Master of Science in Nanotechnology Engineering

Class LM 53 Materials Science and Engineering

International Strand

First year course A.Y. 2023-24

Second year course A.Y. 2024-25

The Master of Science in Nanotechnology Engineering is organized into two alternative strands:

- strand A: with most of the courses taught in Italian
- strand B: for foreign students, with all the courses taught in English

Strand A includes:

I. 6 mandatory (code B) courses (57 CFU in total) to be selected among the ones listed in table A.I

II. 2 courses (12 CFU) to be selected among the ones (code B) listed in table A.II

III. 1 course (9 CFU) to be selected among the ones (code C) listed in table A.III

IV. 2 completion courses (12 CFU in total) to be selected among the ones (code C) listed in table A.IV

Strand B includes:

I. 7 mandatory (code B) courses (66 CFU in total) to be selected among the ones listed in table B.I

II. 1 course (6 CFU) to be selected among the ones (code B) listed in table B.II

III. 1 course (6 CFU) to be selected among the ones (code C) listed in table B.III

IV. 2 completion courses (12 CFU in total) to be selected among the ones (code C) listed in table B.IV

The study plan must be completed (120 CFU in total) with:

V. 2 free-choice courses (12 CFU in total) – code D

VI. Thesis defense (corresponding to 17 CFU) – code E

VII. Other activities aimed at preparing students for careers after graduation (1 CFU) – code F

Some related courses are joined together in an UDI (see below for details).

With reference to point VII), the eligible activities must be approved by the Area Council and certified by the President of Area Council or by delegated professors.

In order to guarantee the maximum flexibility, an individual study plan can be presented for approval. The individual study plan should be prepared according to the guide reported in the

following. The students presenting an individual study plan that is not compliant with the indications reported in the guide are required to integrate it with a motivation letter in order to justify the personal choices. The Area Council reserves the right to approve or reject the plan. At any rate, the individual study plan must be compliant with the above set of rules, from point I) to VII).

1.1.1 STRAND B (International students)

Legend for tables B.I – B.IV

Lang: IT (course in italian); ENG (course in english).
Type (course category): CR (standard course); CL (laboratory course)
Val (type of evaluation): E (final exam with grading out of 30); V (pass-fail grade).
TAF (Type of Educational Activity): B (core educational activity); C (educational activity in elective/similar or supplementary disciplines); D (free-choice); E (thesis defense); F (other educational activities).

Table B.I *– Mandatory courses for strand B*

	Course	CFU	Sem.	SSD	Lang.	Type	Val	TAF
1	Chemistry for Nanotechnology	9	I	CHIM/07	ENG	CR	E	B
2	*Modern Physics for Nanotechnology (UDI: 12 CFU))*							
	Elements of quantum mechanics	6	I	FIS/01	ENG	CR	E	B
	Elements of condensed matter physics	6	I	FIS/03	ENG	CR	E	B
3	*Surface Engineering and Nanostructured Materials (UDI: 12 CFU)*							
	Nanostructured materials	6	II	ING- IND/22	ENG	CR	E	B
	Surface Engineering	6	II	ING- IND/22	ENG	CR	E	B
4	Continuum Mechanics	6	I	ICAR/08	ENG	CR	E	B
5	*Electron microscopies and related techniques (UDI: 9 CFU)*							
	Electron microscopies	6	II	FIS/01	ENG	CR	E	B
	Scanning probe microscopy	3	II	FIS/01	ENG	CR	E	B
6	Micro-nanofluidics	9	III	ING- IND/06	ENG	CR	E	B
7	*Micro-nano devices and materials for electrical/electromagnetic applications and fundamentals (UDI: 9 CFU)*							
	Fundamentals of micro-nano devices and materials for electrical/ electromagnetic applications	3	III	ING- IND/31	ENG	CR	E	B
	Micro-nano devices and materials for electrical-electromagnetic applications	6	III	ING- IND/31	ENG	CR	E	B

Table B.II *– Course to be chosen for strand B*

	Course	CFU	Sem.	SSD	Lang.	Type	Val	TAF
8	Transport Phenomena in Microsystems and Micro-Nano Reactive Devices	6	II	ING-IND/24	ENG	CR	E	B
	Physical metallurgy of innovative nano-structured materials	6	III	ING- IND/21	ENG	CR	E	B
	Additive manufacturing and Laser texturing	6	III	ING-IND/16	ENG	CR	E	B

Table B.III *– Course to be chosen for strand B*

	Course	CFU	Sem.	SSD	Lang.	Type	Val	TAF
9	Semiconductor devices	6	III	ING- INF/01	ENG	CR	E	C
	Artificial materials, metamaterials and plasmonics for electromagnetic applications	6	III	ING- INF/02	ENG	CR	E	C
	Optoelectronics	6	III	ING-INF/01	ENG	CR	E	C

