the admission of the student to the next year of the course or to the final exam. To this aim, a smaller panel for admission to the second or third year may be appointed by the Doctorate Committee.

For admission to the second year, students must deliver a report about the research and other activities carried out during the first year. For admission to the third year, students must deliver a 20' presentation, preferably in English, reporting not only the research and other activities, but also the thesis proposal. After the end of the third year, students submit a draft of their final thesis to two external reviewers indicated by the tutor, approved by the Coordinator, and appointed by the Rector. Reviewers are given 6-8 weeks to examine the work; they can accept or reject it or require revisions. A "major" revision may require up to 6 months of additional work and needs another review.

Students are admitted to the final exams by a panel nominated by the Doctorate Committee on the basis of:

- Their three-year curriculum,
- A 40' presentation of their work,
- The reviewers' comments.

The final version of the thesis is submitted to a Committee, appointed by the Rector, formed by 3 professors/researchers, experts in the scientific area of the thesis; no tutor of the candidate may participate in the Committee and not more than one of its members is allowed to be an "internal" professor. After a few weeks needed for examination of the thesis, the Committee gathers with the candidate to hear its formal presentation and eventually awards the degree.

At student's request, the University of Sannio may attach the label of *Doctor Europaeus* to the PhD degree when the following four conditions have been fulfilled:

1. The two external reviewers of the thesis are professors from two higher education institutions of two European countries, other than Italy;
2. At least one member of the examination Committee comes from a higher education institution in European countries, other than Italy;
3. Part of the defense must take place in one of the official European languages, other than Italian;
4. The PhD thesis has been prepared as a result of a period of research of at least one trimester spent abroad.

## Teaching support

Ph.D. students cannot formally teach a University course. However, they can perform supporting activities to the teaching (i.e., be a teaching assistant) for a maximum of 40 hours per year.

## Technological transfer ("attività di terza missione")

Ph.D. students can contribute to technological transfer activities for a maximum of 20 hours per year. Note that, according to the University regulation, paid activities are subject to authorization from the Doctorate Committee.

## Coherence with the PNRR objectives

The PhD program in *"Information Technologies for Engineering"* aims to develop research activities in collaboration with companies and public administrations on topics relevant to the National Recovery and Resilience Plan (PNRR). In particular, regarding the themes of PhD programs funded by Ministerial Decree 629 of April 24, 2024, the program intends to support research related to the topic of "public administration." Additionally, through scholarships funded by Ministerial Decree 630 of April 24, 2024, the PhD will promote *"innovative*

*doctoral programs that address the innovation needs of companies and encourage the employment of researchers by enterprises."*

The PhD program aims to address research topics that are relevant to the overarching macro-objectives and areas of intervention outlined in the PNRR, in response to the socio-economic challenges it seeks to address. These are structured according to the Plan's Missions and their thematic areas of intervention:

- Digitalization, innovation, competitiveness, and culture;
- Green revolution and ecological transition;
- Infrastructure for sustainable mobility;
- Education and research;
- Inclusion and cohesion;
- Health.

With regard to programs focused on digital and environmental transitions, the PhD program fully covers the relevant areas—particularly Area 09 (with 21 faculty members), Area 08 (6 members), and Area 01 (1 member). The educational offerings will also place significant emphasis on these themes—on the one hand, artificial intelligence and security; on the other, energy efficiency and climate change. It is also worth highlighting that the PhD includes a dedicated curriculum on *"Energy and Environment."*

The strong representation of Area 09, along with the aforementioned educational activities, makes the PhD program especially suitable for career paths related to public administration.

Thanks to the teaching activities and the specific expertise of the faculty and supervisors, the program will place particular emphasis on conducting research in line with the principles of open access to results and data, in accordance with *Open Science* and *FAIR Data* principles.

Finally, through collaborations with local companies, the PhD program aims to contribute to *"innovative doctoral paths that address the innovation needs of businesses and promote the employment of researchers by companies."* To this end, the PhD has collected expressions of interest (through letters of intent) from companies willing to co-finance scholarships under Ministerial Decree 630 of April 24, 2024.

For all PhD tracks where it is necessary and appropriate, the program will include periods of study and research in companies, public administrations, or foreign universities, made possible through partnerships with enterprises, public bodies, and international academic institutions connected to the PhD faculty.

