POLITECNICO DI MILANO

PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 39th cycle

Research Area n. 2 - Electronics

Number of scholarship offered	5
Department	DIPARTIMENTO DI ELETTRONICA, INFORMAZIONE E BIOINGEGNERIA

Description of the Research Area

The Area Electronics of the PhD Programme in Information Technology at the Department of Electronics, Information and Bioengineering (DEIB) carries out research and teaching activity in the various fields of Electronics. It originates from the activity of Emilio Gatti, who was called to cover the first full professor chair of Electronics established in Italy at the Politecnico di Milano in 1957. The reseach area currently has 11 full professors, 11 associate professors, 5 assistant professors, 61 students of the Ph.D. curriculum and about 13 contract researchers and post-doc appointees. An essential characteristic feature of the research in electronics is the imprinting given by Emilio Gatti: always challenge the research issues by facing the objective data coming from the experimental facts. Such attitude is necessary for detecting the problems to be solved and discovering the keys for the solution, for evaluating with critical mind any conjecture and solution devised. It is mandatory for staying competitive at international level in the development of electronic, microelectronic and optoelectronic technologies and their applications. Therefore, it is necessary to own significant experimental facilities and maintain them updated. This constitutes an important commitment in terms of cost, space for laboratories and working time of staff. This approach represents a distinguishing element, which implies specific operating modes and requirements that characterize the Electronics research areas. In the research activity, developments in the science and technology of electronic, microelectronic and optoelectronic devices, circuits and systems give rise and support to new developments in diversified fields of interest for the present-day society. Besides, aiming to typical themes of the ICT (Information and Communication Technology), the research work looks to other developments, such as application of nanoelectronic and diagnostic technologies to genetics and biomedicine, diagnostics of cultural heritage and astrophysics applications. The research framework is naturally dynamical, and it evolves continuously driven by prospects and new initiatives. The Research area in Electronics is organized in Research Lines as follows:

•**Circuit and System Theory and Applications**, which deals with models of circuit parasitic phenomena and numerical methods for circuit analysis.

•**Sensors and Instrumentation**, which deals with the development of advanced detectors for optical and ionizing radiation and of the related electronic systems, addressing applications in various fields that range from life sciences to space research.

•**Microelectronics and Emerging Technologies**, which is devoted to the design of integrated circuits for radio-frequency transceivers and power management, the characterization and modelling of non-volatile memories, and the investigation of electronic properties at the nanoscale and organic semiconductor devices.

Research lines in Electronics share a service for fast PCB prototyping and ad-hoc instrumentation development, bonders and a wafer scriber for device/sample preparation, safety cabinets for chemical handling. In addition to the computer rooms dedicated to integrated circuits CAD and/or devices simulations, labs are dedicated to specific research lines.

Further information:
- Research at the DEIB Department: https://www.deib.polimi.it/eng/
- PhD Programme in Information Technology (IT PhD): https://dottoratoit.deib.polimi.it/
- Electronics Section at DEIB: https://www.deib.polimi.it/eng/electronics

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Research Area n. 2 - Electronics

THEMATIC Research Field: DESIGN AND TESTING OF IN-MEMORY COMPUTING CIRCUITS (PROGETTAZIONE E MISURA DI CIRCUITI DI CALCOLO IN MEMORIA)

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	In-memory computing allows for high parallelism and reduced memory access, thus improving the speed and energy efficiency for data intensive tasks. This project aims at the design of novel analogue circuits capable of accelerating machine learning by matrix vector multiplication in memory arrays. Circuit testing by accurate memory programming will allow for experimental validation and benchmarking with conventional digital circuits.
Methods and techniques that will be developed and used to carry out the research	The activity will consist of the design of circuit for in-memory computing to accelerate linear algebra and machine learning. The methodology includes theoretical study, analogue/digital integrated circuit design and experimental testing of the developed chip to assess the accuracy, performance and energy efficiency of the novel circuits.
Educational objectives	The doctorate activity will include attendance of academic courses, conferences, summer schools and workshops for the training of the student on the topics relevant for the research (clean room fabrication techniques, neuromorphic computing, device physics).
Job opportunities	The competence developed during the doctorate studies

	will enable access to job positions in device engineering and integrated circuit development.
Composition of the research group	1 Full Professors 0 Associated Professors 0 Assistant Professors 10 PhD Students
Name of the research directors	Prof. Daniele Ielmini

Contacts
Prof. Daniele Ielmini daniele.ielmini@polimi.it phone 02 2399 6120 http://home.deib.polimi.it/ielmini/

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The PhD student will have access to a clean room facility after proper training. The PhD student will also have access to the electrical and numerical lab, where he/she will have a desk and a computer available to carry out the research project.