Table B.IV *– Completion courses for strand B*

	Course	CFU	Sem.	SSD	Lang.	Type	Val	TAF
10 e 11	Sensors and electrical/electromagnetic characterization laboratory	6	IV	ING- IND/31	ENG	CR	E	C
	Laboratory of Electrorheology	6	III	ING- IND/31	ENG	CR	E	C
	Laboratories of Atomistic and Micro-Nano- Fluidics Simulations (UDI: 6 CFU)							
	Atomistic Simulations Laboratory	3	IV	FIS/01	ENG	CR	E	C
	Micro-Nano Fluidic Simulations Laboratory	3	IV	ING- IND/06	ENG	CR	E	C
	Nanoelectronics Laboratory (UDI: 6 CFU)							
	Nanoelectronics device characterization	3	IV	ING-INF/01	ENG	CR	E	C
	Nanoelectronics Laboratory	3	IV	ING-INF/01	ENG	CR	E	C
	Biophotonics Laboratory	6	III	FIS/01	ENG	CR	E	C
	Microelectromechanical systems	6	IV	ING- INF/01	ENG	CR	E	C
	Dynamics of micro-mechatronic systems	6	III	ING- IND/13	ENG	CR	E	C
	Optics	6	II	FIS/01	ENG	CR	E	C
	LASER Fundamentals	6	IV	FIS/01	ENG	CR	E	C
	Macromolecular Structures	6	I	BIO/10	ENG	CR	E	C
	Principles of Biochemical Engineering	6	II	ING- IND/24	ENG	CR	E	C
	Electromagnetic Fields and Nanosystems for Biomedical Applications	6	III	ING-INF/02	ENG	CR	E	C
	Molecular Dynamics and Atomistic Simulations (UDI: 6 CFU)							
	Statistical mechanics and Monte Carlo techniques	3	III	FIS/01	ENG	CR	E	C
	Classical molecular dynamics	3	III	FIS/01	ENG	CR	E	C
	Nanobiotechnology	6	III	ING- IND/25	ENG	CR	E	C

1.1.2 Guide to the compilation of the individual study plan – STRAND B (international students)

The student must submit the Individual Study Plan by the deadline set by the teaching secretariat. Furthermore, the student is required to submit it before taking any non-mandatory exam. Students can only submit a single Study Plan per Academic Year. The study plan should include 9 mandatory exams (78 CFU) reported in the Table B.I and B.II.

The study plan must be completed by indicating a number of courses chosen for a total of 24 credits (CFU). In particular:

- the student can include any courses given in the University for a maximum of 12 credits;
- the student must include a number of courses, among those in the lists L1E and L2E, for a minimum amount of 12 credits.

To complete a curriculum coherent with the educational objectives of the Degree Course, the Nanotechnology Engineering Area Council recommends choosing the above courses within the suggested thematic groups (G1, G2, G3). With the aim to complete the student's cultural and technological education, the Nanotechnology Engineering Area Council also suggests:

- to choose at least 2 courses (for a minimum of 12 credits) belonging to the same Thematic Groups (G1, G2, G3) from L1E and L2E lists.

- verify that at least 2 applicative/experimental courses (for a minimum of 12 credits) are included in the study plan among those listed in the L1E.

Some courses, due to their contents, fall into more than one thematic group.

If the student wants to choose, for 12 credits, among the free-choice exams courses provided in other degree courses, it is suggested to first contact the teachers of the courses, in order to verify to have the necessary prerequisites, verify the year and semester of course delivery and the absence of substantial program overlaps with other courses already included in their study plan.

Students are recommended to attend courses respecting the chronological order in which they are taught throughout the academic year.

1.1.2.1 Thematic groups

G1: Modelling and Design

- Sensors and electrical/electromagnetic characterization laboratory
- Laboratory of Electrorheology
- Laboratories of Atomistic and Micro-Nano- Fluidics Simulations (UDI)
- Dynamics of micro-mechatronic systems
- Molecular Dynamics and Atomistic Simulations (UDI)
- Nanobiotechnology
- Microelectromechanical systems

G2: Optics and Electronics

- Nanoelectronics Laboratory (UDI)
- Biophotonics Laboratory
- Optics
- LASER Fundamentals
- Molecular Dynamics and Atomistic Simulations (UDI)
- Microelectromechanical systems

G3: Biotechnology

- Laboratories of Atomistic and Micro-Nano-Fluidics Simulations
- Biophotonics Laboratory
- Macromolecular Structures
- Principles of Biochemical Engineering
- Nanobiotechnology
- Electromagnetic Fields and Nanosystems for Biomedical Applications
- Molecular Dynamics and Atomistic Simulations (UDI)

APPLICATIVE/EXPERIMENTAL COURSES (L1E List)					
Subject		**CFU**	**SSD**	**Lang.**	**Group**
Sensors and electrical/electromagnetic characterization laboratory		6	ING-IND/31	ENG	**G1**
Laboratory of Electrorheology		6	ING-IND/31	ENG	**G1**
UDI (6 CFU): Laboratories of Atomistic and Micro- Nano-Fluidics Simulations	Atomistic Simulations Laboratory	3	FIS/01	ENG	**G1, G3**
	Micro/Nano Fluidic Simulations Laboratory	3	ING-IND/06		
UDI (6 CFU): Nanoelectronics Laboratory	Nanoelectronics device characterization	3	ING-INF/01	ENG	**G2**
	Nanoelectronics Laboratory	3	ING-INF/01		
Biophotonics Laboratory		6	FIS/01	ENG	**G2, G3**
COURSES (L2E List)					
Subject		**CFU**	**SSD**	**Lang.**	**Group**
Dynamics of micro-mechatronic systems		6	ING-IND/13	ENG	**G1**
Optics		6	FIS/01	ENG	**G2**
LASER Fundamentals		6	FIS/01	ENG	**G2**
Macromolecular Structures		6	BIO/10	ENG	**G3**
Principles of Biochemical Engineering		6	ING-IND/24	ENG	**G3**
Nanobiotechnology		6	ING-IND/25	ENG	**G1, G3**
Electromagnetic Fields and Nanosystems for Biomedical Applications		3	ING-INF/02	ENG	**G3**
Microelectromechanical systems		6	ING-INF/01	ENG	**G1, G2**

UDI (6 CFU): Molecular Dynamics and Atomistic Simulations	Statistical mechanics and Monte Carlo techniques	3	FIS/01	ENG	**G1, G2, G3**
	Classical molecular dynamics	3	FIS/01		