## Admission procedure

The selection is made by an admission Committee appointed by the Doctorate Committee and is based on evidence from the following items:

- The *curriculum vitae et studiorum* of the candidate;
- The exams' transcript, with the weighted average grade. For foreigner students, it must be necessary to indicate, in the application form, the minimum and maximum grade;
- A motivation letter;
- Letters of reference;
- A copy of the M.Sc. thesis (if completed) with an abstract in English. If the thesis has not be completed, an abstract of the ongoing work is sufficient;
- Interview with the student.

The interview is based on presentation and discussion of a research project/topic chosen by the candidate, and includes an evaluation of English language skills. The interview can take place in "teleconference".

## Admission requirements

In order to be admitted to the Ph.D. course, the student must possess one of the following degrees:

Italian M.Sc. "Laurea Magistrale" or "Laurea Specialistica:

- LM-4 Architettura e ingegneria edile-architettura
- LM-6 Biologia
- LM-7 Biotecnologie agrarie
- LM-8 Biotecnologie industriali
- LM-9 Biotecnologie mediche, veterinarie e farmaceutiche
- LM-17 Fisica
- LM-18 Informatica
- LM-20 Ingegneria aerospaziale e astronautica
- LM-21 Ingegneria biomedica
- LM-22 Ingegneria chimica
- LM-23 Ingegneria civile
- LM-24 Ingegneria dei sistemi edilizi
- LM-25 Ingegneria dell'automazione
- LM-26 Ingegneria della sicurezza
- LM-27 Ingegneria delle telecomunicazioni
- LM-28 Ingegneria elettrica
- LM-29 Ingegneria elettronica

- LM-30 Ingegneria energetica e nucleare
- LM-31 Ingegneria gestionale
- LM-32 Ingegneria informatica
- LM-33 Ingegneria meccanica
- LM-34 Ingegneria navale
- LM-35 Ingegneria per l'ambiente e il territorio
- LM-40 Matematica
- LM-44 Modellistica matematico-fisica per l'ingegneria
- LM-53 Scienza e ingegneria dei materiali
- LM-54 Scienze chimiche
- LM-66 Sicurezza informatica
- LM-91 Tecniche e metodi per la societa dell'informazione
- 4/S (specialistiche in architettura e ingegneria edile)
- 20/S (specialistiche in fisica)
- 23/S (specialistiche in informatica)
- 25/S (specialistiche in ingegneria aerospaziale e astronautica)
- 26/S (specialistiche in ingegneria biomedica)
- 27/S (specialistiche in ingegneria chimica)
- 28/S (specialistiche in ingegneria civile)
- 29/S (specialistiche in ingegneria dell'automazione)
- 30/S (specialistiche in ingegneria delle telecomunicazioni)
- 31/S (specialistiche in ingegneria elettrica)
- 32/S (specialistiche in ingegneria elettronica)
- 33/S (specialistiche in ingegneria energetica e nucleare)
- 34/S (specialistiche in ingegneria gestionale)
- 35/S (specialistiche in ingegneria informatica)
- 36/S (specialistiche in ingegneria meccanica)
- 37/S (specialistiche in ingegneria navale)
- 38/S (specialistiche in ingegneria per l'ambiente e il territorio)
- 45/S (specialistiche in matematica)
- 50/S (specialistiche in modellistica matematico-fisica per l'ingegneria)
- 61/S (specialistiche in scienza e ingegneria dei materiali)
- 62/S (specialistiche in scienze chimiche)
- 100/S (specialistiche in tecniche e metodi per la società dell'informazione)

Degrees earned before D.M. 509/99 and equivalent to the above ones are also admitted.

For foreign students: Master degree or equivalent degree in Computer Science, Biomedical Engineering, Electrical Engineering, Computer Engineering, Software Engineering, Mechanical Engineering, Civil Engineering, Chemical Engineering, Energy Engineering, Aerospace Engineering, Mathematics, Physics, Material Science

**Note:** when applying, the student must at least possess a Bachelor’s Degree (Laurea Triennale). However, in order to enroll to the Ph.D. program, the M.Sc. must be earned by October 31 of the year (2025 for the 41th cycle).