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Research Area n. 2 - Electronics

OPEN SUBJECT Research Field: ELECTRONICS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	In the research activity, developments carried out in electronic, microelectronic, and optoelectronic devices, circuits, and systems find use in a variety of topics of interest in today's society. Beside typical themes of the ICT (Information and Communication Technology), the research work looks to other developments, such as application of nanoelectronic and diagnostic technologies to genetics and biomedicine, diagnostics of cultural heritage and analysis of materials. The research framework is naturally dynamical and it evolves continuously driven by prospects and new initiatives. http://www.deib.polimi.it/eng/electronics
Methods and techniques that will be developed and used to carry out the research	The research is carried out typically within a research group under the guidance of a supervisor. The activity is frequently carried out in international collaborations as well as in a interdisciplinary framework. Laboratory activity is usually part of the research workplan.
Educational objectives	The doctoral program offers advanced training in the hot topics explored by the scientific community and industry. A period of study within one foreign research institution is encouraged and financially supported by the doctoral school.

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	http://dottoratoit.deib.polimi.it/
Job opportunities	Careers in the leading electronics companies are facilitated by the strong connection between the academic and industrial research. Post doc positions in the university are frequently offered.
Composition of the research group	11 Full Professors 11 Associated Professors 5 Assistant Professors 61 PhD Students
Name of the research directors	Any faculty member can act as research director

Contacts
Prof. Angelo Geraci Coordinator of the Electronics area E-mail: angelo.geraci@polimi.it Phone: +39 02 2399 6095 Web: https://www.deib.polimi.it/eng/people/details/212366 Prof. Luigi Piroddi Coordinator of the Ph.D. IT Programme E-mail: luigi.piroddi@polimi.it Phone: +39 02 2399 3556 Web: https://www.deib.polimi.it/eng/people/details/318548

Additional support - Financial aid per PhD student per year (gross amount)			
	1st year	**2nd year**	**3rd year**
Housing - Foreign Students	1500.0 € per student	1000.0 € per student	1000.0 € per student
	max number of financial aid available: 2, given in order of merit ..		
Housing - Out-of-town residents (more than 80Km out of Milano)	--		

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student. 5.707,20 Euro per student

TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student

There are various forms of financial aid for activities of support to the teaching practice.

The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

COMPUTER AVAILABILITY:
1st year: Yes
2nd year: Yes
3rd year: Yes

DESK AVAILABILITY:
1st year: Yes
2nd year: Yes
3rd year: Yes

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Research Area n. 2 - Electronics

THEMATIC Research Field: PROGRAMMING ALGORITHMS OF NONVOLATILE MEMORIES FOR IN-MEMORY COMPUTING (ALGORITMI DI PROGRAMMAZIONE MEMORIE NON VOLATILI NEL CALCOLO IN MEMORIA)

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	A key issue with in-memory computing circuits is the requirement for high-precision memory devices to enable accurate on-chip machine learning. This project will aim at the development of programming algorithms for nonvolatile memory devices characterized by low energy consumption, fast execution and high precision.
Methods and techniques that will be developed and used to carry out the research	The activity will consist of the development of programming algorithms for nonvolatile memory devices, such as charge-trap memory and resistive switching memory. The algorithm include program, verify and bit slicing methodology. The algorithms will enable fast, precise and low-energy programming for accurate in-memory computing.
Educational objectives	The doctorate activity will include attendance of academic courses, conferences, summer schools and workshops for the training of the student on the topics relevant for the research (clean room fabrication techniques, neuromorphic computing, device physics).
Job opportunities	The competence developed during the doctorate studies will enable access to job positions in device engineering and integrated circuit development.

	and integrated circuit development.
Composition of the research group	1 Full Professors 0 Associated Professors 0 Assistant Professors 10 PhD Students
Name of the research directors	Prof. Daniele Ielmini

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
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Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The PhD student will have access to a clean room facility after proper training. The PhD student will also have access to the electrical and numerical lab, where he/she will have a desk and a computer available to carry out the research project.